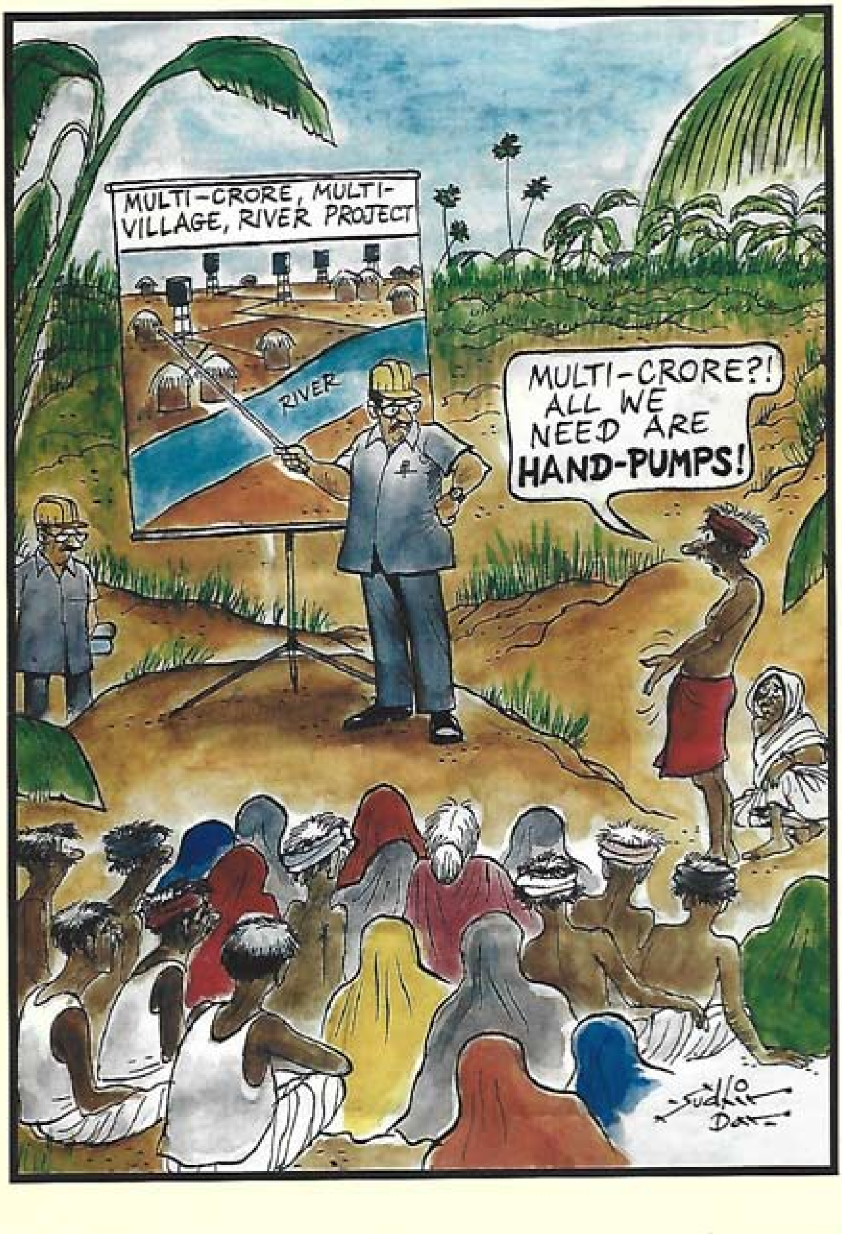
LARGE DAMS IN INDIA

ENVIRONMENTAL, SOCIAL & ECONOMIC IMPACTS



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This book is dedicated to the memory of
late Dr. S. Maudgal
formerly Senior Advisor to the Ministry of Environment and Forests, Government of India.

His honesty, his courage, and his concern for the environment and for social justice will always inspire all those within and outside the government who are fighting for a better world

PREFACE

This publication is an effort to make available, to a wider audience, the two reports prepared for the World Commission on Dams (WCD) by the Indian Institute of Public Administration, one on the financial, economic and distributional aspects, and the other on the environmental and social impacts, of large dams in India. These reports were a part of the larger *India Country Study* that was commissioned by the WCD. The *India Country Study*, as submitted to the WCD, contained summaries of these two IIPA reports along with the following chapters:

- Large Dams in India: A Historical Review by R.Rangachari
- Dams in India: A Brief Review by Nirmal SenguptaLarge
- Dam Projects: The Framework of Laws, Policies, Institutions and Procedures by Ramaswamy R. Iyer
- Assessment of Options by Nirmal Sengupta

The *India Country Study* also contained a final chapter, which was the only chapter in the report that all the authors jointly wrote. This chapter, titled "Some Agreed Conclusions", has also been included in this publication.

In reading these reports, it must be kept in mind that only about four months were available to write them from scratch. Consequently, only secondary data that became available during that time frame could be used. There was no opportunity to collect primary data.

The *India Country Study* has been published by the WCD and distributed to a wide audience. However, only the summaries of the reports on the financial, economic, and distributional aspects of dams, and on their environmental and social impacts, were included in this publication. It was, therefore, thought necessary to compile and publish the full reports so that they also become available to the public.

In doing this study, the authors have gained much from numerous discussions with experts and other concerned people within and outside the government. In particular, the two stakeholder workshops, one in Chennai and the other in New Delhi, provided an invaluable opportunity to discuss an earlier draft of the report. The authors also gratefully acknowledge the help of various government institutions and NGOs, who provided data and documents.

In writing this report, the authors have received assistance and encouragement from many persons. Though it might not be possible to name all of them here, we would like to acknowledge our debt to the Bombay Environmental Action Group, especially Mr. Shyam Chainani, who very kindly made available a wealth of documents. We would also like to thank Dr. N.C. Saxena, Secretary, Planning

Commission, for allowing us access to the data in the Planning Commission. We would like to thank Mr. A.D. Mohile and Mr. M. Gopalakrishnan of the Central water Commission for making available to us various documents of the CWC and for sending us detailed comments on our earlier draft.

We are particularly grateful to Mr. L.C. Jain, Mr. Harsh Mander, the late Dr. S. Maudgal, Mr. Himanshu Thakkar, Ms. Medha Patkar, Mr. Bharat Dogra, Ms. Enakshi Thukral, and Prof Nand Dhameja for many very useful comments on our earlier drafts. Many other people have sent in their comments or otherwise helped us in this work, including a number of officers of the irrigation bureaucracy, and we are very grateful to all of them even if it is not possible to name them here.

Our colleagues in this endeavour, especially Prof. S Parasuraman, Mr. R. Rangachari, Prof. Nirmal Sengupta, and Mr. Ramaswamy Iyer have all very kindly shared with us their comments and views.

The editors and authors also thank Jitendra Vanjani, Anirban Ghosh, Syed Merajuddin, Vivek Rajola, Amit Sanyal, Judhajit Mallik, Kongkona Sarma, Nisha Nair, and Gautam Juneja, for their valuable and constant support so that deadlines could be met. Thanks go to Bimla Sharma, Lalit Dabral, Nitu Suri, Manish Rawat, and Harish Sharma for shouldering all the word-processing burden

Institutional support from the IIPA administration, accounts, academic support section and the computer centre was good. WCD's financial support is gratefully acknowledged. We are also grateful to Ms. Uma Bordoloi for editing the manuscript and for saving us from many typographical errors and for helping to make the text more grammatical. The views and errors are, of course, all ours.

IN RETROSPECT

Much water has flowed down the few, remaining, undammed rivers since this report was written. The World Commission on Dams has released its final report amid much public and bureaucratic debate. Governments, international agencies, NGOs, professional bodies and individuals have expressed their support and opposition for the findings and recommendations, and official stances and positions have begun to coagulate.

The India Country Study has also been a subject of intense, sometimes bitter, debate. The Government of India, or rather the Central Water Commission and the Ministry of Water Resources, seem to have rejected it along with the WCD report. Though the detailed grounds for rejection were not specified, the general complaint seemed to be that it was written by people who were not "authorised" by the government, who were mostly not "experts' and who were bias against large dams. Not much was said about the merits, if any, of the findings and recommendations, though it was alleged that the data used were biased. We have tried to respond to these charges elsewhere, however it might be pertinent to summarise here what appears to be the main message of the India Country Study, or of at least the study on the environmental and social impacts.

The findings of this study suggest that, in India, the environmental and social impacts of large dams were inadequately understood, mostly ignored in the financial and economic calculations, and the prevention and mitigation of adverse impacts usually neglected. Though things have improved in the recent past, the situation remains far from satisfactory.

Because of this ignorance and neglect, many projects appear to have, in reality, caused more harm than good. Recent efforts at internalising some of the environmental and social costs into the cost benefit analysis suggest that projects on an average are currently just breaking even, with their economic costs and benefits being at par (For details, see the section 'Financial, Economic and Distributional Analysis of Dams in India' by Pranab Banerji, in this volume). If all the relevant costs are internalised, it seems inevitable that many (though not all) of these projects would show losses.

Leaving aside the conventional parameters of economic costs and benefits, if dams started to be looked at, as they should, from the perspective of promoting socio-economic equity, or at least not working against it, then again the available data suggest that the performance of large dams in India is on an average negative.

Unfortunately, there are very poor data on the environmental and social costs of past and, sometimes, even ongoing projects. There has also been no systematic effort to conduct a retrospective cost benefit analysis of completed projects. As a result, we cannot with any authority say for certain what the real benefits and costs of past projects were or, indeed, whether the anticipated environmental and social impacts actually occurred and whether the proposed preventive and mitigative measures, for the adverse impacts, were successful.

So, what can we say? Our data and analysis suggest the following:

- That the process of assessing proposed large dams, for their environmental and social impacts and their consequent viability and optimality, must be far more comprehensive, rigorous, participatory and transparent.
- That in order to learn from past failures and successes, we must conduct a comprehensive, rigorous, participatory, and transparent retrospective assessment of past projects.
- That we must also set up clear and measurable standards for social and environmental costs and recognise that there are some non-negotiable costs that cannot be justified just on the basis of financial and economic benefits.
- That based on these assessments and using these standards, projects must be assessed for their viability and, based on a rigorous assessment of possible alternatives, on their optimality.
- That a project should only be cleared and started when it has been established to be both viable and optimal.
- Finally, the process of implementation must also be efficient, participatory and transparent.

Our analysis does not suggest that all dams are necessarily bad, nor does it imply that no new dams should be built. Nevertheless, some people seem to have expressed a view that if the recommendations made as a part of this study are accepted then no new dams would be possible. Perhaps the correct way of debating the issue would be to examine each one of the recommendations and point out those that are intrinsically flawed. If the recommendations by themselves are sound, then the statement that if they were accepted then no large dam would ever be built, is a far greater indictment of large dams than anything we could say.

Shekhar Singh
Delhi
December 2001

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LIST OF ABBREVIATIONS

ADB	:	Asian Development bank
AICRPDA	:	All India Coordinated Research Project on Dryland Agriculture
ARWSP	:	Accelerated Rural Water Supply Programme
AVARD	:	Association of Voluntary Agencies for Rural Development
BC	:	Benefit Cost
B-C	:	Benefit Cost
BCM	:	Billion cubic meters
BCR	:	Benefit-Cost Ratio
BDO	:	Block Development Officer
BGVS	:	Bharatiya Gyan Vigyan Samiti
BOT	:	Build Operate and Transfer
C & AG	:	Comptroller and Auditor General of India
CAD	:	Command Area Development
CADA	:	Command Area Development Authority
CAG	:	Comptroller and Auditor General of India
CAPART	:	Council for Advancement of People's Action and Rural Technology
CASAD	:	Centre for Applied Systems Analysis in Development
CAT	:	Catchment Area Treatment
CAZRI	:	Central Arid Zone Research Institute
CBIP	:	Central Board of Irrigation and Power
CCA	:	Culturable Command Area
CEA	:	Central Electricity Authority
CRIDA	:	Central Research Institute for Dryland Agriculture
CSE	:	Centre for Science and Environment
CSO	:	Central Statistical Organisation
CSS	:	Centrally Sponsored Schemes
cu.m.	:	Cubic Metres
CWC	:	Central Water Commission
CWPC	:	Central Water and Power Commission
DANIDA	:	Danish International Development Agency
DC	:	District Collector
DDP	:	Desert Development Programme
DPAP	:	Drought Prone Area Programme
DST	:	Department of Science and Technology
DVC	:	Damodar Valley Coporation
EAC	:	Environmental Appraisal Committee
EEC	:	European Economic Community
EIA	:	Environmental Impact Assessment
EIS	:	Environmental Impact Statement
EMC	:	Energy Management Centre

EPA	:	Environmental Protection Act
EPCO	:	Environmental Protection and Co-ordination Organisation
EqIA	:	Equity Impact Assessment
FAO	:	Food and Agricultural Organisation
FRI	:	Forest Research Institute
FRL	:	Full Reservoir Level
G.B.M	:	Ganga-Brahmaputra- (barak) Meghna
GEF	:	Global Environmental Facility
GIF	:	Global Infrastructure Fund
GOI	:	Government of India
ha.	:	Hectare
HYV	:	High Yielding Variety
ICAR	:	Indian Council of Agricultural Research
ICID	:	International Commission On Irrigation & Drainage
ICOLD	:	International Commission On Large Dams
ICRISAT	:	International Crop Research Institute for the Semi-Arid Tropics
IDA	:	International Development Agency
IISc	:	Indian Institute of Science
ILO	:	International Labour Organisation
IREDA	:	Indian Renewable Energy Development Agency
IREP	:	Integrated Rural Energy Programme
ISWD	:	Inter State Water Disputes Act
IWDP	:	Integrated Wasteland Developments Project
IWRS	:	Indian Water Resource Society
JRY	:	Jawahar Rojgar Yojana
km	:	Kilometres
Kw	:	Kilo Watts
KWH	:	Kilo Watt Hours
MOU	:	Memorandum of Understanding
M&M	:	Major and Medium
m.ha.	:	Million Hectares
MAF	:	Million Acre Feet
MIDS	:	Madras Institute of Development Studies
MNES	:	Ministry of Non-Conventional Energy Sources
MOEF	:	Ministry of Environment and Forests
MoEF	:	Ministry of Environment and Forests
MoSJE	:	Ministry of Social Justice and Empowerment
MP	:	Madhya Pradesh
MPEB	:	Madhya Pradesh Electricity Board
MW	:	Mega Watts
NABARD	:	National Bank for Agriculture and Rural Development
NBA	:	Narmada Bachao Andolan

NCEPC	:	National Committee for Environmental Planning and Coordination
NEEP	:	National Energy Efficiency Programme
NEEPC	:	North Eastern Electric Power Corporation
NGO	:	Non-Government Organisation
NHPC	:	National Hydro Power Corporation
NSP	:	Narmada Sagar Project
NTPC	:	National Thermal Power Corporation
NWDPRA	:	National Watershed Development Project for Rainfed Areas
NWDT	:	Narmada Water Dispute Tribunal
NWMP	:	National Water Management Project
NWRC	:	National Water Resources Council
O&M	:	Operations and Maintenance
OTEC	:	Ocean Thermal Energy Conversion
PAC	:	Public Accounts Committee of the Parliament
PAD	:	Projects Appraisal Division of the Planning Commission
PAPs	:	Project-Affected Persons
PIB	:	Public Investments Board
PIL	:	Public Interest Litigation
PIM	:	Participatory Irrigation Management
Plan	:	Five Year Plan
PLF	:	Plant Load Factor
PSI	:	Peoples' Science Institute
PWD	:	Public Works Department
R&D	:	Research and Development
R&R	:	Resettlement and Rehabilitation
RBI	:	Reserve Bank of India
RCE	:	Revised Cost Estimate
RIS	:	Reservoir Induced Seismicity
SAP	:	Structural Adjustment Programme
SEB	:	State Electricity Board
sq. km	:	Square Kilometres
ST	:	Scheduled Tribes
STDs	:	Sexually Transmitted Diseases
T&D	:	Transmission and Distribution
T.B.	:	Tuberculosis
TAC	:	Technical Advisory Committee
THDC	:	Tehri Hydro Development Corporation
TISCO	:	Tata Iron & Steel Company
TOR	:	Terms of Reference
TVA	:	Tennessee Valley Authority
UN	:	United Nations
USAID	:	United States Agency for International Development

VLW	:	Village Level Workers
WB	:	World Bank
WCD	:	World Commission on Dams
WDP	:	Wasteland Development Programme
WRCP	:	Water Resources Consolidation Project

Chapter

1

ENVIRONMENTAL AND SOCIAL IMPACTS OF LARGE DAMS IN INDIA

Shekhar Singh, Raman Mehta, Vishaish Uppal, Asmita Kabra, Bansuri Taneja, Prabhakar Rao

1.0 INTRODUCTION

1.1 Objectives

The main objectives of this study were to identify the environmental and social impacts that large dams have and to assess the prevalence of such impacts in India. It was also an objective of this study to determine which of these impacts were anticipated and taken into consideration while assessing the feasibility of the dams and, for adverse impacts, what steps were taken to avoid or minimise them and to what effect. On the basis of all this and along with findings regarding other aspects of large dams, the overall objective was to assess the "development effectiveness" of large dams. The detailed terms of reference are in annex 1.I.

1.2 Conceptual Framework

Dams have intended impacts that are positive and unintended impacts which can be positive or negative.

Adverse impacts can be:

- Inevitable
- Reducible
- Avoidable

Most potential impacts can be anticipated prior to assessing the viability and optimality of a dam, and taken into consideration while making such an assessment. The avoidance, reduction or mitigation of the adverse impacts can also be planned in advance of the dam and the costs of such measures added to the other costs of the dam, for the purpose of determining its economic viability. During and after construction, there can be a monitoring system that continuously or periodically monitors the various environmental and social impacts, determines whether they were by and large as anticipated, and whether the measures for preventing, reducing or mitigating them were effective. Where there are adverse impacts that were not anticipated or where the various measures for handling such impacts are not effective, corrective action can be taken.

1.2.1 *Environmental Impacts*

Environmental impacts of large dams occur at different times and locations. We can distinguish between impacts that occur:

- Upstream of the dam and reservoir
- At the site of the dam and reservoir
- In the command/ rehabilitation sites and along the canals
- Along and adjacent to the power transmission lines, and
- Downstream of the dam and reservoir

Similarly, a distinction can be made between impacts that occur:

- Prior to the construction of the dam, at the investigation and planning stage
- During the construction of the dam and related infrastructure
- After the construction of the dam, during its operation
- During and after the decommissioning of the dam

A tabular representation of possible environmental impacts is given in annex 1.II.

As already mentioned, most such impacts can be anticipated. However, we learn about new impacts every day and also develop improved methodologies and instruments to better measure even known impacts. Therefore, in the past, not all impacts that we know today could have been anticipated, and certainly not measured with the accuracy that they can today.

Many environmental impacts only become obvious over time, sometimes after many years, and therefore many more impacts of dams already constructed and even studied will become known much later. Therefore, such studies must be redone every ten years or so based on knowledge and skills available then. Such an approach on the one hand raises the level of environmental and social standards that dams must meet but also, concurrently, takes into consideration the enhanced capabilities and technologies that become available to meet such standards.

1.2.2 *Social Impacts*

Very often, economic impacts are understood to be *ipso facto* social impacts. Therefore, it is assumed that if people become economically better off then they automatically become socially better off. However, for the purposes of this case study a much wider and independent understanding of social impacts is used. It is not, for example, assumed that if people benefit economically they also necessarily benefit socially. This is so because economic benefits can also have social costs. For example, better incomes can (and have) lead to the consumption of liquor or drugs, to the abandonment of original spouses (mainly wives) in preference to new ones who can be attracted by the raised economic status, or to changes in lifestyles and eating habits which are detrimental to health. There are also cases where families were made economically better off but their social fabric was destroyed and they were relocated in alien surroundings or in a fragmented manner.

The converse is also possible and people might become socially better off even while becoming economically worse off.

For these and many other reasons, it is important to independently assess social impacts without necessarily correlating them to economic costs or benefits.

Social impacts are understood to be those that affect the physical, psychological and emotional wellbeing of a community or group, positively or negatively. It, therefore, includes (though is not limited to) all those elements that impact on a group or community's:

- Physical health and nutritional status
- Mental health
- Livelihood and incomes
- Aspirations
- Vocational or professional choices
- Access to preferred food varieties
- Access to nature and natural resources
- Access to preferred natural surrounds and climate
- Access to infrastructure and development
- Opportunity to live preferred lifestyles
- Cultural and religious beliefs, practices and interactions
- Sense of collective and individual security
- Opportunity for entertainment and leisure activities
- Customary values
- Dignity and self respect
- State of social justice and equity within the group and in relation to the larger society.

Social impacts can also be segregated geographically and temporally, similar to environmental impacts. The various possible social impacts of large dams are tabulated in annex 1.III.

Issues relating to social justice and equity require special and separate analysis, as they are far more complex than the other issues. The indicators for improved social justice and equity are often not direct, for even where matters seem to have improved overall in an absolute sense, relative values could have been adversely affected. The promotion of social justice and equity are also an explicit and overriding objective of all development processes in India, as they should be, considering the existing social and economic inequities in India.

Issues of equity become relevant for at least five levels. Equity can be affected by:

1. The manner in which some people are made to pay the costs of the project while others get the benefits, or the manner in which the costs and benefits of the dam are distributed in society (intra generation class-benefit analysis).
2. The manner in which the costs of the dam are distributed among those adversely affected by the project, and mitigative measures applied (class benefit analysis among PAPs).
3. The manner in which the benefits of the dam are distributed among the beneficiaries of the project (class benefit analysis among project beneficiaries).
4. The manner in which the costs and benefits are distributed among various generations of human beings (inter generation equity).
5. The manner in which the costs and benefits are distributed among species (inter species equity).

Specifically, these imply the following questions:

1. Whether the dam promotes over all equity by benefiting the poor and weak in preference to, or at the cost of, the rich and powerful? In other words, is the social and economic gap between those who benefit and those who pay greater or less, because of the dam? Clearly, only where the costs are paid by the rich and powerful, and the benefits go to the poor and weak, would this be so.
2. Among those who pay the costs (the PAPs), are these costs equitably distributed, with those who have more, paying more, and those who have less, paying less?
3. Are these costs at least equally distributed, with all levels paying the same or do the poorer and weaker pay more?
4. Similarly, are the benefits also equitably, or at least equally, distributed among the project beneficiaries (PBs)?
5. Is human society overall more equitable or less so because of dams?
6. Does the dam represent a sustainable form of development where the rights of future generations of human beings to nature and natural resources, and to economic resources, is not compromised?
7. Do dams promote or adversely affect the rights of other living creatures in relation to human beings?

1.3 Methodology

This study has been seriously handicapped by the lack of data on the environmental and social impacts of large dams. Part of the reason for this lack of data seems to be that, till 1978, there was no formal requirement to conduct an environmental impact assessment or to assess the social impacts of the project. Consequently, this was not done and no data were collected. Even after 1978, though environmental impact assessments were carried out for all large dams, most of the data collected are no longer available. Much of the data that still exist are not in the public domain. Accessing data that were with government agencies was not always easy and in some cases proved impossible. Similarly, data with international agencies like the World Bank also did not become available, despite repeated attempts. Another constraint was the paucity of time. The time available (two months) for preparing the draft report was, by any standard, inadequate.

There is an understandable demand that if large dams are to be judged to have impacts (positive or negative) then comprehensive data must be provided in support of such a judgement. However, such comprehensive data do not exist in India for most environmental or social impacts. What, then, is the option? It could be argued that if there are no data regarding any particular impact then it must be assumed that such an impact does not occur. But this is a misleading assumption, for we cannot assume that such data do not exist, all we know is that no effort has been made to collect it. It is also a dangerous assumption for, if accepted, it would discourage the collection of data about adverse impacts. The agency most likely and able to collect such data is the agency that manages the dam and it rarely, if ever, would like to highlight the adverse impacts.

Nevertheless, the activities that are involved in the construction and operation of large dams are known. Large dams create reservoirs and submerge land, displace people, alter the flow of rivers, divert water through canals and tunnels, distribute water to agricultural fields, industry, and rural and urban habitations, involve earth work, and masonry and concrete constructions, etc. The environmental and social impacts of such activities have been studied in projects abroad and in a few projects in India. Also, there is fair scientific understanding about the sorts of environmental and social impacts these types of activities have. For example, we have a good idea of the role that vegetative cover plays in regulating silt and water flows. We also know to some extent the species and ecosystems that comprise various forest types and what happens to them when their habitat is submerged. We know some of what happens when a river is converted into a lake and the impact this has on water quality, on fauna and flora and especially on various species of fish. We know something about the role of variable river flows in a river ecosystem and about the ecological impact of reduced or enhanced nutrient flows.

Similarly, we have some idea of the sorts of impacts that occur when human communities, especially tribal and other rural communities, are displaced from their traditional homes, especially where such displacement is forced. We also have some understanding of the patterns of resource distribution in society and what happens when a low return resource (like un-irrigated land) is transformed into a high return one.

From this general understanding, we can certainly get a broad idea of what the environmental and social impacts of large dams, in general, are likely to be, or were in the past. From a study of the documentation available on Indian projects, we can also determine which of these impacts were studied, anticipated, assessed, and provided for in which of these projects. Based on the detailed studies available for a few of the Indian dams and on the experience of dams in other countries, we can also identify the required processes and parameters of assessment.

To collect the data and experiences available, a list of the relevant issues was developed and finalised after discussions with various knowledgeable people. Out of this list, a proforma was developed (copy at annex 1.IV) and, based on this proforma, information was gathered from available documents. It was decided to collect information on as many dams as possible. However, as it was not known in advance for which of the dams information would become available, it was not possible to develop any sort of representative sample. Therefore, though 220 dams (list at annex 1.V) were studied for their social and environmental impacts, 67 of them in some detail (list at annex 1.VI), it cannot be claimed that these form a scientifically determined representative sample. Also, though there was no screening of the dams to be studied and all those for whom data became available were studied, time permitting, the sample can also not be considered a totally random one. The fact that data were available for some dams and not for others might itself indicate that the dams for which data were available were the better studied or better planned ones.

As documents and data were collected from wherever they were available, it also cannot be claimed that all the relevant documents pertaining to a particular dam became available and, consequently, were studied, or that similar amounts of data were available for each of the dams studied.

As it became obvious that concern for environmental and social issues has improved as time has passed, it was thought important to study the assessment processes of some of the more recent large dams. Therefore, it was decided to also include, in the study, some ongoing projects. Specifically, three of the ongoing projects, namely the Tehri, Indira (Narmada) Sagar and Sardar Sarovar projects, were looked at in detail. As these are among the latest projects and also perhaps those with the greatest amount of public scrutiny, they could best bring out the strengths and weaknesses in our planning and implementation of large dams. Also, because the first author is or has been a member of various official committees related to each of these projects, current and detailed data were available. Of course, these projects only illustrate the experience of planning, assessment and initiation of projects. It is too early to say what their impacts would be after completion, if they are at all completed.

The constraints within which this case study was developed also did not permit any reconciliation of contrary or even contradictory data. Basic factual information regarding the dimensions of the dam, area submerged, forests submerged, people displaced, area irrigated, etc. was taken, wherever available, from official government documents. However, even the various government documents did not always agree with each other. For example, the data on rates of sedimentation given by the Central Board of Irrigation and Power in its publication [CPIB 1995a] differed hugely with the data supplied by the Central Water Commission in its response to this report [CWC 2000]. Both these also differ with data in another CWC report [CWC 1982/91]. Sometimes such differences were due to varying definitions or varying timeframes. Occasionally they were also due to departments and agencies interpreting and presenting data which promoted their own interests best. Robert Wade observes [Wade 1976a, p -1437] that in some cases the amount of area irrigated was under-reported by the revenue department that had the responsibility of collecting water charges. On the other hand, the irrigation department, that has the responsibility of ensuring that irrigation benefits reach the largest number of people possible, gave figures that were considerably higher.

There were also inconsistencies between figures in government documents and those available with non governmental agencies, especially regarding sensitive information like the number of people displaced, forests submerged or even the extent of the effective command. Wherever irreconcilable discrepancies emerged, the case study has tended to take the more conservative estimate in order to maintain the credibility of the database.

Apart from the information gathered for specific dams, general reports and studies were also looked at and a broad understanding of dams in India, in terms of their environmental and social impacts, was developed. The findings of the case study reflect this dual approach where, based on general studies, broad findings are presented, which are supported by examples and statistics emerging from the study of specific dams.

A letter was also sent to over 700 NGOs and concerned citizens, along with an outline of the case study, with a request to send in information and data. Various individuals and organisations wrote back and sent in useful information.

A draft summary of the section on environment and social impacts of large dams was then circulated to over 200 people, including NGO representatives, professionals, experts and government functionaries. Subsequently, two one-day long meetings (of stakeholders) were organised in Chennai (on 1 March 2000) and in New Delhi (3 March 2000). These meetings were attended by nearly 150 stakeholders from the community and from the government. All the State Governments and the concerned Central Ministries and Departments were invited to send their rep. esentatives. Most of the important Central Government agencies were represented. The Central Water Commission also, subsequently, sent a detailed comment on the draft chapter. Many other experts and stakeholders also sent in their comments, in writing, and these have all been taken into consideration while finalising the chapter.

2.0 ENVIRONMENTAL IMPACTS

Dams mostly have one or more of the three objectives of providing water for irrigation or other purposes, generating electricity and preventing floods. Some dams have the objective of providing water to industry or for urban or rural municipal and domestic consumption. In no case is environmental protection an objective of dams. Therefore, environmental impacts of dams must all be seen as unintended impacts.

As already mentioned, dams can impact on the environment at various geographical areas and in different time frames. Based on a general study and specific assessments of over two hundred dams, the detailed findings are given below.

It must be kept in mind that evidence of what happened after the dam was completed is very scant because, as already mentioned, barring for a few aspects in a few dams, no retrospective assessment has been done. The names of the dams assessed and tables giving their status regarding the various environmental parameters are given as annexes (No.2.II to 2.XV).

As already mentioned, a survey of over 200 dams was undertaken as a part of the study, of which 67 were studied in greater detail. In addition to examining reports and documents dealing with these specific dams, other material covering a number of dams or specific aspects of dams, was also examined. Based on all this, certain findings have emerged, which are reported below.

2.1 Beneficial Environmental Impacts

Dams are not intended to produce beneficial environmental impacts. However, they do often benefit the environment in one or more of various ways, which are described below.

i. Beneficial Impacts of Catchment Area Treatment

For most recent projects, the environmental clearance conditions include the treatment of the catchment. Where this treatment is adequately undertaken and results in the regeneration of natural forests and other ecosystems in the catchment area, there are significant benefits to the environment. Such benefits were not included in the cost benefit ratio of any of the projects studied.

ii. Beneficial Impacts of the Reservoir

The creation of a reservoir provides a habitat to wetland species, especially water birds. The reservoir can also be a source of water to the animals and plants in the adjoining areas and, where such areas have become unnaturally dry, this can be a significant environmental benefit. These benefits were not included in the cost benefit analysis for any of the projects studied.

A short list of national parks and sanctuaries that encompass or are adjacent to human reservoirs is given below.

Table 2a : List of PA's having reservoirs

S.No.	*State*	*Name of the PA*
1.	Andhra Pradesh	Eturnagaram Sanctuary
2.	Andhra Pradesh	Kawal Sanctuary
3.	Andhra Pradesh	Kolleru Sanctuary
4.	Andhra Pradesh	Nelapattu Sanctuary
5.	Andhra Pradesh	Pakhal Sanctuary
6.	Arunachal Pradesh	Namdapha National Park
7.	Arunachal Pradesh	Mehao Sanctuary
8.	Bihar	Palamau Sanctuary
9.	Gujarat	Gir National Park
10.	Gujarat	Khijadaya Sanctuary
11.	Gujarat	Shoolpaneshwar Sanctuary

Table 2A (Contd...)

Table 2A (Contd...)

S.No.	*State*	*Name of the PA*
12.	Karnataka	Bandipur National Park
13.	Karnataka	Nagarahole National Park
14.	Karnataka	Dandeli Sanctuary
15.	Karnataka	Shettihally Sanctuary
16.	Kerala	Periyar National Park
17.	Kerala	Chimony Sanctuary
18.	Kerala	Idukki Sanctuary
19.	Kerala	Neyyar Sanctuary
20.	Kerala	Peechi-Vazhani Sanctuary
21.	Maharashtra	Pench National Park
22.	Maharashtra	Bor Sanctuary
23.	Maharashtra	Great Indian Bustard Sanctuary
24.	Maharashtra	Phansad Sanctuary
25.	Madhya Pradesh	Madhav National Park
26.	Madhya Pradesh	Panna National Park
27.	Madhya Pradesh	Pench National Park
28.	Madhya Pradesh	Sanjay National Park
29.	Madhya Pradesh	Barnawapara Sanctuary
30.	Madhya Pradesh	Gandhisagar Sanctuary
31.	Madhya Pradesh	Karera Great Indian Bustard Sanctuary
32.	Madhya Pradesh	Ken Ghariyal Sanctuary
33.	Madhya Pradesh	Panpatha Sanctuary
34.	Madhya Pradesh	Sanjay (Dubri) Sanctuary
35.	Madhya Pradesh	Semarsot Sanctuary
36.	Madhya Pradesh	Singhori Sanctuary
37.	Madhya Pradesh	Sitanadi Sanctuary
38.	Madhya Pradesh	Son Gharyal Sanctuary
39.	Orissa	Bhitarkanika Sanctuary
40.	Orissa	Chandaka-Dampada Sanctuary
41.	Rajasthan	Ranthambhore National Park
42.	Rajasthan	Jawahar Sagar Sanctuary
43.	Rajasthan	National Chambal Sanctuary
44.	Rajasthan	Ramgarh Sanctuary
45.	Rajasthan	Sitamata Sanctuary
46.	Tamil Nadu	Anamalai National Park
47.	Uttar Pradesh	Corbett National Park
48.	Uttar Pradesh	Rajaji National Park
49.	Uttar Pradesh	Kaimur Sanctuary
50.	Uttar Pradesh	Kishanpur Sanctuary

iii. Beneficial Impacts of the Provision of Water

The provision of water to urban and rural areas for domestic and municipal use can significantly help improve the living environment. The increase in water supply due to a dam can help reduce the incidence of certain water-washed diseases like skin infection and trachoma and on others related to personal hygiene [Ramalingaswamy 1980, as quoted in Verghese op cit].

For areas that have been made arid because of human factors, the provision of water by dams can enhance environmental restoration and can improve environmental productivity. These impacts have also not been included in any of the cost benefit assessments studied.

iv. Beneficial Impacts on Floods

The construction of a dam can help control artificial, human-caused floods, thereby preventing environmental damage. However, in general, flood control cannot be seen as a significant environmental benefit.

It is occasionally argued that flood control as an objective is an environmental objective for, by controlling floods, dams protect or even 'improve' the environment. However, it is an established fact that natural flooding is a part of essential environmental processes. The flood plains are annually enriched by the soil deposited by receding flood-waters and in many areas, for example the flood plains of Assam, agricultural productivity was dependent on the natural flood cycles. Natural floods also perform various ecological functions in a river and its basin. They bring down nutrients and flush river courses. They provide the extra water required by many species of fish to breed and they restrain salt-water ingress at the mouth of the river.

Non-natural or human-caused floods, on the other hand, are a major threat to the environment and to the safety of people and property. However, such floods are caused due to deforestation and vegetation destruction in the watersheds, or because of other artificial barriers, like dams, constructed on rivers. B.G. Verghese, talking about floods, says that " It is man-made interventions in the regime of these rivers, obstruction of the natural drainage, invasion of the flood plain as a result of development and runaway population growth that has turned an otherwise often benign phenomenon into a dreadful visitation" [Verghese 1990, p -121]. Therefore, the most effective and sustainable way of preventing such floods would be to address their basic cause.

Flood control also becomes an objective where the land use in natural flood plains is changed and such a change requires the inhibition of the frequency and intensity of natural floods. While such an objective might have an economic rationale, it can certainly not be justified on environmental grounds.

2.2 Adverse Environmental Impacts

Dams also have many adverse environmental impacts. Some of the major ones are described below.

2.2.1 *Findings*

Impacts Prior to Construction at the Site of the Dam, Reservoir, Canals, Transmission Lines and in the Rehabilitation Sites

The main impact that has been observed before construction has been the premature cutting of trees in areas that are to be submerged or otherwise deforested. Often the trees are felled much in advance of the actual submergence or need. Consequently, the area is denied the ecological functions of trees even before this becomes inevitable.

Though, occasionally, especially in the last few years, there has been a stipulation that trees are not to be cut below 2 to 4 m of FRL, there still appears to be no stipulation that the trees should not be cut prematurely. There have been complaints from various projects, including Tehri, Narmada Sagar and Sardar Sarovar that tree felling was done much before it was necessary. However, it is not known how prevalent this practice is. This is a totally preventable adverse impact of dams.

i. Impacts of the dam on the Catchment

Impacts on the Forests and Vegetative Cover

The state of the catchment is very important for maximising the benefits and minimising the adverse impacts of dams. The degradation of the catchment results in greater silt flows into the reservoir, thereby reducing the life of the dam and also posing a threat to the safety of the dam and to the equipment and machinery installed in the dam. Degraded catchments also result in erratic water flows resulting not only in dry season shortages but also a serious threat of surplussing during heavy rainfall and cloudbursts, again threatening the safety of the dam. The degradation of the catchments also adversely affects the biodiversity value of the forests upstream and their other ecological functions.

The construction of a dam can itself contribute to the degradation of its catchments. In the past, the labour force that worked on the dam was not provided cooking fuel. Consequently, in numerous projects, during the many years it took to construct a dam, the labour force working on the dam was forced to collect firewood from the neighbouring forests, thereby degrading the catchments [GOR 1995b]. It was also recorded that labourers resorted to tree felling for firewood and to sustain their livelihood during the lean season when construction activity was at a standstill [CWC 1991].

Most recent projects stipulate that fuel wood or other types of fuel will be supplied to the workers. In recent years the MoEF, for almost all the projects that it has cleared, has also stipulated this [TNEB nd; Shah nd; WAPCOS 1994; CWC 1991]. However, In many recent projects, despite there being a clear guideline that provision for supply of fuel wood to labourers at the construction site must be made, satisfactory implementation has not been reported even though this provision was a part of the contract signed with the contractor [CWC 1994 and CWC 1995].

Forest degradation also takes place in the catchment area due to improved access, both during and after dam construction. After the construction of the dam, where forests and other vegetation are submerged under the reservoir, the pressures on the remaining forests, mostly in the catchments, go up significantly. For example, an environmental impact study of the Narmada Sagar Project, done for the Narmada Planning Agency of Madhya Pradesh Government, records that " Apart from the affected population itself, people on the periphery of the submerged area also meet some of their requirements like timber, fuel, bamboo, fibres, etc, and MFP from the submerged area. Neighbouring forests will, thus, come under greater pressure after filling of the reservoir" [EPCO 1984, p 70]

Also, where catchments get degraded due to the construction of the dam, the access to biomass, of the people living in and around those catchments, is adversely affected. This often results in their further degrading the catchment or shifting their pressures to other areas that also, therefore, get degraded.

The construction of roads and other infrastructure and the enhanced activities in the area put an additional strain on the catchment. Unfortunately, the impact of these on the forest has not been assessed at the planning stage of any of the dams surveyed. However, the fact that there has been such an impact has been reported from many projects [CBIP 1995; GOR 1995b]. The negative impacts of the dam on the catchment have also been reported from various dams [CWC 1991; WII 1994]. Also see annex 2.II for further details.

All the adverse impacts of the dam on the forest and vegetative cover in the catchment are preventable. Most were not anticipated and, till recently, mostly not prevented.

Impacts of mining/quarrying for construction materials

The soil, stones and sand required for the construction of dams/canals are often mined and quarried from around the dam/canal site. Such extraction can also have adverse environmental impacts, especially by aggravating dust pollution, disturbing wildlife and destroying vegetation. The scars and pits that such mining and quarrying leave (sometimes called borrow pits) remain as ecological sores and can also have an adverse impact on the dam and the canals.

These impacts were not assessed as a part of the planning of any of the projects studied. In at least one recent project, Indira (Narmada) Sagar [ISP 1998], the project authorities have been asked not to allow any mining or quarrying for excavating construction material for the dam, in the catchment. Effect of this activity on the catchment is also rarely documented. In some instances, e.g. Subarnarekha [CWC 1991] and Malana [WAPCOS 1994], Rajghat [Shah nd.] and Upper Indrawati [CWC 1991] restoration of construction sites had been recommended. In another case, Almatti, the project authorities stated that they had a plan for restoration and beautification of the construction area [CWC 1993a]. However, in the case of the Subarnarekha, the official evaluation report states that this restoration was not carried out [CWC 1991].

In its Annual Report for 1992-93, the Environmental Monitoring Committee of the Central Water Commission states that "In majority of cases no action is being taken by the project authorities for restoration of construction areas with the plea that borrow pits are generally situated in the submergence area of the reservoir and as such, do not need any restoration. This does not appear to be a fact ..." [CWC 1994, p 11].

These are again impacts that can be prevented by ensuring that such mining or quarrying is done in an environmentally friendly manner and, in any case, not close enough to the dam to have a direct impact on it. Where this is inevitable, the mined area should be restored prior to submergence. In most cases, such impacts were not taken into consideration while assessing the dam.

ii. Impacts of the Catchment on the Dam

Siltation of the Reservoir

Siltation of the reservoir poses many threats to the dam. It not only shortens the life of the dam but also threatens its safety and the safety of the turbines, other machinery and structures. According to the Ministry of Irrigation (as it was then known): "The effects of reservoir sedimentation are felt in many ways; through the direct loss of water storage capacity in the reservoir itself, through increased evaporation losses in the reservoir pool, through increased transpiration losses in delta areas, and through the economy of a region depending upon the reservoir" [GOI 1985, p -152].

A World Bank Technical Paper on Reservoir Sedimentation states various adverse impacts of sedimentation. " By raising the bed level of channel upstream of reservoir limit, backwater deposits create problems of flooding, waterlogging and non-beneficial use of water by phreatophytes. The physical impact of in-reservoir deposits is to reduce the volume of storage available for water.

> "As the sediment deposits approach the dam, they are released, to an extent, with the flow passing through outlet works and power turbines. Here, the sediment has another harmful effect. It abrades the structures it passes through" [Mahmood nd, p2).
>
> Siltation of reservoirs has been recognised as a major problem in India. The Central Board for Irrigation and Power in its report on 'Sedimentation Studies in Reservoirs' (1977) has the following to say.
>
> "The annual rate of siltation from a unit reservoir has been 2 to 3 times more than what was assumed at the time of the project design.
>
> "These measurements have shown that sediment has deposited not only in the dead storage space, but has also encroached on the live storage. Till now it was believed that all the silt would be deposited in the dead storage space, and recent measurements have exploded this belief. The encroachment on live storage capacity has affected the function of the reservoir..." (p2).
>
> The rate of silt flow is calculated in all the recent dams, as a part of the project report. In many cases, independent studies have also been carried out to determine what the rate of siltation would be. Anticipated and observed siltation rates were available for

24 dams. The actual rates were found to be higher than predicted in most of them. [See Table 2.B and Annex 2.III for details]

For the Ukai reservoir, the survey report states that " The rate of silting is higher than that assumed. The silt index of 1.49 ham/100 sq km/year was adopted in project report...... the rate of silting during the two surveys is 6.26 and 8.07 ham/100 sq km/year respectively" [CBIP 1995a]. Similarly, for the Kadana project it is stated that at the time of design the siltation rate assumed was 1.3 ham/100 sq km/year. The actuals observed were 6.57 and 4.60 ham/100 sq km/year in the two years surveyed [CBIP 1995a]. Occurrences of inordinate levels of sedimentation were also recorded for the Krishnarajasagar Dam in Karnataka, which was completed in 1932. As late as 1992 catchment area treatment was recommended [CBIP 1992]. For Malaprabha reservoir, the first sedimentation survey was done from 1979 to 1981 and the second from 1987-1991. The results of surveys done between 1981 and 1991 indicated an annual sediment deposition rate of 7.86 M cu m against assumed rate of 0.94 M cu m, i.e. a steep rise of the order of 8.36 times. If this rate continues, the entire dead storage will be filled up in another 20 years and the capacity up to FSL in about 33 years. Thus the total life of the reservoir will be only about 50-60 years against the planned life of 100 to 2000 years. [CCPA 1995, p2]

In the case of Loktak, the lake was silting up due to destruction of vegetation cover in the catchment as well as adverse land use practises. In order to mitigate the problem, dredging of the lake was being done but the monitoring committee felt that it was not enough to do just dredging and also the silt removed from the lake was flowing back into it. [CWC1993a].

For the Bhadar (Rajkot) Project, according to the official consultants "In the original project the sedimentation rate had been taken equivalent to 1.31 ham/100 sq. km/year. This was very low and the reservoir sedimentation survey in 1974 indicated a rate of about 13.5 ha m/100 sq. km/year......Based on the average figure for the period 1966 to 1986, the Consultants have recommended a sediment load of 7.6 ha m/100 sq. km/year." [CCPA 1996, p xxix]

In Mayurakshi Dam, in West Bengal, the official consultants found after a survey that the actual rate was 1358 m^3/year/sq. km as opposed to the assumed rate of 380 m^3/ year/sq. km. RS Varshney, Chief Engineer, Ganga Valley Hydroelectric Projects, UP, states that "Maneri Dam on Bhagirathi is 39m high and it is already silted upto crest level. Similar fate is expected of the proposed Shrinagar Dam (85 m high) on Alakhnanda [CPIB 1995, p 68].

Given below is a table recording the assumed and observed rates of siltation of some of the dams, as per the data of the Government.

Table 2B : Sedimentation data of selected reservoirs

Sr. No.	*Reservoirs*	*Yr of impounding*	*Annual rate of silting in ham/100 sq. km.- CPIB*[1]			*Annual rate of silting in ham/100 sq.km.- CWC*[2]			
			Assumed	*Observed*	*3 as percentage of 2*	*Assumed*	*Observed*	*6 as Percentage of 5*	*7 as percentage of 4*
		1	2	3	4	5	6	7	8
1.	Beas unit II	1974	4.29	14.30	333.33%	4.29[3]	27.85[4]	649.18%	315.85%
2.	Bhakra	1959	4.29	6.00	139.86%	4.29	5.66	131.89%	-7.97%
3.	Dantiwada	1965	3.61	5.14	142.38%				
4.	Ghod	1966	3.61	15.40	426.59%				
5.	Hirakud	1956	2.52	3.57	141.67%	2.50	6.62	264.72%	123.05%
6.	Kangsabati	1965	3.27	3.76	114.98%				
8.	Machkund	1956	3.90	2.57	65.90%				
9.	Maithon	1956	1.62#	13.10	808.64%	9.05	10.25[5]	113.23%	-695.42%
10.	Matatila	1958	1.43	4.30	300.70%	1.33	6.00	451.13%	150.43%
11.	Mayurakshi	1955	3.61	16.56	458.73%	3.75	16.83	448.69%	-10.03%
12.	Nizamsagar	1931	0.29#	6.65	2293.10%	2.38	4.89[6]	205.46%	-2087.64%
13.	Panchet	1956	2.47#	10.00	404.86%	6.67	5.88[7]	88.11%	-316.75%
14.	Ramganga	1974	4.29	18.20	424.24%	4.25	22.94	539.76%	115.52%
15.	Shivajisagar	1961	6.67*	15.24	228.49%	6.67	7.71[8]	115.59%	-112.89%
16.	Tawa	1974	3.61	6.38	176.73%				
17.	Tungabhadra	1953	4.29	6.54	152.45%	4.29	6.48	151.05%	-1.40%
18.	Ukai	1972	1.49	8.00	536.91%	1.49	7.16	480.54%	-56.38%
19.	Kadana	1977	1.30	4.60	353.85%	1.30	3.92	301.38%	-52.46%

SOURCE: CBIP 1995a.
* Source GOI 1985.
# Note the marked difference in even the assumed rates between the two sources.

[1] As per CPIB data (CPIB 1995a)
[2] As per CWC data (CWC 82/91; courtesy R. Rangachari)
[3] In CWC 2000 the assumed rate is given as 25.29 ha. M/100 sq. km/year
[4] In CWC 2000 the observed rate is given as 21.11 ha. M/100 sq. km/year
[5] In CWC 2000 the observed rate is given as 10.75 ha. M/100 sq. km/year
[6] In CWC 2000 the observed rate is given as 3.78 ha. M/100 sq. km/year
[7] In CWC 2000 the observed rate is given as 5.12 ha. M/100 sq. km/year
[8] In CWC 2000 the observed rate is given as 8.10 ha. M/100 sq. km/year

Though efforts were made to assess the probable rate of siltation for many of the dams, the levels anticipated were not always accurate, as can be seen from the above table.

Water Availability

Degraded catchments lead to erratic water flows. Though all recent dams are required to study the available water flows as a part of their project preparation exercise, very few assessment of whether the anticipated flows actually materialised, exist. Studies on water availability could be found for only 6 of the 67 dams studied. Of these, five stated that the amount of water actually available was lower than that envisaged at the time of planning. For only one project: Hasdeo-Bango [REDECON 1996a] did the water flow meet expectations.

For example, the Malaprabha project was planned for a 75% dependable yield of 1338 M cu m. On the basis of 21 years of reservoir inflow data from 1972-73 to 1992-93, and 13 years of observation at Kochi Weir downstream, 75% dependable yield works out to 878 M cu m, which is 34.35% short of planned dependable yield. According to the official consultants, CC Patel and Associates Pvt. Ltd., "Such a major reduction in 75% dependable yield calls for a critical review of the project." [CCPA 1995, p 2].

The Bhadar (Rajkot) Project was designed for a 75% dependable flow of 161.60 Mm^3. However, as per the 1996 study of the official consultants, the flow is actually 93.79 Mm^3 [CCPA 1996, p xxviii].

According to the official consultants, the actual inflows in the Barna Dam were 11% lower than what was estimated at the time of project formulation [Redecon 1996, p 2.1.10].

Overestimation of water flows would mean that the benefits derived from dams would be curtailed. Further, adverse impacts on downstream areas would be greater, as they would get less water because irrigation needs would be met first.

Though water flows can perhaps never be measured with absolute certainty, especially since rainfall and snow melt patterns and the quality of the catchment are ever changing factors. Consequently, it is all the more necessary to take a conservative view of water availability so that only the minimum assured project benefits are projected. Given the data, this principle does not seem to be followed.

iii. Catchment Area Treatment

One common prescription to avoid the negative impacts of dams on the catchment and of degraded catchments on dams is the carrying out of catchment area treatment (CAT). In the last twenty years or so, since the requirement for obtaining an environmental clearance for dams has been in place, almost all dam projects are required to carry out CAT.

If properly done, the treatment of catchments due to the project and at project expense can be seen as a significant positive impact on the environment. This is because, ideally, the catchments would be improved and treated to a point where they would not only counteract the negative impacts of the dam but also improve the soil, water and vegetative profile.

The efficacy of CAT as an inhibitor of soil erosion is not without controversy. Verghese, for example, states that " It would be as well to dispose of some other myths here. It is widely believed that deforestation causes floods by reducing infiltration and augmenting runoff. ... Infiltration is a slow process and vegetation (does) augment percolation by extending the residence time of each raindrop that falls to the ground. But only to a point. ... Once the soil is saturated, all excess water must runoff as rejected recharge or be lost to evaporation...Forests do increase residence time by intercepting rainfall and letting it down gradually, by absorbing it in humus and leaf litter and in facilitating infiltration through the root structure which too acts as a passage and sponge. But once the sponge is full, its retention capacity is exhausted."

He goes on to say that " What forests do is to reduce erosion and consequent sedimentation. This is best done by leaf litter and undergrowth covering the forest floor" [Verghese ibid, p - 149].

However, Verghese does not seem to succeed in "disposing the myth" that CAT inhibits silt flow and regulates water runoff. All he seems to establish is that the capacity of a forest to do this is not infinite and that the litter and undergrowth plays a very important role in this. This is, of course, not disputed. In fact, it would be terrible if the forest stopped all silt and water from flowing down the river. The important point is that a forested and well littered catchment is necessary for maintaining natural levels of water and silt flow.

Catchment Area Treatment plans were a part of the plans for 9 out of the 67 projects that were studied (Bhakra Nangal, Champamati, Chandil, Kollimalai, Loktak, Malana, Ramganga, Srinagar, Upper Kolab Projects). In addition, for 3 projects (Bhakra Nangal, Champamati, Chandil) other mitigative measures were planned. [GOM 1992, Goodland 1987, GOO 1988 and Annex 2.II]

Apart from recognising the need for CAT and accepting responsibility for it, many other problems surface. Some of the problems observed with respect to large dams in India are described below.

- **Inappropriate treatment:** The major objective of CAT is to inhibit the runoff of water and silt and thereby not only improve the local environment but also minimise adverse impacts on the dam. This would imply that CAT ought to involve extensive plantation and regeneration of vegetative cover. However, most often the treatment is restricted to the planting of trees and that also of a few species, some of which are either exotics or unsuitable for CAT, like Cheer pine [Tehri 1997]. Also, there is no effort to reduce or divert those pressures, especially the ones unrelated to the dam, that have, in the first place, led to the degradation of the catchment. Also, as there is little or no effort in making the local communities partners in CAT, the sustainability of the treatment is doomed to failure and the catchments, even when treated, rapidly deteriorate to their earlier levels. In their annual report for 1992-93, the Environmental Monitoring Committee of the Central Water Commission states of catchment area treatment that "Sufficient emphasis is not generally being laid on integrated soil and water conservation along with proper watershed management techniques are essential to maintain the health of the catchment areas of the reservoirs for their sustainable beneficial use." *(sic)* [CWC 1994, p12]

- **Delayed treatment:** If the dam is to be allowed to have its full life and the reservoir is to be prevented from silting up prematurely, the catchment treatment must become effective prior to any impoundment taking place. Unfortunately, this almost never happens. Current experience shows that CAT has not been completed in many of the large dams even after impoundment has taken place. In fact, as CAT involves extensive afforestation, for which pits are dug, the actual flow of silt into the river increases rather than decreases while CAT work is going on. This means that if impoundment takes place before CAT is completed (and allowed to stabilise for at least two years), the silting of the reservoir is even faster in the initial years than it would have been without CAT [NCAenv].
- **Treatment of inadequate area:** In the last ten years or so there has been a hesitation on the part of project authorities to treat the entire catchment or, as prescribed, the entire area which is determined to be of very high or high erodibility. This debate started around three of India's largest dam projects, namely Sardar Sarovar, Indira (Narmada) Sagar and Tehri [Tehri 1997 & NCAenv]. The project authorities have taken a stand that they will only treat the "directly draining" catchments as a part of the project and in accordance with the project construction schedule.

  A "directly draining" catchment has been described as one that drains directly into the reservoir or, in other words, is adjacent to the reservoir. This has meant that a large proportion of the catchment would remain untreated, at least as a part of the project and in time for the project to benefit from its treatment. The distinction between "directly" and "indirectly" draining catchments or watersheds remains an illogical one from the point of view of the impact of the catchment. After all, by definition a catchment is an area from which water and silt flow into the dam, either directly into the reservoir or indirectly into the river, which then conveys it to the reservoir. There is, therefore, no reason to neglect one and focus on the other. Besides, the "indirectly" draining catchment is invariably much larger than the "directly" draining one and, as such, has the greater impact.

  Of course, the question of who should pay for CAT of the entire catchment needs to be resolved. Where the catchment is very large and subjected to many pressures unrelated to the dam, it might not be correct to book the cost of treating the catchment on to the project cost. However, from whatever head the money comes from, CAT has to be done, and done in time and in a manner such that its adverse impacts on the dam and on the environment are minimised. This is essential to safeguard the huge investments being made by the society in building large dams.

- **Problems of ownership:** Not all of the catchment is forest or government land and much of it is agricultural land which is privately owned. Here, treatment cannot be done and certainly not maintained unless the owners of the land agree and find it in their interests. CAT schemes are, however, usually insensitive to this aspect and therefore the progress in private lands is even worse than what it is in government and forest lands. In a recent project (Sipu in Gujarat), while an allocation has been made for CAT, problems in acquiring the land for treatment have resulted in there being no progress. Reportedly, the land identified for CAT is in private hands [CWC 1994]. In another case (Bawanthadi in Maharashtra and Gujarat), an integrated CAT has not yet been prepared due to multiple ownership and lack of coordination between different departments of two different states [CWC 1995].

iv. Impacts of Backwater Build up

When a free flowing river meets the relatively static reservoir, there is a build-up of back-pressure and a resultant back-water. This can damage or destroy the upstream ecology and damage property. Backwaters can also build up due to deposit of sediments and silt upstream of the reservoir as "backwater deposits".

The build up of backwaters cannot be totally prevented, if a reservoir is to be created. However, it can be minimised by controlling siltation and its impacts lessened by anticipating the extent and ensuring that loss of property or land is prevented. Unfortunately, assessment of possible back-water impacts was missing from most of the projects studied.

Impacts at Dam/ Reservoir Site

i. Dust Pollution

Construction activities almost always significantly raise the levels of dust in the atmosphere. Such dust not only negatively affects the forests and other vegetation in the region, it also pollutes the river and other water bodies. There is also a significant impact on the health of the people living and working in the region. Impact of dust pollution during construction has not been assessed in any of the dams surveyed. It has been acknowledged only in three instances: Rajghat [Shah nd], Middle Vaitarana [Badrinath et al.1991] and Tehri [Tehri 1997]. In Ramganga air and noise pollution was reported to be tremendous. Dust pollution increased occurrence of T.B. [CBIP 1995].

Though dust pollution during construction cannot be totally prevented, it can be minimised in many ways. Besides, measures can also be taken to minimise the impact on human health and on the fauna and flora.

ii. Impacts on Aquatic Ecosystems and Biodiversity

Construction activities, including the diversion of the river through a tunnel, cause major disturbances and have adverse impacts on the aquatic ecosystem. In many cases, vulnerable species, with either limited distribution or low tolerance, become extinct even before the dam is completed. However, in most projects the study of aquatic biodiversity has been limited to the study of fish, and those also to the commercially important species. Only in some of the recent high profile projects like the Tehri Project [Tehri 1997] has there been an attempt to study the impact of the dam construction activities on the aquatic ecosystem and biodiversity as a whole. The results of these studies indicate that there are significant adverse impacts on the aquatic ecosystems and biodiversity at and around the site of the construction.

Even after the construction of the dam, there can be various adverse impacts of the dam on aquatic ecosystems. The blocking of a river and the formation of a lake significantly alters the ecological conditions of the river, adversely impacting on the species and ecosystem. There are changes in pressure, temperature, oxygen levels and even in the chemical and physical characteristics of the water. Besides, by interrupting the flow of water, ecological continuity is broken. This is most obvious in the case of those species of fish whose passage up to their breeding grounds is blocked by the dam. However, many other species get affected, though not always so dramatically.

According to a World Bank Technical Paper "On the upstream side, the thermal regime of the flow is changed so that the impounded water may become anaerobic or it may become hostile to the wildlife previously supported by the river" [Mahmood nd, p2) .

Most studies done on the impacts of the dam on the aquatic ecosystem focus on commercially important fish species. Only in one of the projects (Uri) surveyed were there attempts to study aquatic ecosystem in its totality [UHPP 1989].

Though the adverse impacts on the aquatic biodiversity cannot be totally prevented, they can be reduced. Besides, as these are very significant impacts, they must form a part of the assessment process of a project. Unfortunately, they have remained largely unanticipated costs.

iii. Impact on Terrestrial Fauna and Flora

The disturbance caused by the construction activities, including the noise and movement, the building of roads, extraction of stone and soil, construction of buildings, etc. also negatively impact on the fauna and flora at the dam site. This has also not been studied in any of the projects surveyed. In the Tehri Project [Tehri 1997], the report on the impact of the dam on fauna incidentally mentions that there has already been much damage to the fauna even before the study started, due to ongoing construction activities. .

As impoundment starts, the dam's reservoirs invariably submerge large tracts of forests and other ecosystems, including grasslands and wetlands. Efforts are sometimes made to "compensate" for this loss by attempting to recreate such ecosystems elsewhere. However, it is not possible to 'recreate' natural ecosystems. One can create a plantation but never a natural forest or grassland.

The most obvious impact of reservoirs on terrestrial ecosystems is the submergence of forests. Of the 221 projects studied for this aspect, Information on the amount of forests submerged was available for 60 dams (Annex 3.VI). Of these 60 dams, forest land formed the majority (over 50%) of the land submerged in 21 cases (Table 2.C).

Data regarding forest submergence as a proportion of total submergence for the 60 dams are given below.

Table 2C : Forest submergence

S. No.	*Dam Name*	*Total Area Submerged (Hectares)*	*Forest Area Submerged (Hectares)*	*Percentage of Forest Area Out of Total Area Submerged*
1.	Almatti	79,020	532	0.67%
2.	Aner	800	690	86.25%
3.	Bagh	3,900	1,640	42.05%
4.	Bargi	30,860	8,478	27.47%
5.	Bariarpur	3,078	119	3.85%
6.	Bhadra	11,700	11,000	94.02%
7.	Bhakra	16,835	5,750	34.16%
8.	Bhatsa	2,700	2,460	91.11%
9.	Bisalpur	21,836	358	1.64%
10.	Chamera	1,270	983	77.40%
11.	Chandil	17,409	1,060	6.09%
12.	Damanganga	4,368	1,199	27.45%
13.	Dimbhe	2,272	70	3.08%
14.	Gandhi Sagar Dam	72,300	3,302	4.57%
15.	Hasdeo-Bango	21,279	10,250	48.17%
16.	Heran/Lalpur	17,720	200	1.13%
17.	Hirakud	72,700	28,000	38.51%
18.	Ibadoh	6,020	3,840	63.79%
19.	Jakham	10,150	6,460	63.65%
20.	Jamrani	450	176	39.11%
21.	Kabini	6,100	2,690	44.10%
22.	Kadana	16,600	7,750	46.69%
23.	Kamthikhairy	2,330	2,330	100.00%
24.	Karjan	3,994	1,405	35.18%
25.	Kelo	3,116	708	22.71%
26.	Koteshwar	456	379	83.11%
27.	Loktak	257	27	10.51%
28.	Lower Wunna	6,275	131	2.09%
29.	Mahi Bajaj Sagar	13,300	450	3.38%
30.	Malana	18	18	100.00%
31.	Meja	3,173	2,688	84.71%

Table 2C (Contd...)

Table 2C (Contd...)

S. No.	*Dam Name*	*Total Area Submerged (Hectares)*	*Forest Area Submerged (Hectares)*	*Percentage of Forest Area Out of Total Area Submerged*
32.	Middle Vaitarna	673	528	78.45%
33.	Nagarjunasagar	28,500	5,000	17.54%
34.	Narmada Sagar	91,348	40,332	44.15%
35.	Nizam Sagar	12,950	6,130	47.33%
36.	Pandoh	123	70	56.91%
37.	Polavaram	63,691	3,540	5.56%
38.	Pus	800	240	30.00%
39.	Rajghat	23,390	990	4.23%
40.	Ramganga	7,831	6,720	85.81%
41.	Rengali	2,256	67	2.98%
42.	Sardar Sarovar	39,134	13,744	35.12%
43.	Serlui	2,554	2,554	100.00%
44.	Sharavathi (Tail Race Scheme)	596	489	82.05%
45.	Sipu	2,863	317	11.07%
46.	Sohira	41,970	31,970	76.17%
47.	Sondur	2,439	2,025	83.04%
48.	Sriramsagar and Lower Manair	55,970	84	0.15%
49.	Tawa	20,200	15,770	78.07%
50.	Teesta (Stage V)	68	49	72.06%
51.	Tehri	4,200	2,583	61.50%
52.	Tipaimukh	50,100	19,000	37.92%
53.	Ukai Dam	60,100	31,000	51.58%
54.	Upper Indravati	11,000	1,655	15.05%
55.	Upper Kolab	11,432	76	0.66%
56.	Upper Penganga	9,845	189	1.92%
57.	Upper Wain Ganga	5,603	228	4.07%
58.	Upper Wardha	11,362	1,181	10.40%
59.	Waghur	3,140	297	9.45%
60.	Warna	[illegible],900	753	25.97%
	TOTAL	**1,019,324**	**292,724**	**28.72%**

SOURCE: Various, as listed in annex 3.VI.

It has been stated in various places that, till 1980, the loss of forests due to dams was only 500,000 ha of forests. As per the figures given by the Central Board of Irrigation and Power [CBIP nd01], up to 1980, 2178 large dams had been completed. From 1981 to the present 1877 dams have either been completed or are under construction (for another 236 the date of completion was not known).

Data were available regarding forest submergence for 60 dams (see table 2.C above). On the basis of these, the average forest area submerged per dam works out to approximately 4879 ha. Therefore, in the 1877 dams to be built between 1980 and 2000 would be likely to submerge 9,157,883 ha (roughly 9.1 million ha) of forests. The CWC has stated that, according to a study they did of 116 projects (details not available) the average forest submergence per project was 2,400 ha. [CWC 2000, p 43]. Even if we take this to be the correct figure, the total submergence between 1980 and 2000 would be 4,504,800 ha.(roughly four and a half million hectares). This is certainly a very large loss of forests, especially considering the record of compensatory afforestation, described later, and the fact that against the stipulated 33% of forest cover required as a minimum, India has only about 24% of forest land and only about 11% of closed forests at present.

The adverse impacts of forest loss are being anticipated only since 1980. The most common mitigative measure prescribed was compensatory afforestation.

However, available evidence indicates that "compensatory" afforestation is difficult to implement, and in some cases was not complete many years after completion of the project. In fact, the practice of insisting on compensatory afforestation started only in 1986, six years after the enactment of the Forest Conservation Act (FCA), at the behest of the Prime Minister [GOI 1986]. The FCA prohibited transfer of forest land for non-forest use without the clearance of the Government of India (GOI). As diversion of forest land for dams was considered a non forest use, clearance had to be sought from the GOI and, as a condition of clearance, it was specified that an equal amount of non forest land must be afforested and legally declared forest land. Where non-forest land was not available, the GOI could permit the afforestation of twice the area of degraded forest land, as a special case.

The rationale of such a stipulation seems to be that if a particular forest type is depleted in a particular region, because of the dam, it must be 'compensated' by creating the same type of forest in the same region. Also, as legally designated forest land has been de-notified, an equivalent amount of non-forest land must be notified as forest land, so that the total stock of forest land in the country, which is already much below the required 33%, is not further reduced.

However, in 1998, the GOI had amended these conditions and now the states have the freedom of regenerating twice the amount of degraded forest land, even where non-forest land can become available, for certain categories of projects including all central projects. Though this might meet the condition of 'compensating' for the forests lost, it can not compensate for the depletion in the stock of forestland. Also, as forestland is easy to come by, especially degraded land, the earlier hesitation of state governments to convert forestland to non-forest use because of the difficulty in finding non-forest land for compensatory afforestation, has disappeared. Considering the submergence of forests between 1980 and 2000 was anywhere between 4.5 and 9.1 million hectares (see above), if all or most of the compensatory afforestation is done in existing forest lands, the country stands to lose, in 20 years, between 6.2 and 12.6% of its forest lands just to dams.

There are, however, many other problems with the current scheme of things. For one, it is impossible to replace a natural forest by a plantation. Therefore, though there is formal 'compensation' for the forests lost, in terms of forest area, however, the actual ecological and biodiversity losses that the destruction of natural forests symbolise, cannot be compensated for.

Secondly, in many cases compensatory afforestation is done in areas and ecosystems far removed and different from those that it was meant to compensate. For example, the forests being submerged under the Tehri Project, in the hilly terrain of Tehri Garhwal, have been 'compensated' for by plantations in the distant districts of Jhansi and Lalitpur, in the plains. Similarly, the forest submerged and being submerged under the Sardar Sarovar Project has been 'compensated' for by plantations in the distant grasslands of Kutch.

Also, the record of state governments in actually carrying out compensatory afforestation has been very poor. According to the MoEF, the performance of the state government in raising compensatory afforestation has not been very satisfactory. Till 1997, only 46% of the area stipulated to be afforested has been taken up [Enviro 1998, p - 14].

Apart from forests, the reservoir and the dam also affect other ecosystems and various fauna and flora species. Unfortunately, till recently, there was little effort to assess the impact on flora and fauna and on non-forest ecosystems.

Of the 67 dams studied, information on the impact on flora and fauna was available in 22 cases. Of these 22, 10 stated that there was no adverse impact on the flora and fauna, primarily because there were no 'valuable wildlife' in the submergence area. In 12 cases it was stated that important forestland will be destroyed and important species or ecosystems will suffer damage. In another 2 dams (Bisalpur, Hasdeo Bango), the creation of wetlands was seen as enhancing the biodiversity. (See Annex 2.V for details)

Even the studies that have been conducted on the impact on fauna and flora have been inadequate on many counts. For one, there is a tendency to consider only large mammals as 'wildlife', despite the fact that the Wildlife (Protection) Act of 1972 includes all wild fauna and flora into the meaning of 'wildlife'. Also, there has been a stress on 'valuable' species, which often means the more prominent or visible species. However, some of the less visible species might actually be even more important to conserve. There is also a tendency to focus only on endangered species. Being concerned only about endangered species results in other species also becoming, over time, endangered. Besides, the endangered status is usually applied to species that are nationally or globally endangered. If a proper survey is not carried out it can never be determined which of them were locally endangered and, therefore, requiring protection. Whereas some species have been studied, however unsatisfactorily, there is almost no study of the cumulative impact of a dam on the ecosystem.

Some of the measures of mitigation that were recommended and implemented included the creation of bridges for the movement of elephants (Dalma - Subernarekha Project) and the creation of sanctuaries (Sardar Sarovar).

In some cases, the mitigative measures suggested are totally inappropriate. In may projects it is stated that there would be no impact on wildlife as they would migrate to neighbouring forests. For example, a study done on the impact of the Indira (Narmada) Sagar project on wildlife, by EPCO in Madhya Pradesh, suggested that the wildlife would either voluntarily migrate into neighbouring forests when impoundment took place or be driven there by squads of specially trained staff [EPCO 1984, pp74-76]. Similarly, studies done in relation to the Tehri Project maintained that the fish would migrate and establish themselves upstream of the dam. For Rajghat Project, it is suggested that "The National Park at Shivpuri is also not far off. It is thus felt that there is ample scope for migration of the wild life to the adjoining forests and there would be no difficulty on this account" [Shah nd, p - 15]. Verghese [1990] also suggests that "Forest corridors need to be provided to enable wildlife to migrate to other areas so that loss or diminution of habitat has little or no adverse effect. In other circumstances it may be necessary to remove animals, especially rare and endangered species, to parks and sanctuaries, or to relocate them if possible, maybe in areas of compensatory afforestation" (P 217). The CWC also states [CWC 1992, p 18] that "wild life could be shifted and rehabilitated. Birds will migrate on their own".

Clearly, such thinking is flawed. For one, the areas where these animals will hopefully move would have their own complement of wildlife. Therefore, these cannot be considered 'vacant habitats', awaiting the ousted animals. Secondly, wild life, even wild animals, do not move down corridors of forests as the flood waters advance. They are not aware of such corridors and what lies beyond. They are rightly wary of leaving their own territory, and they are panic stricken when the waters roll in. Besides, some animals are nocturnal, others roam around during the day, others live underground or on trees and in caves. And wild life includes plants. What of them? Also, the task of "removing" all the wild animals to other habitats, even if such were available, is a gigantic one which has never been tried anywhere in the world. Even if it were to be done, the costs would be so phenomenal that most dams would become non-viable from the start.

In none of the dams studied were there any efforts to monitor the status of wildlife after the construction of the dam, to assess the impact of the mitigative strategies and to check the veracity of the estimates of impact done prior to construction.

The adverse impacts on terrestrial wildlife and biodiversity cannot be prevented. They, therefore, need to be calculated and taken into consideration while assessing the project. In most of the dams surveyed, there had been no real effort to assess the impact on wildlife. For many of the recent dams, studies have been undertaken on wildlife and most of them are little more than lists of some of the species found in the submergence zone, especially the large and 'rare' ones. Most of these studies end up either certifying that nothing 'valuable' will be lost or give, as described earlier, impractical suggestions on how to minimise the loss [Tehri 97; NCAenv].

v. Impacts on Cultivated Biodiversity

Reservoirs also submerge productive agricultural land in the valley. This not only has a social and economic cost but also adversely affects cultivated biodiversity and a host of birds, insects, mammals and reptiles that have adapted to agricultural ecosystems. In many cases, traditional crop varieties and methods of cultivation have disappeared because of the submergence of agricultural lands. However, this is another aspect that has not been assessed as a part of project evaluation, in any of the projects studied.

vi. Impacts on Grazing Land (Rangelands)

Lands grazed by livestock and wild animals alike are also often submerged by reservoirs. This, again, leads not only to economic losses, but also to the loss of natural and domesticated biodiversity. Where preferred habitats of wild animals are submerged, there is an inevitable reduction of their populations. Also, the users of these habitats shift to the other remaining grasslands, thereby overusing and degrading them. Grassland species of plants and animals also suffer especially as there is no 'compensatory' creation of grasslands. However, impacts on grasslands have not been assessed by any of the projects studied.

Though the impacts on rangelands cannot be prevented, by creating alternate rangelands in appropriate locations at least some of the adverse impacts could be minimised.

vii. Impacts on Rim Stability

The creation of an artificial reservoir often results in the gradual or rapid erosion of its rims. Destabilisation of the rim not only poses a threat to the reservoir ecology but can also threaten the safety of the dam. The sudden collapse of the reservoir sides can create a wave that can over-top a dam and result in disaster.

The impacts on rim stability can not be prevented but, in some cases can be minimised if proper measures are taken. Also, in other cases the threat posed by a possible collapse of the rim can be such that the very viability of the dam can be questioned. Only the recent dams have commissioned studies on rim stability [NCAenv; Naidu 1994].

viii. Impacts on Human Health

For reservoirs in the tropical regions of the world, especially those that are below 1000 m elevation, there is a significant threat of vector breeding. Mosquitoes, which are carriers of malaria, filaria, dengue and other such diseases breed in small pools of water created in the edge of the reservoir due to the lowering and raising of the water level of the reservoir. In some areas snails, which are carriers of schistosomiasis, are also found to proliferate because of dams.

The World Bank identifies sexually transmitted diseases (STDs) and HIV, Hepatitis B & C, Malaria, Schistosomiasis, and Japanese encephalitis as diseases whose potential is increased by dams [WB 1997 p - 4]. Schistosomiasis is currently not prevalent in India and the CWC reports that "In India, only about three or four focii of schistosomiasis snails have been observed" [CWC 1992, p 17]. However, the fact that they are present in India and in some of the neighbouring countries means that there is an ever present danger of their spreading in India also, if a proper check is not maintained.

Increase in breeding of disease vectors has been anticipated in many instances. It has been part of the project study in 13 out of the 67 dams studied. In 3 instances it was stated that increased vector breeding was unlikely, because of the montane location of these projects: Tipaimukh – [GOI 1995], Srinagar [Goodland 1987] and Uri – [UHPP 1989]. However, in other projects, for example Sriramsagar and Ukai, the incidence of malaria reportedly increased [Annex 2.VI]. Raichur district in Karnataka became highly endemic for malaria after construction of Tungabhadra dam and its canal network [ERRC 1996]. In the Sirhind Feeder Canal Command Area, there is a "menacing increase in mosquitoes"[Dhesi 1996, pE.2].

The correlation between the spread of vector borne diseases like malaria and irrigation projects has been well studied and established (see, for example, Sharma 1991).

Primary Health Centres are generally recommended as remedial measures, though in one case it was stated that local farmers would be trained to control the occurrence of malarial vectors. Further, fluorosis was also noticed in Nagarjunasagar [Jauhari nd]. *Genu valgum,* a crippling bone disease associated with skeletal fluorosis, developed in young people, especially males. 75% of the cases were in the age group 10-20 years. Also, increased incidence of hepatitis was recorded in the case of Tawa [Choudhauri nd]. In the case of the Hasdeo-Bango reservoir, it is even stated that the increase in incidence of malaria could not be controlled by conventional measures [CWC 1991]. Even in monitoring reports of the Gandhi Medical College, Bhopal, significant rise in morbidity was recorded for the Narmada Project in post impoundment areas as compared to pre impoundment areas [ISP 1998].

The growth of malaria, especially since the 1970s, and the role of irrigation projects in this is most alarming. According to B.G. Verghese, "The resurgence of malaria in India appeared to coincide with the green revolution as the new hybrid varieties demanded more intensive irrigation. This in turn augmented and enlarged the area of breeding sites along the entire canal network. These mosquitoes could be vectors of malaria, filariasis or Japanese encephalitis [Verghese 1990, p - 239]. He goes on to quote V.P. Sharma, who says: " In many areas of the country it was, and still is, observed that the construction of canals brings malaria to healthy areas" [Verghese ibid].

The setting up of primary health centres and the spraying of pesticides are the two most common responses to the threat to human health. Unfortunately, the first is a curative rather than a preventive measure. Also, the effectiveness of pesticides is doubtful. Besides, the application of chemical pesticides results in health hazards that also need then to be assessed and tackled.

The new agricultural practices, many of which are consequences of the irrigation waters brought in by dams, also promote the use of chemical pesticides and fertilisers. These have well recorded and significant adverse impacts on the environment and on human health.

However, though the benefits of the anticipated increases in agricultural productivity are taken as a benefit of dams, the resultant costs of pesticides and fertilisers on the environment are very rarely computed or even studied.

It is unlikely that adverse health impacts can be totally prevented in dam projects. However, through proper efforts, they can be lessened. Unfortunately, in none of the projects studied was there a realistic assessment of health impacts. Many of them did not assess these impacts at all and the few that did, kept making the unrealistic assumptions that application of pesticides and the provision of primary health centres dissolved the problem.

ix. Impacts on the Water Quality

As already mentioned, the creation of a lake significantly changes the quality of water. It can reduce the oxygen content and result in the release of gases like methane and sulphuretted hydrogen. It can result in thermal stratification, with the cold water trapped underneath. Soils and stones containing naturally occurring mercury and other minerals can contaminate the water. These can then pass on to the fish and finally to human beings. There have been cases in the USA where people and animals have been diagnosed to have mercury poisoning due to this. Also, water falling over spillways can force air bubbles into the water, which can sometimes be absorbed into fish tissue, ultimately killing the fish. Stretches of stagnant water can encourage the growth of weeds and exotics [WWF 1999, p - 15].

In addition to the changes mentioned earlier, there is also a build-up of concentrations of pollutants that come into the lake through the atmosphere or through watercourses flowing into the reservoir. There is also significant non-point pollution due to human settlements and activities around the rim and in the immediate catchments. Whereas much of this would have flowed down the river, the dam prevents this and causes a build-up of concentrations of pollutants.

A form of contamination that is peculiar to reservoirs is mineral contamination from underground contaminants. Because of the weight of the reservoir, water is forced through cracks and faults in the reservoir bed, to a great depth. Such hydraulic continuity sometimes brings water into contact with mineral substances, such as arsenic, and results in the water in the reservoir becoming contaminated.

Within the available data, water quality has often been analysed only from the point of view of potability and suitability for irrigation. Analysis of the Middle Vaitarana dam water quality stated that sedimentation and siltation adversely affected the water in the reservoir [Badrinath et al. 1991]. The nutrient status of the reservoir has not been studied generally, though for Teesta Stage III project, it is stated that the reservoir will remain oligotrophic [NEERI 1991].

Water quality was studied for 11 dams, of these 5 reported no change, 2 reported better water quality and 4 stated that the water quality became worse. (See Annex 2.VI for details). However, considering changes in water quality are inevitable, both upstream and downstream of the dam, clearly more detailed studies are required.

Adverse impacts on water quality cannot be prevented. Some aspects can be controlled. However, as these are significant impacts, they must be taken into consideration, as they almost never were, while assessing the project.

x. Impacts of Reservoir Induced Seismicity

The weight of the reservoir, by itself or in conjunction with other reservoirs in the region, can create the sorts of pressures that result in an earthquake. The weight of the reservoir can also force water down cracks and faults till it catalyses an earthquake. The occurrence of reservoir induced seismicity is now a well accepted fact [WB 1990].

Verghese [1990] states that: "..Bhatsa Dam, near Bombay experienced an earthquake of 4.5 while minor tremors have been felt in the region of Hirakud, Nagarjunsagar, Ukai, Idduki and Mula dams (Srivastava). However, there was consternation when an earthquake of a magnitude of 6.5 shook Koyna in 1967, killing 117 people and causing some damage to the dam in an area regarded as seismically quiescent" (p 234). However, it is generally believed that RIS can only cause moderate earthquakes upto 3 or 3.5 M and that often the dam acts only as a trigger to larger earthquakes.

RIS has occurred in various dams across the world. Some of the cases are given below.

Table 2D : Reported cases of Reservoir-induced seismicity greater than magnitude 4.0 (Richter Scale)

Dam	*Country*	*Dam height (m)*	*Reservoir volume ($m^3 x 10^6$)*	*Impounding began*	*Largest earthquake*	*Magnitude*
Koyna	India	103	2,780	1962	1967	6.3
Kariba	Zambia/Zimbabwe	128	175,000	1958	1963	6.2
Kremasta	Greece	160	4,750	1965	1966	6.2
Xinfengjiang	China	105	14,000	1959	1962	6.1
Srinakharin	Thailand	140	17,745	1977	1983	5.9
Marathon	Greece	67	41	1929	1938	5.7
Oroville	USA	236	4,400	1967	1975	5.7
Aswan	Egypt	111	164,000	1964	1981	5.6
Benmore	New Zealand	110	2,040	1964	1966	5.0
Eucumbene	Australia	116	4,761	1957	1959	5.0
Hoover	USA	221	36,703	1935	1939	5.0
Banjina-Basta	Yugoslavia	90	340	1966	1967	4.5-5.0
Bhatsa	India	88	947	1981	1983	4.9
Kerr	USA	60	1,505	1958	1971	4.9
Kurobe	Japan	186	149	1960	1961	4.9
Monteynard	France	155	275	1962	1963	4.9
Shenwo	China	50	540	1972	1974	4.8

Table 2D (Contd...)

Table 2D (Contd...)

Dam	*Country*	*Dam height (m)*	*Reservoir volume ($m^3 x10^6$)*	*Impounding began*	*Largest earthquake*	*Magnitude*
Akosombo[2]	Ghana	134	148,000	1964	1964	4.7
Canelles	Spain	150	678	1960	1962	4.7
Danjiangkou	China	97	16,000	1967	1973	4.7
Grandval[2]	France	88	292	1959	1963	4.7
Kastraki	Greece	96	1,000	1968	1969	4.6
Lake Pukaki	New Zealand	106	9,000	1976	1978	4.6
Nurek	Tadjikistan	317	10,500	1972	1972	4.6
Fuziling	China	74	470	1954	1973	4.5
Khao Laem[3]	Thailand	130	8,860	1984	1985	4.5
Piastra	Italy	93	13	1965	1966	4.4
Vouglans	France	130	605	1968	1971	4.4
Clark Hill	USA	60	3,517	1952	1974	4.3
P. Colombia/ Volta Grade*	Spain	49	37	1960	1964	4.1
Manicouagan[3]	Canada	108	10,423	1975	1975	4.1

* Epicentre near Porto Colombia and Volta Grande dams.
SOURCE: Various, as quoted in Jauhari 1999.

Reservoir induced seismicity (RIS) was studied in nine of the 67 dams surveyed. In six of these, it was predicted. (See Annex 2.VII for details) It is interesting to note that 17 of the 75 cases of RIS reported world-wide have been reported from India [Singh 1990].

Though RIS cannot be prevented, the damage it causes can be minimised by strengthening all dam structures and also by strengthening other structures and buildings, old or new, in the region. This has a cost that should be assessed as a part of the project cost, but rarely is.

xi. Impacts on Micro Climate

The existence of a reservoir and the resultant changes in temperature and humidity can adversely affect the fauna and flora of the region, which might be naturally adapted to a warmer and drier climate. However, this aspect has also not been looked at in any of the dams studied. In one case it was reported that vegetation around the reservoir was affected and altered due to changes in the reservoir level. Groundwater levels around the reservoir were recorded to have risen in this instance and in the case of Tawa it was stated that trees around the reservoir were dying due to a stagnant water table [Choudhaury nd.].

A common impact of dams and irrigation canals is the infestation of weeds due to micro-climatic changes. This problem is mentioned in some of the projects. For example, in the case of Loktak, the existence of water hyacinth and other aquatic weeds in formidable quantities is creating many problems. The weed has reduced the live storage of the lake. Integrated watershed development combined with removal of water hyacinth and other aquatic weeds through manual harvesting and biological processes is necessary to improve the environment of the lake [CWC 1993a]. Weed infestation has also been reported from other projects: Malaprabha [CCPA 1995] and Hasdeo Bango [Redecon 1996a].

Impacts on micro climate can also not be prevented. However, the environmental impacts they have should be assessed while formulating and appraising the project.

At the Canal/ Command

i. Impacts of Water Logging and Salinity

Water Logging

Canals themselves can directly contribute to water logging. If not properly lined, or maintained, significant amounts of water can seep out of canals and inundate the lands around [GOI 1989, p - XI-3]. Also, when subsidiary canals are not well maintained, when the releases of water are not properly monitored, or when drainage is not assured, water logging results. There is an unfortunate tendency among engineers to pay less attention to subsidiary canals which aggravate water logging problems [Verghese 1990, p – 93].

Water logging not only reduces the anticipated agricultural benefits from irrigation projects but sometimes reduces them to levels below even those before irrigation was introduced. A well known and documented case is that of the Tawa dam in Madhya Pradesh. According to the Comptroller and Auditor General (CAG) of India:

"The table given below shows the comparative position of the yields per acre under various crops after irrigation during 1977-78 and 1978-79 and the yields prior to introduction of irrigation (1971-72) in Hoshangabad district, as per the Agricultural Statistics compiled by the Commissioner. Land Records.

Table 2E

Crop	Before irrigation	Average yields per acre after irrigation (in quintals)	
		1977-78	1978-79
1. Paddy	4.00	2.98	3.83
2. Jowar	2.82	3.64	2.74
3. Maize	4.81	4.07	4.01
4. Wheat	3.14	3.30	3.06
5. Gram	2.43	1.96	2.08

"It will be noticed that the yields per acre after irrigation had actually declined.

"According to the scientific and technical opinion now available, because of the soil and weather conditions in the command area of the Tawa project, agricultural operations in both *kharif* and *rabi* seasons with the help of irrigation could not have been productive, but on the other hand, irrigation could be even harmful. There was also resistance on the part of cultivators to a change in their habits and the cropping pattern they have been used to. Thus, it would appear that the project was ill conceived and the benefits that were presumed would be available could not have been realised" [CAG 1979-80].

Water logging can also be one of the causes of salinity and provide a conducive habitat for vector breeding. It destroys natural vegetation and damages houses, buildings and roads.

In some of the recent dams an attempt has been made to study this aspect. Two such examples are the Narmada (Indira) Sagar Project and the Sardar Sarovar Project. However, a report by Kalpavriksh [KV 1988] on the Narmada dams has the following to say:

"A similar situation could arise in the NSP and SSP commands. A study on the waterlogging potential of NSP, done by the Indian Institute of Science (IISc), Bangalore, and sponsored by the Narmada Planning Agency, notes that a very large part (perhaps about 40%) of the command area will become water-logged given the surface/ground water use pattern proposed in the original design of the project (Sridharan and Vedula, Mar.1985). This report has suggested a different surface-groundwater use ratio, viz. predominantly 70:30 instead of 80:20 as now proposed, to avoid waterlogging. This would necessitate the sinking in of a tube well every 6.3 ha. With a 3 bhp motor to prevent water logging. The cost of doing this has been computed at Rs.54 crores (Narmada Valley Development Authority, JAN.1986-II), but it is not clear if this cost has now been included in the cost-benefit ratio (it had not been in the original ratio). One estimate puts the power requirement for the wells at 45 MW, which is one-third of the firm power generation of NSP! [Alvares and Billorey 1987].

"Even the IISc study, critical as it is, does not take into consideration the reservoir of the SSP which will intrude into or border the NSP Command area over a long stretch. If the reservoir is taken into consideration, the problem of water logging could become much more severe and the sinking of additional wells would not solve the problem as the wells, in effect, would be attempting to drain the reservoir. This scenario has not been studied.

"For SSP, the project authorities claim that lining of canals, conjunctive use of groundwater, and a much more limited supply of water per unit of land than given in previous irrigation projects, will greatly reduce the possibility of waterlogging [NPG 1983]. However, of the huge command area of over 18 lakh ha, only a small portion of 4.7 lakh ha. – the Narmada-Mahi Doab – has actually been studied for drainage and potential waterlogging [CCPL 1982]. The remaining over 13 lakh hectares has not yet been studied. Much of this is semi-arid land which is known to be prone to salinisation problems. This is because the hot climate causes rapid evaporation of irrigation water from the surface of fields, leaving an encrustation of salts behind. Besides, it is also known that the sub-surface water in this region is saline and, therefore, salinisation could be aggravated even further" [KV 1988].

Water logging is studied in 23 of the 67 dams for which data were examined. However, its occurrence has been recorded in only 11 cases. In some instances, more than half of the proposed command area has been subject to water logging. Of these 23 dams, six dams have predicted that there would be no water logging. However in two dams water logging has occurred despite it not being predicted (See Annex 2.XIV for details).

Water logging can be prevented by lining and properly maintaining the canals, and by regulating water use and cropping patterns. However, in some cases either it is impossible to prevent water logging or the costs of prevention are so high that they make the project economically non viable. In fact, the Central Water Commission, in the Theme Paper on Water and Environment, 1992, says: " Provision of drainage is expensive and many water resources projects may not be economically viable, if, this component is added to the cost of new projects. The issue needs to be resolved quickly." [p 31]

There have been various estimates of the extent of water logging in different command areas. Two such estimates are given below.

Table 2F : Water logged areas in different irrigation command areas of India*

S. No.	*Irrigation command area*	*Area (million ha.)*
1.	Ukai-Kakarpar Project, Gujarat	0.008
2.	Male Prabha Project, Karnataka	0.001
3.	Gandak Project, Bihar	0.400
4.	Ram Ganga Project, U.P.	0.350
5.	Rajasthan Canal Project, Rajasthan	0.170
6.	Sri Ram Sagar Project	0.080
7.	Hirakund Project, Orissa	0.060
8.	Kosi Project, Bihar	0.120
9.	Nagarjun Sagar Project, A.P.	0.110
10.	Chambal Project, M.P.	0.030
11.	Tungabhadra Project, Karnataka	0.010
	TOTAL	**1.339**

* SOURCE: [Rao 1984]

Table 2G : Extent of water logging in selected irrigation projects in India (000 hectares)

S. No.	*Irrigation Project*	*State*	*Water logged area*	*Percentage-Water logged area ---x100 Potential*
1.	Sriram Sagar	Andhra Pradesh	60.00	47.62
2.	Tungabhadra	Andhra Pradesh	4.65	1.27
3.	Gandak	Bihar and Uttar Pradesh	211.01	21.11
4.	Ukai-Kakrapar	Gujarat	16.25	4.32
5.	Mahi-Kadana	Gujarat	82.00	16.81
6.	Malaprabha	Karnataka	1.05	0.99
7.	Chambal	Madhya Pradesh and Rajasthan	98.70	20.31
8.	Tawa	Madhya Pradesh	-	-
9.	Rajasthan Canal	Rajasthan	43.10	7.98
10.	Sarda Sahayak	Uttar Pradesh	303.00	28.34
11.	Ram Ganga	Uttar Pradesh	195.00	38.99
	TOTAL		**1014.76**	

SOURCE: [Joshi and Agnihotri 1984, p 528-536]

This, then, remains one of the major hidden costs of many of the dams in India.

Salinity

Of 67 dams surveyed, the possibility of salinity had been studied in seven dams (Bisalpur, Dharoi, Gandhi Sagar, Hasdeo Bango, Isapur, Kadana and Polavaram). The occurrence of salinity was reported in five dams (Dharoi, Gandhi Sagar, Hasdeo Bango, Isapur and Kadana). Mitigation Plans were also prepared for five dams (Bisalpur, Gandhi Sagar, Hasdeo Bango, Isapur and Kadana) (See Annex 2.XV for details).

For the Chimmoni dam, the Environmental Monitoring Committee recommended that a monitoring mechanism must be set up to study soil salinity levels at regular intervals in the command area (Trissur Kole Land Area) [CWC 1993a]

Extensive salinity and water logging was also reported from the Chambal Project in Rajasthan by the official consultants [WAPCOS 1996b]. Similarly, the official consultants for Dharoi Project, in Gujarat, report heavy water logging and salinity [KICONS 1996, p E-14].

Given the loss of productivity due to soil salinity, this is again an undervalued cost.

ii. Impacts on Terrestrial Biodiversity

Like dams, canals also have significant impacts on terrestrial biodiversity. A large amount of forest land is diverted due to canals. For example, 1359 ha of forests was diverted for the Srisailam Right bank Canal. Similarly, 273.12 ha was diverted for the Sriram Sagar canal and 118.577 ha for the Bariarpur Left Bank Canal (MP) [CWC 1996]. For the Surya Canal (UP), 1250 ha of forests, 8000 ha of agricultural land, and 3250 ha of grazing land were diverted [Afroz and Singh 1987]. Apart from destroying natural ecosystems and impacting on species of fauna and flora, they very often cut the migratory routes of animals and also divided up their habitats. There are many examples of this, including the recent one where the range of the Wild ass in Gujarat will be adversely affected by the construction of the Sardar Sarovar canals [NCAenv]. In none of the projects that were studied was this aspect assessed. Consequently, the costs of such an impact were not taken into consideration while assessing any of the projects studied.

iii. Impacts on Natural Drainage

The construction activities associated with canals also interfere with natural drainage across a slope and thereby lead to water logging on the up slope side of the canal, where the water collects, and aridity on the down slope side. However, none of the projects studied assessed the impact of this.

Even after they are constructed, canals interfere with natural drainage and thereby lead to water logging, on the one hand, and aridity on the other. However, none of the dams studied took cognisance of this fact.

iv. Impacts on Vector Breeding

Like in reservoirs, canals also provide a habitat for the breeding of vectors. The areas that get water logged because of canals are also good habitat for disease carrying vectors. However, none of the dams studied took cognisance of this fact.

At or Adjacent to Power Lines

i. Dust Pollution

The construction of power lines results in a certain amount of dust pollution. This has also not been studied in any of the projects surveyed.

ii. Impacts on terrestrial biodiversity

Very often corridors have to be cut through forests and other natural ecosystems to accommodate power lines. This adversely affects the terrestrial ecosystems. These corridors have also to be maintained in order to allow the repair and upgradation work on power lines. Therefore, the impact of these corridors is often long term.

According to one estimate, the right of way required for power lines varies in width from seven metres in the case of 11 kv lines to 15 metres for 33 kv, 18 meters for 66 kv, 22 metres for 110 kv, 35 metres for 220 kv and 52 metres for 400 kv [Verghese 1990, p - 199]. In Uri Project, for example, 98.54 ha. of forest land was given clearance for transmission lines in J&K.

The impact of power lines on forests, in terms of the forestland required, is now assessed as projects need forest clearance. However, the impacts on biodiversity were not assessed in any of the projects surveyed.

iii. Impacts of Radiation

Power lines, especially high-tension lines, are known to produce high levels of radiation, affecting ecosystems and human beings. High-tension power-lines can also be sources of fire hazards and be hazardous to birds and other animals. These aspects have also not been looked at in any of the dams studied.

Impacts Downstream

Despite popular belief that the major environmental impacts of dams are upstream of the dam, the downstream adverse impacts of dams are often even greater. However, historically these have been relatively ignored.

i. Impacts on aquatic ecosystem and biodiversity downstream

Even during construction there are a lot of downstream impacts. For one, construction activities cause a lot of pollution of the river and send down huge amounts of silt and mud. Also, the diversion of the water through a tunnel leads to adverse ecological impacts. The dumping of excavated and construction material in a way that it contaminates the environment is another problem. For example, this has been identified as a problem in the Subarnarekha Project [CWC 1991] and in the Indira (Narmada) Sagar Project. Also, due to the construction of four dams as a part of the Upper Indrawati project, there would reportedly be a vast dry area down stream as the water would not be released downstream but would be channelled to river Hati - a tributary of Mahanadi. [OKM nd.] Due to Uri project, 5 endemic species of fishes and some molluscs would also get affected as no water would pass through the barrage during dry spells. [UHPP 1989]

The interference that dams cause to the natural flow of a river causes significant downstream impacts. By interfering with river flows, they adversely affect downstream flora and fauna. There is a popular misconception that as most dams supplement dry season flows and only partially curtail rainy season flows, their impact downstream is negligible or even, sometimes, positive. However, in actual fact, riverine ecology needs the heavy rainy-season flows as it is during this time that many fish species breed. By curtailing rainy-season flow, the dam inhibits the ability of the ecosystem to regenerate itself.

According to a World Bank Technical Paper [Mahmood nd] : "On the downstream side, the flow tends to pick up the sediment load from the stream bed leading to retrogression of channel bed and water level, erosion of banks, elimination of nutrients carried by the fine sediments, deterioration of channel morphology, increase in the hydraulic resistance of flow, elimination of oxbow lakes and reduction of wildlife food supply" (p2).

Heavy rainy season flow also acts as a flush for the riverbed and mouth, clearing them of accumulated silt, garbage and stale water. The absence of such a flow creates significant problems down stream and decreases the capacity of the riverbed to accommodate peak flows, leading to larger floods in the case of cloudbursts or sudden releases of water.

In many irrigation projects, a significant amount of water is diverted from the river and transported out by canals. This results in significant shortfalls in the natural flow and in the net flow of water in the river. There are, again, serious ecological implications of this.

In 'run-of-the-river' projects with diversion tunnels, often a stretch of the river downstream of the dam, to the point where the diversion tunnel feeds back into the river, becomes dry. This has adverse impacts on riverine ecology and breaks the ecological continuity of the river ecosystems.

A large proportion of the nutrients that flow down the river and form an essential part of the food-chain of the river's ecosystem, get trapped by the dam thereby starving the ecosystem. This also has significant deleterious effects.

The reduction of river flows can also result in the collapse of riverbanks leading not only to erosion but also to a muddying of the river. This leads to a filling up of riverbeds, making the rivers more prone to flooding, and also to the river becoming insufficiently oxygenated and relatively opaque and impervious to sunlight. All these also negatively affect aquatic fauna and flora.

The fact that, in hydroelectric projects, the water has to pass through turbines also results in significant fish and other faunal mortality and trauma. In some projects screens are provided that filter out fish, thereby denying them passage to the lower reaches of the river.

The inability of certain species of fish to travel up stream, which they must do in order to breed, has already been mentioned earlier. The recent tendency to, therefore, set up breeding centres for such fish might ensure the availability of these fish downstream but does not compensate for the ecological roles these fish species played in the riverine ecosystem upstream of the dam.

Impacts on the river ecosystem downstream were studied in five of the 67 dams surveyed. In all these five dams it was predicted that there would be adverse downstream impacts. There is further indication that at least in four of these it was subsequently studied and confirmed that there were adverse downstream impacts (See Annex 2.IX to 2.XII for details).

These impacts cannot be avoided but they must be recognised and minimised. Besides, as these are among the severest of the impacts of a dam, they must be taken into consideration while assessing dams.

ii. Impacts on Downstream Fish

The disturbance and pollution of the river, during the construction phase, has impacts on the fish downstream. This was, however, not studied in any of the dams surveyed.

Post construction effects, as already described above, have many adverse impacts on downstream fish. These can also have a negative impact on coastal and sea fish. The two mitigative measures that are occasionally planned are the construction of fish ladders for species that migrate upstream to breed, like the *mahseer*, or the artificial breeding and introduction of fish species downstream.

Though this has been recognised as a problem for most dams, there are very few studies that assess the impact on downstream fish after the dam has been operationalised, except for commercially valuable species. Of the dams studied, only five had studied the impact on fish after the commissioning of the dam. In one of these (Isapur) of these it was stated that fish populations downstream of the reservoir would increase. (See Annex 2.IX for details).

Again, this impact cannot be avoided but can be reduced. The cost of reduction and the cost of the residual impacts must be computed and included into ihe CB ratio of a dam. This is very rarely done.

iii. Impacts of activities related to the rehabilitation of project affected persons

Often sites for rehabilitating the project-affected persons are carved out from forest areas or from other ecologically valuable areas. This obviously leads to the degradation of the area. Also, when large human populations are shifted to new locations, there is often serious adverse impact on the neighbouring environment. This is especially so if adequate resources have not been planned for and made available to meet the water, land, fuel wood and fodder needs of these populations. Forests and other natural resources are also sometimes degraded because lack of other livelihood options force the project affected people to earn their living by extracting fire wood and fodder at an unsustainable rate.

Many examples of this are available. For Chandil Dam, forest land was to be diverted for resettlement [WB nd.]. In Nagarjuna sagar 14,000 ha. of reserved forest was denotified for rehabilitation [Jauhari nd. & Rao 1979]. In case of Sriram Sagar, compensatory afforestation was reported to be less than what was diverted for rehabilitation [Kothari 1994a]. Forest land was also diverted for rehabilitating PAPs of the Sardar Sarovar Project [NCAenv].

Almost no attention has been paid to these impacts.

iv. Impacts of water availability downstream

The variation and reduction in water-flows in the river also adversely affect water availability downstream, both from surface sources and because of inadequate re-charging of ground water. The fact that some of the rivers waters are diverted into the canal also result in less water coming down. This affects the downstream ground and surface water resources. There are also huge water losses from the canals and the reservoir. In Malaprabha, for example, "Conveyance losses in both lined and unlined systems are generally 300% of those assumed. In MLBC, in lined reaches, losses are as high as 7.48 and 20.24 cumecs/ M sq m against assumed loss of 0.61 cumec/ M sq m" [CCPA 1995, p5]. Similarly, in Hasdeo Bango Project, "Seepage losses in the conveyance system are 2 to 3 times more than the designed conveyance losses.." [REDECON 1996a, p56].

Though in some of the recent projects this aspect has been studied, its impact tends to be underestimated. Very few assessments of what actually happens after the dam comes up were available.

v. Impacts on water pollution levels downstream, especially due to reduced river flow

River pollution could occur downstream, during construction, due to one or more of the following reasons:

- Waste water from excavations
- The construction and removal of coffer dams
- Wash water from concrete and aggregate plants
- Oil leakage and waste disposal
- Sewage and storm water
- Hot water effluents
- Soil erosion during reservoir clearing

Even after construction, reduction and variation in the flow of the river can also result in the increase of concentrations of pollutants downstream, as less water is available for diluting the pollutants.

In none of the dams surveyed were downstream pollution impacts assessed prior to the appraisal of the project. Studies were conducted after the construction of the dam in a few cases. Regulation of the flow downstream is stated to have had a positive impact on the water quality in one case (Gandhisagar) [WAPCOS 1996b]. However, in another case it is mentioned that lower volume of water downstream resulted in greater concentration of pollutants. In Hasdeo Bango there is a negative impact on water quality due to increase in fluoride content [CWC 1991]. Also, there is thermal pollution of the canal water by the neighbouring industries and power stations [REDECON 1996a, p111]. The only other study of water quality dealt with the potability and usefulness for irrigation of the water in the command area: Malaprabha [CCPA 1995]).

This is an impact that can be reduced by proper management. However, the cost of reduction and the cost of the residual impacts must be taken into consideration when a project is being assessed. This also remains an unanticipated impact.

vi. Possible salt-water ingress

Where the quantity and force of water reaching the river mouth and, through it, the sea, is reduced, there is a danger of salt-water ingress. Such ingress can not only destroys the riverine and terrestrial ecosystems but can also contaminate ground water resources.

The phenomenon of salt-water ingress, though not studied in any project formulations, was noted in post-construction analyses for one dam (Ukai). A project for the prevention of salinity ingress has been initiated in Gujarat since 1976, to deal with 160 km of the Saurashtra coast subject to saline ingress [CWC 1996].

This is an inevitable impact for dams located near the sea or where the total water flow below the dam remains very low compared to the natural flow. Though this impact can be reduced, it cannot be totally eliminated. However, its costs are never taken into consideration during dam appraisal.

vii. Impacts on coastal and marine ecology

Changed water and silt flows also have an impact on coastal and marine ecology. In certain areas, the first monsoon floods are essential to open the sand barriers that seal coastal backwaters from the sea during the dry season. This enables a flushing of the backwaters and a mixing of fresh and saline water, which is essential for the breeding of many fresh water and marine fish and crustaceans. The changes in river regime disrupt this ecological function and inhibit the reproductive cycle of these species. Also, the depleted flow of nutrient's result in insufficiency of food for various marine species.

In other cases, reduced flows can lead to the erosion of estuaries and coasts.

This impact is also inevitable, though it can be somewhat reduced. However, its costs are never taken into consideration while appraising a project.

viii. Impacts of sudden release of water or of dam failure

Construction of dams is done in stages, sometimes with the help of a coffer dam. Therefore, water starts getting impounded much before the dam is completed. If for any reason there is a sudden release of water or dam failure at this stage, it can have disastrous results. A case was reported from Western Sikkim, where the coffer dam of the Rangit Hydro Power Project was washed away due to flash floods, even while the dam was being constructed [ET 23/07/1995]. However, this possibility is not assessed or provided for in any of the dams surveyed.

Even after construction, due to degraded catchments, excessive rainfall or over-filling of reservoirs, it may become necessary to make sudden releases of water from the reservoir in order to protect the dam structure. Such sudden releases can be disastrous for the people living downstream, for their crops and for the downstream ecosystems.

Reportedly, such releases occurred twice from the famous Bhakra Dam, in the late 1970's and again in 1988 [ET 09/07/1995].

A recent case was that of the Rihand Dam. In 1997, huge amounts of water were suddenly released and flooded 175 villages in Rewa district of Madhya Pradesh as well as Rewa town, killing 14 people and causing an estimated damage of Rs 200 crores [IE 29/09/1997].

The failure of the dam, where the structure collapses and allows the reservoir to partially or totally drain out, is a catastrophe for downstream ecosystems and human populations. There are many causes of dam failure. It can be due to faulty design or construction, use of sub standard materials, over-topping due to surplus water, due to deliberate sabotage or bombing, and because of severe earthquakes. In some cases, whereas the dam structure might remain intact, the neighbouring hillsides crumble having the same effect as the dam collapsing (see chart below).

Causes of Dam Failures
(World wide 1900-1975 for dams in excess of 15 m)

Type of Dam	*Cause*	*%*
Concrete Dam	Overtopping	29
	Foundation	53
	Seepage	0
	Other	18
Fill Dams	Overtopping	35
	Foundation	21
	Seepage	38
	Other	6
All Types	Overtopping	34
	Foundation	30
	Seepage	28
	Other	8

SOURCE: [WB 1990]

In the case of the Manchu Dam – II. "The initial design flood capacity of the spillway was 200, 000 cusecs based on an estimated PMF of 191,000 cusecs. However in August 1979 the dam was overtopped by a flood of 460,000 cusecs. As a result of this a complete review of the hydrology lead to a revised PMF estimated at around 739,000 cusecs, which was nearly four times the original design flood. Even as this revised design was about to be built a still greater flood occurred which required the PMF to be raised still further to around 933,000 cusecs. This is a five fold increase on the original design flood in just 20 years." [WB 1990, p 71]

According to Dr. Y.K. Murthy [WB 1990, p 62], a study of 131 dams funded by the World Bank in India showed the following results:

1.	Spillway capacity not satisfying Indian Standard Code	20
2.	Freeboard not conforming to Indian Standard Code	25
3.	Seismic factor not taken into account in the design of the dam (mostly old dams)	15
4.	Non-study of Emergency Reservoir Operation Plans	90
5.	Distress manifestations reported	36

Dr. Murthy goes on to report that, according to the CWC data, an increasing number of dams are showing distress. In Maharashtra State alone, distress in 46 dams has been reported.

An assessment of dam failures reveals that foundation seepage and overtopping are the two most common reasons (see diagram below).

Recently, fears have been expressed that the Tehri dam is not safe. In case the Tehri dam collapses, according to the MoEF (Prime Minister's briefing note) the impact would be as follows.

Table 2H

Place	*Distance from Dam (Km)*	*Arrival Time for Surge (Hrs)*	*Depth of Surge (meters)*
Dam	0	Approximate Time of Emptying of Reservoir = 22 (minutes)	260
Rishikesh	80	0.63	260.00
Hardwar	104	0.80	232.00
Bijnor	179	4.45	17.72
Meerut	214	7.25	9.85
Hapur	246.5	9.50	8.78
Buland Shahar	286.5	12.00	8.50

As can be seen from the Table 2.H above, in less than an hour and a half the water would hit Rishikesh and Hardwar and wipe out these two cities. This is certain because the height of the water would be 260 metres and 232 metres respectively. This would result in horrific loss of life and property. In order to assess how this can be minimised and to what extent, a disaster management plan is essential. This plan would also prescribe the communications and personnel networks that would need to be in position and the costs involved in all this. These costs would have to be calculated as a part of the cost benefit analysis of the project.

There have been many dam failures across the world in the last 140 years. Some of them are listed below.

Table 2I : Recorded dam failures since 1860 which have killed more than 10 people [Sources: Various, as quoted in Jauhari 1999]

Dam	*Country*	*Type*	*Height (m)*	*Year completed*	*Year failed*	*Cause of failure*	*People killed*	*Cost of damage*
Dale Dyke (Bradfield)	England	E	29	1858	1864	SF	250[1]	£0.5 m
Iruhaike	Japan	E	28	1633	1868	OT	>1000[2]	
Mill River	MA, USA	E	13	1865	1874	SF	143	>$1m
El Habra†	Algeria	R	36		1881	OT	209	
Valparaíso	Chile	E	17		1888	SF	>100	
South Fork (Johnstown)	PA, USA	E	22	1853	1889	OT	2,209	
Walnut Grove	AZ, USA	R	34	1888	1890	OT	150	
Bouzey	France	G	15	1881	1895	SF	150[1]	
Austin	PA, USA	G	15	1909	1911	SF	80	
Lower Otay	CA, USA	R	40	1897	1916	OT	30	
Bila Desna	Czechosl-ovakia	E	17	1915	1916	SF	65	
Tigra	India	G	24	1917	1917	OT	>1,000[2]	
Gleno	Italy	M, G	44	1923	1923	SF	600	
Eigiau/Coedty §	Wales	G/E	11	1908/19	1925	PI/OT	16	
St.Francis	CA, USA	A	62	1926	1928	SF	450	
Alla Sella Zerbino	Italy	G	12	1923	1935	OT	> 100	
Vega de Terra (Ribadelago)	Spain	B	34	1957	1959	SF	145	
Malpasset (Fréjus)	France	A	61	1954	1959	F	421	
Orós	Brazil	E	54	const	1960	OT	c.1,000	
Babii Yar	Ukraine	E			1961	OT	145	
Panshet/Khadakwasla§	India	E/R	54/42	const/1879	1961	SF, OT/OT	> 1,000[2]	
Hyokiri	S.Korea							
Kuala Lumpur	Malaysia							
Vaiont	Italy	A	261	1960	1963	OT	2,600	
Quebrada la Chappa	Colombia							

Table 2 I (Contd...)

Table 2 I (Contd...)

Dam	*Country*	*Type*	*Height (m)*	*Year completed*	*Year failed*	*Cause of failure*	*People killed*	*Cost of damage*
Swift	MT, USA							
Zgorigrad (Vratza)	Bulgaria	Ta	12			OT	> 96	
Nanaksagar	India	E	16	1962	1967	SF/OT	c.100	
Sempor	Indonesia	R	54	const	1967	SF/OT	c.200	
Frías	Argentina	R	15	1940	1970	OT	> 42	
Buffalo Creek	WV, USA	Ta	32	const	1972	OT	125	$30-50m[15]
Canyon Lake	SD, USA	E	6	1938	1972	OT	237*	$60m
Baniqao, Shimantan, 60 others	China	E		late 1950s	1975	OT	≤230,000[4]	
Teton	ID, USA	E	90	1976	1976	SF	11-14	$0.4-1bn
Laurel Run	PA, USA				1977		39[3]	$20-45m[2]
Kelly Barnes (Toccoa Falls)	GA, USA	E	13	1899	1977	SF	39[3]	
Machhu II	India	E	26	1972	1979	OT	> 2000	$15m crops
Gopinatham	India			1980	1981	OT	47[5]	
Taus	Sapin	R	77	1980	1982	OT	> 20[6]	
Stava	Italy	Ta		1960s	1985		269[7]	
Kantalai	Sri Lanka	R	15	1952	1986	PI	82[8]	
Sargazon	Tadjikistan		23	1980	1987		> 19[9]	
Belci	Romania	E	18	1962	1991	OT	c.48[10]	
Gouhou	China	R	71	1987	1993	PI	342[11]	$18m
Tirlyan	Russia	E	10	<1987	1994	OT	19-37[12]	Rs40bn
Virginia No.15	S.Africa	Ta	47		1994		39[13]	$15m
Lake Blackshear Project/Flint River Dam	GA, USA	E	< 15		1994	OT	15[14]	
N/A	Philippines	N/A	N/A	N/A	1995	N/A	c.30[15]	

Notes : *Dam types:* E=Earthfill; R=Rockfill; G=Gravity; M=Multi-arch; B=Buttress; A=Arch; Ta=Tailings. *Cause of failure :* OT=overtopping; PI=piping; SF=structural failure; F=geological/foundation weakness.

* unable to distinguish dam break fatalities with those caused by 'natural' flood.

† El Habra first failed in 1872 without loss of life. It was then rebuilt, failed again in 1881, rebuilt again, then failed again in 1927 (without fatalities) and was then abandoned.

§ The flood from the collapse of the first dam breached the second dam downstreams.

The impact of dam failure on downstream areas has not been studied in any of the dams. Critical assessments of the Hirakud dam do point out though that the dam developed cracks even before it was completed [Subakar nd]. The Nizamsagar dam is designed for a lower peak outflow than the magnitude of the maximum expected flood [GOAP 1965]. In Gandhisagar [Gupta 1998] it has been stated that peak flows could be higher than anticipated and could, therefore, put the dam at risk.

In 1995, the Central Water Commission made a list of 33 Indian dams which have structural and hydrological defects. In the same year the World Bank reportedly categorised 25 Indian dams as unsafe [IE 27/05/1995].

For example, the Bhadar (Rajkot) Project has been judged as unsafe by the official consultants. According to them "the spillway has been constructed for a design flood of 5660 cumecs ..... in 1979, the CDO of Gujarat revised the design flood in consultation with the CWC and accordingly probable maximum flood was placed at 24887 cumecs. The present spillway obviously cannot cope up with this large flood" [CCPA 1996 p xxix]. The consultants go on to say that " The present inspection seems to be cursory and the Dam Safety Organisation attached to the Gujarat Engineering Research Institute (GERI), because of staff constraint, finds time to inspect only once in 3 or 4 years. The necessity of dam break flood analysis and corresponding inundation maps as well as disaster preparedness plans has also been emphasised" [op cit, p xxx]

In none of the dams studied was there a proper disaster management plan, which not only laid down how to prevent or minimise disasters but also on how to minimise and mitigate the effects of such a disaster.

The huge loss of human life and property that dam failures imply, along with the threat perception that the downstream populations have to live with, make the assessment of dam safety a very critical issue. Unfortunately, in dam after dam it has been observed that the required attention is not being paid to this very serious aspect of dam appraisal. However, there is a dam safety Organisation that presumably is charged with assessing the safety status of dams in the country. Unfortunately, despite efforts, reports of this organisation were not available and do not appear to be in the public domain.

ix. Decommissioning of Dams

At the end of the life of a dam it has to be decommissioned otherwise the structure could collapse and cause havoc downstream. Decommissioning involves the safe disposal of all the silt that has accumulated in the dam, of the dam material and of the water accumulated in the reservoir. It also involves the opening up of the river course. This has significant financial costs and also various environmental costs, especially if it is not done properly. At the time of decommissioning it has to be ensured that the structure does not suddenly collapse as this would lead to huge destruction downstream.

Unfortunately, for none of the dams were the impacts of decommissioning studied or the costs calculated.

2.2.2 Discussion

It would be clear from the findings presented above that all is not well with large dams, at least as far as the anticipation, assessment, prevention and mitigation of environmental impacts goes. However, by just looking at the findings, it is not obvious why such a state of affairs exists. To understand that, we must examine the process by which large dams are assessed for their environmental impacts.

For activities and projects that can have an impact on the environment, usually it is considered necessary to conduct an environmental impact assessment (EIA) that assesses the likely impacts of the project or activity on the environment. Based on an EIA, preventive and mitigative strategies can be designed and the cost of such strategies and the residual impacts can be calculated. All this should be the basis for assessing the environmental viability of the project or activity. It should also feed into the overall decision making process by which the proposed project or activity is approved or rejected.

The Process in India

For large dams, the requirement of getting environmental clearances and, therefore, conducting an environmental impact assessment, was introduced in India only in 1978, and that also more as a matter of policy than a statutory requirement. It became a statutory requirement only in 1994, with the necessary modifications in the rules of the Environment (Protection) Act (EPA) of 1986.

From 1978, all dams were required to get an environment clearance from the Department of Science and Technology (DST), before they could be posed for investment clearance to the Planning Commission. The DST accorded environmental clearances based on an environmental impact statement (EIS) prepared by or on behalf of the project proponents and assessed by the National Committee on Environmental Planning and Co-ordination (NCEPC).

In 1980, the Department of Environment was formed and the responsibility of according environmental clearances was transferred to it. In the same year, the Forest (Conservation) Act was notified and under this act any diversion of forest land for non-forest purposes, which included dams, had to be cleared by the Government of India. From 1980 till 1985, the Department of Forests and Wildlife in the Ministry of Agriculture had the responsibility of according forest clearances for forest lands to be submerged or otherwise diverted for dams.

In 1985, the Ministry of Environment and Forests was set up and both the Department of Environment and the Department of Forests and Wildlife became a part of this new Ministry. Since 1985, it is this ministry which has the responsibility of carrying out an environmental impact assessment and giving both the environment and forest clearances. However, as already mentioned, though forest clearances were legally mandatory after 1980, environment clearances became legally mandatory only in 1994.

In 1985, the Ministry of Environment and Forests (MoEF) issued guidelines for environmental impact assessment of river valley projects. These guidelines are still in use and deal mainly with the upstream impacts, but include questions relating to rehabilitation (copy at annex 2.I).

For many years now, the environmental appraisal committee (EAC) for river valley projects, set up by the MoEF, performs the function that was originally performed by the NCEPC. The EAC is composed of expert members from both within and outside the government. Traditionally, the chairperson has been a non-official. Since 1994, it has been specified in the rules that the Chairperson must be "an outstanding and experienced ecologist or environmentalist or technical professional with wide managerial experience" (EAP rules). Unfortunately, in the recent past there has been a tendency to appoint retired government officials as chairpersons, some of whom might have the prescribed qualifications, but many do not.

The EAC assesses the impacts of river valley projects, based on the EIS prepared by or on behalf of the project proponents. The EAC also visits some of the project sites. Based on all this, it recommends to the MoEF whether a project should be unconditionally cleared, cleared with conditions, or rejected. Even before the final recommendation is made, it advises the MoEF on what further information or undertakings are required from the project authorities and assesses the information and undertakings so provided. However, it is essentially an advisory committee whose advice can be rejected by the MoEF, or by the Government. Similarly, there is an advisory committee to recommend cases for forest clearance.

In January, 1994, the rules of the EPA were amended to make public hearings a mandatory part of the assessment process. However, within a very short time the rules were again amended to make such hearings optional, replacing the word 'shall' with the word 'may' in the operative sentence. In 1998, public hearings were once again made mandatory by a further amendment of the EPA's rules.

Within the Central water Commission, an Environmental Monitoring Committee was constituted in 1990. This committee is supposed to oversee the implementation of environmental safeguards stipulated by the MoEF [CWC 1996b] Similarly, state and project level environmental monitoring committees were also supposed to be set up and many have been set up.

Some Issues Relating to the Assessment Process

i. A lack of assessment till 1978

Projects cleared before 1978 were not required to go through any environmental assessment. The results of this are obvious when the data concerning such dams are studied. In such cases the only two environmental aspects assessed, and that also in a few cases, as a part of project assessment were the rates of reservoir siltation and the extent and severity of water logging. However, these were also not assessed from the environmental perspective but only from the techno-economic perspective, in terms of the threats or design challenges they posed and the economic costs they implied. This scenario emerges from the earlier discussed findings.

Even for these, the findings suggest that in many cases the actual rates of siltation and the actual extent of water logging were much higher than what was anticipated. Unfortunately, information on only a few dams is available for, in most cases, no retrospective assessment was done.

Another aspect that was sometimes studied was the threat to the dam because of possible seismic activities. Here, again, the techno-economic aspects specific to the dam were studied.

There was also, in a few cases, concern about the impact on fisheries, especially at the reservoir, but again only in terms of economic losses and gains.

Apart from these, most of the many other likely and inevitable impacts of dams, listed earlier, were not by and large looked at.

ii. Appropriateness of Environmental Impact Assessments

There is a general paucity of data, especially credible independent data, on environmental aspects relevant to the assessment of dams. There are Botanical and Zoological Surveys in India, and a Ministry of Environment and Forests along with state departments of environment and forests. However, despite this, detailed information on terrestrial and aquatic ecosystems for almost all of the potential impact areas of dams are not available in advance of the dam being proposed. Therefore, much of the data required are collected after the dam has been proposed and the environmental impact assessment initiated. This results in at least the following problems:

- As the environmental studies are usually initiated very late in the day, there is a tendency to hurry them along so that the environmental clearance and the consequent completion of the project are not delayed. Considering that data have often to be collected from scratch, this results in the use of unscientific methodologies and an inadequate assessment. An example of this is the Tehri dam where the fauna and flora studies were not even initiated by the time the dam was cleared, and were finally taken up only after the passing of the deadline prescribed for completion in the clearance letter. The fact that they were taken up at all was probably due to public pressure, in the form of a public interest litigation in the Supreme Court of India.

  As a result, the study on fauna was completed within six months of initiation, though scientifically at least two annual cycles must be studied before any assessment of fauna can be made. The botanical studies were done with similar haste and carelessness [Tehri 1997].

  Similar experiences are recorded from most of the other projects where such studies have been undertaken. These include the Sardar Sarovar and the Indira (Narmada) Sagar.

  Unfortunately, there is no system by which basic environmental parameters are studied much before the project is posed for clearance or as soon as potential sites for dams have been identified.

- These studies are paid for by the project proponents and their cost is included in the project cost, while calculating the economic viability of the project. This results in a tendency to try and do them as cheaply as possible, thereby cutting corners and compromising on quality.
- The project proponents are interested in getting their project cleared as soon as possible and with the least costs. Consequently, there is pressure on project consultants to produce a report that either shows no adverse environmental impacts or suggests very cheap (and, as seen earlier, usually ineffective) methods of mitigating these impacts. The problem is exacerbated by the fact that the MoEF and its EAC have little ability to independently verify these reports and the data they contain. They can, at best, check up superficially on a few aspects or refer the matter back to the same consultants to review the data provided. This also results in delays in the assessment process that, in turn, makes the MoEF susceptible to criticism and to pressure for early clearances.

  Unfortunately, there is no system by which the financing of environmental studies can be done by an independent institution like the Planning Commission and debited on a fixed percentage basis to project cost, thereby freeing the project consultants from pressures by the project authorities.
- The guidelines of the MoEF, which were drafted in the late 1970s, have not been significantly amended since then and are woefully inadequate (see annex 2.1 for copy). As the project authorities follow these guidelines, many of the critical aspects are not covered at all.

iii. Lack of Retrospective Assessments

Apart from the fact that for all the projects designed and initiated before 1978, none of the environmental impacts were assessed, there has also not been any retrospective assessment since they were constructed. Though it might no longer be possible to fully assess many of the adverse impacts, especially those on terrestrial and aquatic biodiversity, many of the other impacts could be assessed even today. However, no effort has been made towards this end, except for siltation and water logging, as already mentioned.

This is despite the fact that the need to conduct retrospective assessments has often been highlighted by various agencies and experts. The Working Group for the eighth plan on Major and Medium Irrigation Projects says, in their report " ..studies are necessary in respect of the environmental impacts created by the projects. There is a considerable divergence of opinion in the country regarding both the beneficial and adverse impacts created by the major and medium projects. However, it is based mainly on the experience of projects in other countries. There is hardly any realistic data on the performance of Indian Projects" [GOI 1989, p - IV 18].

The lack of such assessments makes the task of assessing the overall impacts of dams on the environment very difficult. It is also a wasted opportunity to learn from past experience.

Consequently, even today, many of the impacts assumed and the mitigative measures planned have little experiential basis.

iv. *Political and Administrative Pressures*

The process of environmental impact assessment has been subjected to political and administrative pressures almost from the start. Pressure is brought upon the professional project consultants to prepare EISs in a manner such that the project is cleared. Pressure is brought upon the EAC to recommend the clearance or rejection of projects. Also, the MoEF or the Government of India rejects recommendations of the EAC, without assigning any reasons.

A well-known case is that of the Tehri Project, in Uttar Pradesh. The EAC that considered the project was unanimous in recommending that the project should not be accorded environmental clearance (1990). However, despite that, the government decided to give environmental clearance without assigning any reasons for rejecting the advice of their own expert committee. In his submission before the Expert Committee set up by the Power Ministry of the Government of India to assess the rehabilitation and environmental aspects of the Tehri dam (1996-97), the then Secretary of the MoEF said:

> "..that records indicate that the decision for conditional clearance of the Tehri project was taken not by the MoEF, which did not favour clearance, but at a higher level" [Tehri 1997, p -104]
>
> The minutes of the said Expert Committee go on to record that:
>
> "The Secretary was also asked to comment on how the MoEF could have determined that the Tehri Project was environmentally viable, and consequently given environmental clearance, when the various studies which were to assess the environmental impact of the project had not been completed. The Secretary agreed that the MoEF could not determine the environmental viability of the project prior to the studies being completed and reiterated that environmental clearance had not been given at the behest of the MoEF but at the behest of a higher level" [Tehri 1997, p -105].

Similarly, in the case of the Narmada (Indira) Sagar and Sardar Sarovar projects, the MoEF categorically stated, in writing, that the projects were not fit to be given environmental clearance. Yet, at the highest level, the decision was taken to grant them conditional clearance with a *pari passu* clause.

In other cases, projects were initiated much before clearances were received. This served to pressurise the Government of India to clear the project as so much expenditure of public funds had already been incurred.

This is what happened in the case of the Tehri Project, where work started much before environmental clearance was finally given in 1990. This is also the case in many other projects, for example:

- Rengali Project in Orissa where Rs. 186.95 crores of the total estimated cost of Rs. 233.64 crores had been spent till March, 1994, without any environmental clearance [CWC 1996].
- Bargi Project in Madhya Pradesh where Rs. 360.74 crores of the total estimated cost of Rs. 566.34 crores had been spent by March, 1994, despite no environmental clearance [CWC 1996].
- Jurala Project in Andhra Pradesh where Rs.123.18 crores of the total estimated cost of Rs. 275 crores had been spent by March, 1994 without environmental clearance [CWC 1996].
- Karjan Project in Gujarat where Dam had been completed, Right Bank Canal completed, Left Bank Canal 90% completed and Rs. 222.80 of the total estimated cost of Rs. 264.10 spent by March, 1994, without environmental clearance [CWC 1996].
- Tillari Project in Maharashtra and Goa where, by March, 1994, Dam was 86% complete, and the Maharashtra canals were 89% (LB), 65% (RB) and 88% (Link) complete. In Goa, 73% of the LB canal and 199% of the RB canal were complete. The expenditure was Rs. 179.01 crores of the total approved cost of Rs. 217.22 crores. All this without environmental clearance [CWC 1996].
- Jayakwadi Irrigation Project in Maharashtra where the Malagaon Dam has been completed, Paithan RB Canal completed and Majalgaon RB Canal half completed till March, 1994, without environmental clearance [CWC 1996].
- Mahanadi Reservoir Project in Madhya Pradesh, involving the Sondur Dam and Pairy High Dam, where Rs 337.54 crores had been spent till March 1994, out of a total estimated expenditure of Rs. 1223.45 crores, without environmental clearance [CWC 1996].
- Upper Wainganga Project in Madhya Pradesh where by March, 1994, the dam had been complete and the canals were nearly complete. The total expenditure was Rs. 136.19 out of an estimated total of Rs. 176.53 crores. No environmental clearance [CWC 1996].

This was the status as on March, 1994. Current status is not known.

v. The ability to Enforce and Monitor Conditions

Projects that are cleared are basically of three types.

- First, there are those which are unconditionally cleared, which means that the project proposal, in terms of the anticipated environmental impacts and the proposed preventive and mitigative measures, is found acceptable.

- The second (a large majority) are those where certain conditions are specified while clearance is being granted and, in that sense, the clearance is conditional.
- The third are those where the required environmental assessments have not been carried out but clearance is given with the understanding that the required environmental studies would be completed within a specified period and that the preventive and mitigative measures would be carried out *pari passu* with the construction work.

For each of these types, it is essential to monitor that their environmental impacts are within the anticipated limits, that the preventive and mitigative measures proposed by them or stipulated by the MoEF are being carried out properly and in time, and that they are having the anticipated affects. For the third type (with *pari passu* clearances), it is also necessary to ensure that the studies are carried out within the stipulated period and that the viability of the project is assessed as soon as possible and certainly before it has reached a stage where it cannot be abandoned. Where the project is found viable, it then has to be ensured that appropriate action plans are formulated and implemented in time to prevent and mitigate all that is preventable and mitigable.

The MoEF must also have the willingness and capability, as is implied by the law, to withdraw environmental clearance from, and thereby stop construction of, projects where the prescribed environmental conditions are not being complied. It must also have the willingness and ability to scrap projects, even after their initiation, if they prove to be environmentally non-viable.

The ability of the MoEF to monitor compliance to the stipulated conditions is limited. It is expected to monitor this through its regional offices which, in turn, rely mainly on the returns submitted by the project authorities themselves. And even this system of monitoring has come up only in the last five years or so.

Far more serious is the inability of the MoEF to enforce compliance. A study done by a member of the EAC for dams, in 1998, states that:

> "Data emerging from the records of the Government of India, collected by the regional offices of the MoEF, suggests that in a shocking 90% of cases, project authorities had not complied with the conditions which their projects had been cleared under" [Kothari 1998, p - 5].

Kothari goes on to say that:

> "Our EAC assessed the state of monitoring and reappraisal of the dams cleared by the MoEF in the 1980s and 1990s. The most shocking fact that our EAC found was that, despite being told of the huge scale of defaulting (that) was taking place, MoEF rarely took stringent action, indeed, on no occasion had it used its powers to halt construction and prosecute concerned officials even in cases of extreme violations of conditions" [Kothari 1998, p - 7].

An interesting example is that of the Tehri Dam. As already mentioned, the viability of the dam was not assessed before it was cleared. In 1996, an expert committee was set up to assess the environmental aspects of the project. The findings of the committee, in terms of compliance with conditions of clearance, were as follows:

> "Consequently, the committee came to the conclusion that the conditions of clearance, as laid down by the MoEF in its letter No. 2-19/81-HCT/IA-1 dated 19 July, 1990 read with DO letter No. 2-19/81- IA.I dated 11 October, 1993, had not been complied with. The status of compliance is summarised in table 2.J below...."

Table 2J

Management Plans/Action Plans	*Prescribed date of submission*	*Actual date of submission*	*Whether got approved from MoEF*	*Whether implemented as per conditions*
Catchment Area Treatment	31.12.90	January, 1994	NO	Not fully implemented as per conditions as it was not completed by 31.12.1995, as stipulated by the MoEF in its letter of clearance. Also, though 29,000 ha have been treated till today, only directly draining areas are being treated
Command Area Development	31.3.91 (31.12.93)*	Not yet submitted	NO	Not relevant, as the plan has still not been drawn up.
Flora	May 1991	July, 1993	NO	Not as per conditions. See the section on fauna and flora for details.
Fauna	May 1991	March, 1993	NO	Not as per conditions. See the section on fauna and flora for details
Water Quality Maintenance	No date specified	November, 1992	NO	Not applicable
Disaster Management	31.3.91	April, 1992**	NO	Not relevant as the plan has Still not been submitted to the MoEF

Activity	*Prescribed date of completion*	*Actual date of completion*	*Whether completed by approved date*
Setting up Bhagirathi Basin Management Authority on a statutory basis through legislative action	31.3.1991 (12/1993)*	Not yet set up	NO

* extended date

** According to THDC, submitted to the Ministry of Agriculture.

The findings of the committee (as seen in the table above) were that "while there have been delays in the submission of studies and action plans, the position is that even several years after such submission there has been neither any final approval by MoEF nor a final rejection followed by consequential action in terms of the conditions of clearance" [Tehri 1997, p - 29].

In the case of the Tehri Dam, despite these violations, the work on the project continues uninterrupted.

Also in the case of Narmada (Indira) Sagar and Sardar Sarovar, the project authorities violated most of the conditions of clearance [NCAenv]. Yet, the work on the project continued till the Supreme Court had to intervene, on the basis of a public interest litigation, and order a halt to the construction of at least the Sardar Sarovar Project.

The survey done by Ashish Kothari also establishes that "Though it has the mandate and power, the MoEF has almost never exercised its right to revoke clearance, or punish the offending project authorities and state government officials/agencies, in cases of violation of environment conditions. The few cases we came across where the MoEF had revoked clearance, were related to other violations or technical difficulties; but on environmental grounds, no project in the country had been stopped and the appropriate agencies punished" [Kothari 1998, p - 8].

3.0 SOCIAL IMPACTS

Social impacts are the overarching impacts that occur on the human society. All economic impacts also have social impacts. So do all environmental impacts, as the improvement or degradation of the environment also affects human beings. However, though economic impacts can all be seen as having essentially social impacts, environmental impacts do not only affect the human society but also affect plants and animals.

Dams are intended to produce beneficial social impacts, primarily through the enhancement of the availability of water for irrigation and other purposes, the generation of electricity for industrial, agricultural and domestic purposes and the regulation of floods. Each of these has multiplier beneficial impacts such as the increased availability of food, the increase in incomes, in industrial productivity and in the prevention of loss and destruction due to floods. There are also incidental benefits, like those resulting from the restoration of catchments or the creation of the reservoir.

However, apart from all these beneficial impacts, large dams also have many adverse social impacts. Historically, whereas most of the beneficial impacts were recognised, many of the adverse impacts remained unacknowledged. As they were neither assessed prior to dam construction nor looked at after construction, it is difficult, in retrospect, to determine their intensity. Even today, only some of these adverse impacts are being internalised into the process of planning for and assessing large dams.

Nevertheless, an effort has been made to collect whatever data are available about the social impacts of past projects.

Most adverse social impacts of large dams are either not reflected at all or only partly reflected in the financial and economic analysis of dams. For example, the financial analysis reflects the direct financial costs of relocating and rehabilitating PAPs. These, therefore, are not being discussed here. However, there are many other costs that remain unacknowledged and, therefore, are not reflected in the financial or economic assessments, or are inadequately reflected. These are being discussed here.

As in the case of most environmental impacts, It is difficult to lay down standards for social impacts, because most social impacts do not lend themselves to quantification. It is, for example, difficult to measure trauma, alienation, fear and insecurity. And, for that and other reasons, it is difficult to prescribe how much of psychological trauma, indeed if any at all, is acceptable. To what extent is cultural and social alienation bearable. At what point does fear and insecurity become unbearable. One view is that none of it is acceptable. But, then, all large dams might become unacceptable. The other view is that though some social costs are inevitable, such costs must only be permitted under the 'rarest of rare' circumstances and all efforts must be made to minimise them and to compensate for those that still occur.

As the direct economic impacts of dams are being discussed in another section, they are not being repeated here. Also, as most of the environmental impacts mentioned in the earlier section also have related social impacts, they are also not being detailed here, but only referred to.

Based on a survey of 67 dams (list at annex 1.VI) our findings regarding the possible and actual social impacts of dams are given below. Detailed tables of the above mentioned impacts are given in annex 3.I to 3.VI

3.1 Beneficial Social Impacts

The major beneficial impacts of large dams are captured in financial and economic terms and are dealt with in another chapter. Therefore, they are not being discussed here. There are, however, other benefits that are not usually included in an economic analysis of dams. These are discussed below.

Beneficial Impacts Upstream of the Dam

i. Beneficial Impacts of the Restoration of Catchments

One major beneficial impact, upstream of the dam, is the added biomass, incomes and ecological security that follows for the local communities from the restoration of degraded catchments. For almost all the projects approved after 1980, there is a requirement to treat severely degraded catchments. However, in recent years there has been a tendency to treat only the directly draining areas of the catchment.

Where the catchment is actually restored, apart from the benefits to the project, there are various benefits to the people living in and around the restored areas. These involve a heightened availability of biomass, better water availability and restored micro-climatic conditions.

These benefits have not been quantified in any of the dams studied and are not usually included in the cost benefit calculations. They have been predicted for three dams, Polavaram [Rao *et al* nd], Chandil and Gandhisagar [ORSAC, WAPCOS nd & CBIP 1987a].

Beneficial Impacts at the Dam/Reservoir

i. Stimulation of economic activities

The reservoirs created by large dams often become tourist attractions. As per the data available, there are at least fifty reservoirs that have also been made into national parks or sanctuaries and, consequently, not only contribute to wildlife conservation but also serve as tourist resorts (see section on environmental benefits for details). The development of tourism, and of communications and other infrastructure, because of the dam, also contribute to the stimulation of the overall economic activities in the area. These benefits were not quantified for any of the dams that we studied and were not taken into consideration while conducting the cost-benefit analysis.

ii. Increase of Fisheries in the Reservoir

Though the profile of fisheries might change because of the creation of a reservoir, efforts to stock commercially valuable fish in these reservoirs has often led to the increase in fisheries (catch and income) in the reservoir area. This has been a benefit to the fisher folk who have access to the reservoir fisheries. This has been mentioned as a benefit in three of the projects studied.

iii. Impacts on Micro Climatic Changes

In dry or semi-arid regions the reservoir, by changing the humidity levels and temperature in its vicinity, might make the local environment more comfortable for the people to live in. Five of the projects studied reportedly assessed this possibility. Of these, two of the projects, viz. Champamati and Malana, reportedly predicted that no micro climatic change would take place due to the project while one project, i.e.; Sriramsagar, predicted an improvement. In the case of two projects, i.e.; Mahi Kadana and Ukai, a decrease in the maximum and increase in the minimum temperature was reported to have occurred [see annex 3.III for details and sources].

Beneficial Impacts Downstream of the Dam

i. Flood Control

Dams often, by intent or otherwise, play the role of regulating floods. How effectively dams can play this role depends on many factors including the severity of the floods, the dam design, the time of the floods and the advance warning that is available. The number of large dams that specifically have flood control as one of its objectives are reported to be very small (0.5% of the total). The extent of floods controlled has been calculated for many projects. For example, In the case of Hirakud, the benefit was calculated at Rs. 12 lakhs per year (1947 prices) [IWRS 2000]. In the case of Ramganga, it was reported that low lying areas in the command had been relieved of floods and could be used for growing crops [CBIP 1995].

ii. Improved sanitation and hygiene

In areas that are water deficient, the provision of water because of dams can significantly improve the sanitation and hygienic conditions, thereby having a beneficial impact on human health. These benefits were not quantified for any of the dams that we studied and were not taken into consideration while conducting the cost-benefit analysis.

iii. Improvement in Land Prices

The price of land in the command area also rises, except in those areas where land becomes water logged or otherwise adversely affected. This significantly benefits the landowners in the command area. These benefits were not quantified for any of the dams that we studied and were not taken into consideration while conducting the cost-benefit analysis.

iv. Impacts on ground water recharge

In command areas and around the reservoir, the ground water is recharged because of the reservoir or the canals. Where ground water is normally deep, this has a beneficial effect. These benefits were not quantified for any of the dams that we studied and were not taken into consideration while conducting the cost-benefit analysis.

3.2 Impacts of Displacement[9]

Among the most significant adverse social impacts of dams are those that result from forceful (or involuntary) displacement of human populations from their homes, fields, towns and regions. This has many specific impacts, which are described below. As a part of the case study, the rehabilitation packages and details for 47 dams were studied. Details of the rehabilitation packages are given in annex 3.V. Relevant information is included in the description below.

Apart from the displacement because of the dam itself, canals and other dam structures and infrastructure also cause displacement. Though the social impacts of all such displacement are essentially similar, often the PAPs of dams get better rehabilitation packages than those of canals and other works. This is partly because sometimes the canals and other structures are completed much before or after the dam and the attention focussed on the dam is much greater than that focussed on them. Also, as the number of people being affected by dams is usually (though not always) greater than those being affected by canals and other works, the latter have a weaker voice.

[9] In this paper a distinction is made between 'displacement", which is the uprooting of people from their homes, 'resettlement', which is their location to their new sites of habitation, and 'rehabilitation', which is the provision of all that is required to rebuild their lives to a minimum acceptable level.

3.2.1 *Findings*

i. Compensation

(a) Eligibility

In most projects the family is the unit that is eligible for compensation and rehabilitation. However, the family is defined differently in different projects. Some of the definitions are given below.

- All those living under the same roof (eg. Upper Kolab). This can be detrimental in areas and for families that live jointly. In many parts of the country the joint family system still prevails and, if this criterion is applied, then twenty or thirty people can become clubbed as one family and receive compensation due only to one family.
- All those sharing a common kitchen. This can have the same problems described above.
- In terms of the ' head of the family' or the eldest surviving male member, in whose name the property is. This can also lead to problems. For example, in Tehri, as in many tribal areas, there is a tradition by which the land and other property remains in the name of the eldest male, as long as he is alive, without being divided up among the sons/daughters or grandsons/granddaughters. Here, the following of such a system, in the original package, caused major hardships. Such a criterion of eligibility is also gender insensitive.
- All married males (eg. Loktak). This discriminates against women, especially unmarried, abandoned or divorced women. It also leaves out major unmarried sons.
- All major males (eg. Almatti, Narayanpur, Upper Indravati, Bisalpur, Srisailam). This is gender insensitive. Also, the cut-off date to determine adulthood, is critical. In most of the projects this is prescribed as the date on which the first notice was issued. However, as rehabilitation takes place much after this, such a cut-off date seems unfair.
- All adult married or unmarried sons and adult unmarried daughters (eg. the new Tehri package). This discriminates against married women. Here, also, the cut-off date is critical.
- All married males (compensation and titles to be jointly owned by the husband and wife), all unmarried major sons and daughters (though only half entitlement), including widows/widowers, divorcees and abandoned persons. This is perhaps the best of the alternatives.

(b) Loss of common property resources

Though many rehabilitation packages attempt to compensate for the loss of individual property and livelihood, very rarely is there an attempt to compensate for the loss of common property resources, especially by replacing them. The displaced populations would most likely have had free access to the water and other resources of the river, including the riverbed land and the fish. They might have had access to common grasslands, forests, wetlands and to a host of natural resources, from which they derived not only subsistence resources but also incomes. Most often the sites where they are rehabilitated do not provide a similar access to nature and it is not easy, nor proper, to compensate for these in monetary terms.

Of the 47 projects studied, only two acknowledged the cost of common property resources and attempted to compensate for them. Bisalpur and Upper Kolab reported in its official documents that the project sought to compensate in kind, though the local activists working in Bisalpur disputed this. The adequacy of the compensation could not be assessed. (See Annex 3.V for details)

This, therefore, remains a hidden social cost for most dams.

(c) Loss of cultural heritage sites and monuments

Many individuals and societies have strong cultural and religious links with their ancestral surrounds. The displacement of such individuals and communities causes cultural and psychological trauma that is difficult to mitigate.

Some of the notified archaeological sites and major temples were being shifted out of the submergence zone in some projects, including Narmada Sagar and Nagarjunsagar. In a few cases, fresh places of worship were to be constructed (Tungabhadra, Bhadra, Nagarjunsagar [Rao 1979], Srisailam, Konar, Pochampad, Sriramsagar and Lower Manair). In most other cases either there was no compensation or monetary compensation was paid (Rs. 500 per temple in Warna). In a recent project (Singur in Andhra Pradesh), while some sculptures that were going to be submerged were moved out into safe zones, they were still being kept out in the open and were not stored properly [CWC 1995].

In any case, sites and monuments of local significance are regularly lost and though this might not be preventable, the resultant cost to the society must be recognised as a cost of the dam. As such, it must form a part of the assessment of the costs and benefits of the dam.

In some cases, depending on the value of the site or monument, their existence in the submergence zone of the proposed dam must be reason enough to abandon the dam. Our national heritage should certainly be one of those values that cannot be traded off, whatever the financial incentives.

(d) Loss of home and hearth

Most people have a strong attachment to their homes, especially where these are ancestral homes. The forced abandonment of one's home is always traumatic and can not be compensated for by an alternate house.

This is an inevitable, perhaps incalculable, but nevertheless significant social cost of a dam, which is rarely acknowledged. Unfortunately, the only cost that is recognised and computed is the cost of providing an alternate house.

Most of the projects provide some compensation for the physical loss of a house, either in terms of cash, or materials, or both. In many projects land is also made available for the construction of houses.

In only five of the projects studied was it proposed to provide a house as replacement for the house being lost. In one, Pipai (Rihand), it was proposed to construct houses for all those who lost houses. In four others, Konar, Maithon, Panchet and Tilayia, some of those affected were proposed to be given houses, while others it was proposed to give others land and cash. In Upper Kolab, low cost houses were to be constructed and sold to the displaced persons, who would be compensated for their lost houses in cash. (See Annex 3.V for details)

The practice of giving land for homes was also not universal. Of the 47 projects, 11 promised land for homes. These included Tungabhadra, Pong, Narayanpur, Almatti, and Pochampad. Another seven promised partly land and partly cash (including Bisalpur; Balimela and Srisailam). Another seven gave a choice, while 11 offered only cash. These included Majalgaon (ongoing) Rs. 105 per house; Rengali at the cost of construction; Warna (ongoing) Rs 500 per house; Hirakud (1957) Rs 3000 per house; Vir (1965) Rs. 3226 per house; Phagne and Ujjani (1975) Rs 3400 per house; and Kamthikairy (1977) Rs 2000 for 10% of the houses and Rs. 500 for the remainder. There was no information about the remaining. (See Annex 3.V for details)

As can be seen, the rate at which a house was to be compensated for, varied from project to project. In many projects the compensation was either a fixed amount or according to slabs. In many other cases the compensation was as per a pre-determined value, but was never the true replacement cost.

(e) Loss of familiar social and geographical surrounds

Communities, especially rural communities, have a strong social ethos within which individuals grow and are shaped. They have norms, values and traditions that help them to interact with each other and with other communities. When such communities are fragmented, isolated or placed in unfamiliar social surrounds, there is a lot of trauma, insecurity and social dislocation. There is also a breakdown of the community's social and political processes and, consequently, of their decision making abilities.

Similarly, the physical surrounds within which a community lives have a profound influence on the psyche and life styles of its members. The climates, terrain, scenery, even the types of plants and animals found, all shape the thinking and behaviour of individuals and communities. A drastic change of physical surrounds can seriously disorient individuals and communities. Where the change is to a much less natural surrounding, there are additional deprivations, especially for tribals and other communities living in close harmony with nature.

These aspects also remained unacknowledged. There were also no perceptible efforts at trying to ensure that people were relocated in surrounds as similar to their original homes as possible.

This is also a major unacknowledged cost.

(f) Loss of preferred or familiar sources of livelihood

The forced change of occupation and methods of earning a livelihood, as often happens when people are displaced, can be a source of significant trauma. The world over, most people prefer to follow professions they know and are familiar with. Where changes are made, they are usually made on a voluntary basis, especially in mid-life, and are in keeping with talents and abilities. However, where forced displacement occurs, this is usually not possible. There is also the additional trauma of having to adopt a profession which one is not trained or suited for. To become a third rate shopkeeper or vendor after being a first-class farmer or artisan, takes a toll on the self-value of an individual.

Though some efforts have been made in a few projects to provide training to the project affected persons and to ensure that farmers get agricultural lands even after they have been relocated, this is not a universal practice.

Of the 47 projects studied, only 14 proposed or gave agricultural land for agricultural land. In three of these (Pong, Lower Bhawani and Pandoh), part of the cost of the land given was taken from the compensation paid. In two (Bisalpur and Bhadar) it was partly cash and partly land. In 11 there was a choice given between land and cash, however land was not guaranteed but was to be provided only if available. In another 16, only cash compensation was given for land. There was no information on this aspect for the remaining. (See Annex 3.V for details)

However, there are powerful and vocal advocates for discontinuing the practice of giving land for land. One among these is BG Verghese, who says:

> "That displaced persons should be rehabilitated in their chosen livelihoods as far as possible is understandable. Where land is available, even landless agricultural labour has been promised and given land on relocation. While this may be a viable policy in certain areas or to a certain extent, any firm or binding commitment to give land for land is unwise and impracticable and could and, indeed, has aroused expectations that may not be easily fulfilled if at all" [Verghese 1990, p - 203].

The fact that land is being given is not by itself enough. The quantity of land and its quality are also important (what Verghese calls 'soil for soil'). It was not possible to assess the quality of land but the quantity differed from 2 acres to 5 acres of irrigated land, free of cost. In the case of Pandoh and Pong, the PAPs were offered upto 15.625 acres of land per family, but on payment, albeit at a concessional rate. (See Annex 3.V for details)

The fact that in many projects no land or very little land was given must have resulted in immense hardships for hundreds of thousands of poor people in various parts of the country. In many of the earlier projects, there was no real effort at rehabilitation and the PAPs have all scattered without it being possible now, in retrospect, to determine what happened to them.

(g) Trauma, uncertainties and insecurities

The prospects of leaving all that is familiar and known for the unfamiliar and unknown, is always traumatic. It is especially so for rural communities who might not have had exposure to much more than their own and neighbouring villages. A new location often means new problems and conflicts to handle, which the displaced persons are not always equipped to do.

Though this is also an inevitable cost of relocation, it can be minimised by ensuring proper orientation for the PAPs, by effecting the shift in location gradually and by being sensitive to the suitability of the social environments within which PAPs are being settled.

An interesting example is of the PAPs from Tehri. Many of them resettled in the plains of Uttar Pradesh, complained that while their families lived in the hills of Gharwal they were secure and the men could go and work in the cities, leaving the women and children behind. However, when they were shifted to the plains, the social conditions there made the families feel insecure and the men, therefore, had to give up their jobs and the incomes that such jobs implied, and come back to live with their families.

Unfortunately, this is another unacknowledged social cost of dams.

(h) Adverse impacts on physical health

The change in climate, water, food, sanitary conditions and in the profile of pathogens and bacteria can seriously affect the health of the displaced persons. Added to that is the adverse impact, on physical health, of the various psychological traumas listed earlier.

Very often the relocation of PAPs is planned purely on an economic basis without being concerned about their climatic preferences. Examples of this were recorded with regards to the Pong, Bhakra and Pandoh dams where people living in the hills of Himachal Pradesh were to be relocated to the deserts of Rajasthan. Similarly, people being ousted from the Tehri town are being shifted to the new Tehri town , which is much higher and colder. Others displaced by the Tehri dam have been, as already mentioned, shifted from the hills of Garhwal to the hot plains of UP.

Also, very often the PAPs, especially tribal PAPs, find it difficult to get a nutritionally balanced and adequate diet in their culturally chosen food-style. Traditional health practices are not always substituted by alternate acceptable systems. Studies done in relation to the Narmada Sagar and Sardar Sarovar Dams indicate a higher rate of morbidity among PAPs than among control populations.

Unfortunately, more details of the impacts of such relocations were not available and this also remains as an unacknowledged cost.

(i) Adverse impacts on living standards

The economic and social factors listed above also adversely affect the living standards of displaced people and, consequently, their future prospects. Though many of the recent rehabilitation packages take into consideration the direct and immediate economic impacts of relocation, the indirect impacts and the future prospects are never assessed.

Again, no mention of these impacts was found in any of the documents studied and therefore these must also be classified as unacknowledged costs.

(j) Social alienation from, and conflicts with, host communities

Given the density of human population in India, it is unlikely that displaced persons would be rehabilitated in spaces that are empty and have no other occupiers or users. The fact that mostly rehabilitation sites come up near other existing settlements can often result in tensions and conflicts between the host community and the displaced persons. These tensions are aggravated when land for resettlement is acquired, through a legal process, from host communities or their friends and relatives. Sometimes land for rehabilitation is made available by displacing those who do not have legal titles to the land they are occupying or cultivating. This, then, causes secondary displacement. However, none of the projects have schemes for rehabilitating those affected by secondary displacement. Interestingly, it was reported that the Government of Uttar Pradesh had passed an order specifying that all those affected by secondary displacement should also be rehabilitated at project cost and according to project norms. However, by all accounts, this order was never implemented.

There have been many instances of clashes between the host communities and the PAPs or the project authorities. One such was reported in August, 1984 when five persons were killed in police firing in Sabarkantha District in Gujarat, when villagers of neighbouring villages attacked the police party which had gone to Tarudi village to supervise the land allotment process to some displaced families (Verghese 1990, p 204). Similar clashes have been reported from among the PAPs of Sardar Sarovar, Tehri, Bisalpur and many other dams. [SM 2000]

Tensions and conflicts can arise on the sharing of common resources, on social or religious grounds or, sometimes, just because the new-comers are treated as outsiders.

Sometimes the host communities resent the compensation package being given to the displaced persons, even if it is not princely, for it might bring out more starkly the fact that the host communities are getting nothing. This is especially so when the host communities are themselves desperately poor.

(k) Loss of infrastructure and access

In those cases where rehabilitation sites are far away from other human settlements, there might not be problems with host communities but there is then significant isolation and loss of infrastructure. The access that the displaced persons had in their original homes to the facilities available in the region, like hospitals, educational institutions, leisure and entertainment places, roads and transportation, might not be so easily available in these new sites. The access to such colonies is also often poor, especially during the rainy season.

In recent rehabilitation packages this has become an important consideration. Of the 47 projects studied, in 19 there were provisions for amenities like schools, dispensaries, roads, community centers and such like. (See Annex 3.V for details)

However, the adequacy and appropriateness of these amenities could not be determined. For example, in the case of a recent project (Telugu Ganga, Andhra Pradesh), it was reported by the Central Water Commission itself that the provision of amenities left much to be desired [CWC 1995].

ii. Estimates of Displacement

For the purpose of this case study we were able to compile the figures of human displacement for 83 dams. In compiling these figures we have again chosen the most conservative estimates available. Wherever official figures were available, they have been relied upon. Where such figures were not available, we have taken the most conservative of the figures available, provided they do not seem obviously wrong. Dams for which the displacement figures available seemed obviously wrong, have not been included in the list.

Table 3A : Area submerged, Population affected and density of population affected

S No.	*Dam Name*	*State*	*Year of Completion*	*Total Area Submerged (Hectares)*	*Total Population Affected*
1.	Vani Vilasa Sagar	Karnataka	1908	8,800	160
2.	Nizam Sagar	Andhra Pradesh	1931	12,950	67,445
3.	Krishnaraja Sagar	Karnataka	1932	12,900	15,000
1901-1950; Number of People Affected per Hectare = 2.38					
4.	Tilaiya	Bihar	1953	7,500	13,455
5.	Tungabhadra	Karnataka	1953	37,800	54,452
6.	Konar	Bihar	1955	2,800	5,747
7.	Hirakud	Orissa	1957	72,700	75,000
8.	Maithon	Bihar	1957	10,700	28,030
9.	Matatila	Uttar Pradesh	1958	14,243	7,500
10.	Panchet Hill	Bihar	1959	15,300	41,461
11.	Gandhi Sagar	Madhya Pradesh	1960	72,300	51,514
1951-1960; Number of People Affected per Hectare = 1.19					
12.	Koyna	Maharashtra	1961	11,535	30,000
13.	Rihand	Uttar Pradesh	1962	46,600	55,000
14.	Bhadra	Karnataka	1963	11,700	140
15.	Bhakra	Himachal Pradesh	1963	16,835	36,000
16.	Shetrunji	Gujarat	1964	6,700	8,200
17.	Vir	Maharashtra	1965	420	6,000
18.	Rana Pratap Sagar	Rajasthan	1967	19,800	12,500
19.	Yeldari	Maharashtra	1968	10,200	120
1961-1970; Number of People Affected per Hectare = 1.20					
20.	Ukai	Gujarat	1972	60,100	80,000
21.	Jawahar Sagar	Rajasthan	1973	2,258	610
22.	Kabini	Karnataka	1974	6,100	11,250

Table 3A (Contd...)

Table 3A (Contd...)

S No.	*Dam Name*	*State*	*Year of Completion*	*Total Area Submerged (Hectares)*	*Total Population Affected*
23.	Nagarjunasagar	Andhra Pradesh	1974	28,500	24,400
24.	Pong	Himachal Pradesh	1974	26,000	20,722
25.	Karanjwan	Maharashtra	1975	1,820	1,600
26.	Tawa	Madhya Pradesh	1975	20,200	3,070
27.	Paithan	Maharashtra	1976	39,761	490
28.	Balimela	Orissa	1977	16,900	60,000
29.	Kamthikhairy	Maharashtra	1977	2,330	889
30.	Pandoh	Himachal Pradesh	1977	123	150
31.	Dhom	Maharashtra	1978	2,400	19,735
32.	Ramganga	Uttar Pradesh	1978	7,831	0
33.	Waghadi	Maharashtra	1978	658	489
34.	Hidkal	Karnataka	1979	7,100	31,133
35.	Kadana	Gujarat	1979	16,600	28,470
36.	Ujjani	Maharashtra	1980	33,650	35,069
1971-80; Number of People Affected per Hectare = 1.17					
37.	Harangi	Karnataka	1981	1,900	40
38.	Jamrani	Uttar Pradesh	1982	450	1,500
39.	Narayanpur	Karnataka	1982	13,200	48,125
40.	Srisailam	Andhra Pradesh	1984	61,700	2,342
41.	Sriramsagar and Lower Manair	Andhra Pradesh	1985	55,970	75,090
42.	Upper Kolab	Orissa	1986	11,432	8,475
43.	Damanganga	Gujarat	1989	4,368	11,805
44.	Sondur	Madhya Pradesh	1989	2,439	1,510
45.	Upper Wain Ganga	Madhya Pradesh	1990	5,603	6,435
1981-1990; Number of People Affected per Hectare = 0.99					
46.	Hasdeo-Bango	Madhya Pradesh	1992	21,279	13,585
47.	Almatti	Karnataka	Ongoing	79,020	200,000
48.	Amarja	Karnataka	Ongoing	641	1,560
49.	Bargi	Madhya Pradesh	Ongoing	30,860	37,725
50.	Bariarpur	Madhya Pradesh	Ongoing	3,078	3,000
51.	Bennithora	Karnataka	Ongoing	2,132	3,000
52.	Bhatsa	Maharashtra	Ongoing	2,700	665
53.	Bisalpur	Rajasthan	Ongoing	21,836	57,138
54.	Dimbhe	Maharashtra	Ongoing	2,272	6,824
55.	Hemavathy	Tamil Nadu	Ongoing	8,500	11,600
56.	Heran/Lalpur	Gujarat	Ongoing	17,720	21,210
57.	Ibadoh		Ongoing	6,020	2,258

Table 3A (Contd...)

Table 3A (Contd...)

S No.	*Dam Name*	*State*	*Year of Completion*	*Total Area Submerged (Hectares)*	*Total Population Affected*
58.	Isapur	Maharashtra	Ongoing	9,830	16,940
59.	Jakham	Rajasthan	Ongoing	10,150	335
60.	Kanher	Maharashtra	Ongoing	2,014	7,080
61.	Karjan	Gujarat	Ongoing	3,994	8,025
62.	Kayadhu		Ongoing	7,530	8,857
63	Kelo Irrigation Project	Madhya Pradesh	Ongoing	3,116	7,336
64.	Lower Wunna	Maharashtra	Ongoing	6,275	12,650
65.	Mahi Bajaj Sagar	Rajasthan	Ongoing	13,300	34,875
66.	Majalgaon	Maharashtra	Ongoing	8,080	65,296
67.	Narmada Sagar	Madhya Pradesh	Ongoing	91,348	82,120
68.	Ozarkhed	Maharashtra	Ongoing	740	1,354
69.	Palkhed	Maharashtra	Ongoing	561	1,716
70.	Polavaram	Andhra Pradesh	Ongoing	63,691	154,484
71.	Rengali	Orissa	Ongoing	2,256	4,015
72.	Sardar Sarovar	Gujarat	Ongoing	39,134	150,720
73.	Serlui	Mizoram	Ongoing	2,554	300
74.	Sipu	Gujarat	Ongoing	2,863	5,494
75.	Srinagar	Uttar Pradesh	Ongoing	350	343
76.	Sohira		Ongoing	41,970	42,000
77.	Tehri	Uttar Pradesh	Ongoing	4,200	70,990
78.	Upper Mullamari Reservoir	Karnataka	Ongoing	2,800	750
79.	Upper Penganga	Maharashtra	Ongoing	9,845	16,940
80.	Upper Wardha	Maharashtra	Ongoing	11,362	11,817
81.	Uri	Jammu & Kashmir	Ongoing	266	1,000
82.	Waghur	Maharashtra	Ongoing	3,140	1,220
83.	Warna	Maharashtra	Ongoing	2,900	7,906
1991 and After; Number of People Affected Per Hectare = 1.99 From 1901 To The Present; Number of People Affected Per Hectare = 1.51					
TOTAL				**1,361,504**	**2,054,251**

(See Annex 3.VI for sources)

The debate on how many people have or are being displaced by dams has raged for many years. Though no definitive figures exist, some of the estimates that have become public include those of Fernandes, Saxena and Roy. Himanshu Thakkar, in his paper on displacement for the WCD (Thakkar 2000), says:

> "Displacement due to dams in India has been variously estimated. Fernandes, Das & Rao (1989) claimed a decade ago that Indians displaced by dam projects numbered 21 million. As the authors themselves pointed out, these were very conservative

> estimates. A recent statement by Shri N.C. Saxena (the then Secretary, Ministry of Rural Development, Government of India) however put the total number of persons displaced due to large dams at 40 million. He said in an open meeting that most of them have not been resettled. Roy (1999), based on a survey of 54 projects estimated the people displaced by large dams in last 50 years to be 33 million.
>
> "The compilation of figures in the present study shows a total of 4,387,625 persons displaced across the 140 large and medium dams included in the survey. The average for these 140 dams thus comes to 31,340 persons per dam. It is apparent then that estimates of only 2 million people having been displaced by all dams in India till 1990 are vastly inaccurate (Gleick 1999). While the sample used here is not meant to be representative of all of the India's dam projects, it emerges that the order of magnitude in which displacement should be estimated is in the tens of millions." [Thakkar 2000]

We have also attempted an estimate based on the figures emerging from the table above and the table in the annex, on total area submerged. As per our calculation, in the 213 dams for which this information was available (see annex 3.VI) the average area submerged, per dam, was 8,748 ha. Interestingly, a study of 11 dams between 1978 and 1988, done by the World Bank, and quoted by the Central Water Commission [CWC 1992, p 10], records that submersion per dam was 13,000 ha. Also, a CWC study [CWC 1992, p 10-11] of 54 projects shows a per dam submergence of 24,555 hectares per project.

Similarly, if one takes the average of the 83 dams for which we have both submergence data and the number of people displaced (Table 3.A above), the average submergence per dam comes to 16,604 ha. Compared to these, our estimate of 8,748 ha per dam is conservative.

According to our calculations, the average displacement per hectare is 1.51 (table above). The World Bank study of 11 dams, quoted above, records that human displacement was a little over 2.6 persons per hectare. Also, the CWC study quoted above shows a per hectare displacement of 1.1 person. Therefore, our estimate on the basis of 83 dams, seems plausible.

The total number of large dams constructed or under construction, according to the CBIP (CBIP nd01, p 21) is 4291. Therefore, as per our calculations, the total area that can be expected to be submerged is 4291 x 8748 ha, which is a whopping 37,53,7668 ha (approximately thirty-seven and a half million hectares). Based on this, the number of people displaced, using the average of 1.51 persons per hectare, would be an astounding 56,681,879 (approximately 56 million six hundred and eighty thousand). This is clearly an overestimation. However, given the hesitation of the government to make data available, this is the best estimate that can be made. In any case, what it does establish is that the displacement figures cannot be anywhere as low as suggested by some official sources. At best the variation would be of the order of 25%.

It must be noted here that, for the most part, these figures only represent those persons displaced by dams. Those displaced by the canals, or by the construction of colonies or other infrastructure, by transmission lines and those displaced while acquiring land for the resettlement of PAPs, are not necessarily included in our estimates. Judging by some recent projects, their number would also be significant.

Added to these would be those who have been subjected to multiple displacement, like in Rihand, Koyna and Sardar Sarovar.

iii. Implementation of Relocation and Rehabilitation Programmes

In the earlier section the official compensation packages, as announced by the government and the project authorities, for various projects, were given. However, in reality much of what is promised, however inadequate it might be, is also not delivered. Some of the major movements against dams, in India and worldwide, are fuelled as much by the inadequacy of the package as by its poor implementation. In fact, it is mainly because of the abysmal records of governments to properly rehabilitate dam affected people that an increasing number of people today refuse to accept that justice can ever be done, or will ever be done, for those who pay the major price for large dams.

Official data on what actually happened to the PAPs in various dams, are very scarce and not always reliable. Therefore, for this section a heavy reliance has been put on information gleaned from people's movements and from independent institutions and sources. Nevertheless, wherever credible government data have become available, they have also been included.

Given below are a few of the many problems and issues related to the implementation of the rehabilitation process. Though it has not been possible to verify each of the issues raised, the fact that there is widespread dissatisfaction with the rehabilitation efforts regarding many, if not most, dams, is well accepted.

- **Eligibility:** Apart from the problems of definition of eligible families or individuals, already described earlier, there are problems relating to the application of these criteria. The most common complaint has been regarding the inclusion of names among those considered eligible for rehabilitation. There have been complaints that the original lists of PAPs do not include all those families and individuals who qualify to be PAPs. This not only results in a lot of effort and anguish on the part of those who have got left out but also distorts the economic assessment of the project. In many cases, such an underestimation also results in a shortage of resources for proper rehabilitation, especially land. There are also complaints of corruption and arbitrariness in applying the criteria and sometimes an unwillingness to universally apply the criteria even when they have been officially accepted.
- **Process of displacement:** Many complaints have been made regarding the process of displacement. Starting from complaints about a lack of information to

wrong and misleading information, there are complaints about not being given adequate warning and notice of impoundment, not being informed of the processes of relocation and rehabilitation, not being helped in the process of relocation and of secrecy, corruption and incompetence.

- **Quality and quantity of land:** Perhaps the largest number of complaints are about the quality of land given for rehabilitation, in those few dams where land is given. In many projects the PAPs have complained about their land being uncultivable. There are also complaints about the non-availability of irrigation and about poor soils and rocky land. In other cases there have been complaints that the quantity of land given is less than what was promised or is scattered rather than consolidated.
- **Availability and adequacy of other inputs:** Another common complaint is the non-availability or the inadequacy of the rehabilitation inputs to be given under the project. The major complaints focus on the cash compensation. There are many complaints that cash compensations are delayed, often not given till bribes are handed out, and are inadequate for the purpose, for example for constructing a new house or buying adequate land. The provision of other facilities and common resources and infrastructure are also often reported to be unsatisfactory, either because the promised inputs are not given, or delayed, or inadequate or of bad quality.
- **Availability and quality of services:** Many of the promised services, like transportation, education, health care, electricity, drinking water, roads and security are also found to be non-existent, delayed or inadequate.
- **Follow up and grievance redressal:** Another common complaint is that once the initial shifting takes place there is no system of monitoring and correcting problems or of redressing the grievances of the displaced populations.

SOME EXPERIENCES OF 'REHABILITATION'

In the earlier section the official compensation packages, as announced by the government and the project authorities, for various projects, were given. However, in reality much of what is promised, however inadequate it might be, is also not delivered. Some of the major movements against dams, in India and worldwide, are fuelled as much by the inadequacy of the package as by its poor implementation. In fact, it is mainly because of the abysmal records of governments to properly rehabilitate dam affected people that an increasing number of people today refuse to accept that justice can ever be done, or will ever be done, for those who pay the major price of dams.

Official data on what actually happened to the PAPs in various dams, are very scarce and not always reliable. Therefore, for this section a heavy reliance has been put on information gleaned from people's movements and from independent institutions and sources. However, wherever credible government data have become available, they have also been included.

Given below are a few of the many accounts of rehabilitation problems that have been recorded. Though it has not been possible to verify each of the issues raised, the fact that there is widespread dissatisfaction with the rehabilitation efforts regarding many, if not most, dams, is well accepted.

Telugu Ganga Project, Andhra Pradesh

- Each PAF to be given 0.2 ha. of homestead land as per MoEF norms. However, PAFs of Velugaddu Reservoir given only 0.08 ha. In many cases, not even this land was given and only cash was paid to the PAFs.
- While jobs were to be given to PAPs on a priority, none have so far been provided with a job.
- Facilities provided to PAFs in R&R sites were not found to be adequate.
- Monetary compensation was to be given to PAPs through fixed deposits. However cash was handed over to them directly. [CWC 1995]

Bawanthadi Project

- 354 families in 11 villages affected by the Project.
- Land provided for houses, but not for cultivation to 32 families that have been shifted so far.
- Only Rs 3000/- per ha. paid for cultivable land. Not sufficient according to the Environmental Monitoring Committee.
- A Proper R&R plan has not yet been made for the project. [CWC 1995]

Sipu Reservoir Project, Gujarat

- Rehabilitation to be done for 1381 families in 14 villages.
- In one of the rehabilitated villages visited by Environmental Monitoring Committee, only 7 houses had been constructed though 36 plots had been allocated.
- In another R&R village, only 27 houses had been constructed even though 65 plots had been allocated. [CWC 1994]

Upper Ganga Canal

- During the field visit of the project, particularly, in the Stretch from 177 km. to 200 km. near Bulandshahar, EMC had an opportunity to see a village namely Nidhauli, affected by the new canal and discuss the problems with the affected people. The displaced persons complained that adequate land for the house sites was not given. Some of the displaced persons whose properties were acquired, are working as labourers while about 10 to 15 families have left the area and their whereabouts are not known. Project Authorities were asked to formulate comprehensive plans for resettlement and rehabilitation of the village immediately and to send a report thereof to EMC. [CWC 1993a].

Sardar Sarovar Project

Some of the major problems in the five rehabilitation sites (Somaval, Dekati, Amoni, Roswa, Amlibari) are as follows :

- Non-allotment of agricultural land to PAPs : The land allotted to PAPs was originally forestland.
- The plots were allotted sometime in 1992 on the Forest Department maps when the plantations were still standing. Many PAPs had returned to their original submergence village. After the plantation was cleared, they returned to the rehabilitation site to cultivate the land.
- The plots allotted to many of the PAPs have not been clearly demarcated by boundary markers. As the fields are not properly demarcated, some people have more land, while the others have less.
- Following number of PAPs have not been able to cultivate their lands as they have not got the actual possession of the land. They just have paper possession. (Somaval 6, Amoni 16, Dekati 9, Rozwa 112).
- In Dekati there are 19 cases of land non-allotment. These oustees from Paula and Chimalkhedi submergence villages are landless agricultural labourers, hence entitled to one hectare of agricultural land.
- About 34 PAPs have received land in coup no. 457 not from the Forest Department, but Revenue Department of Maharashtra and NCA (Narmada Control Authority). That has lead to many problems between the people and the Forest Department.
- Forest Encroachment cases : The Ministry of Environment and Forest handed over coup no. 458 to Rehabilitation and Resettlement (R&R) authorities in the year 1992. There was no report of any encroachment at that time. The land was allotted to the PAPs though the clearance for tree felling was pending. PAPs went back to their submergence village in 1992 and returned in 1995, to claim their possession. It was at this point that some encroachments came to light. PAPs are not able to cultivate their land and hence are living in very hard conditions.
- Shortage of roofing tiles and bamboo for the houses : In all the R&R sites, roofing tiles and bamboo have not been supplied to the PAPs.
- Ineligible major sons : There are about 60-70 cases of ineligible major sons yet to be settled in the rehabilitation sites.
- Compensation for trees and houses : About 250 PAPs have not been compensated for the trees and houses in the submergence villages.
- Employment : There are educated persons amongst PAPs, but the 5% reservation for PAPs has not been followed. Even posts like primary school teacher, available in the R&R site are given to outsiders.

- Irrigation facilities : In Somaval and Amoni sites tube wells have been provided, though their work is incomplete. In other three sites (Rozva, Dekati and Amlibari) there is no provision for irrigation what so ever.
- Electricity : In all the five sites there are no street lights. The work is still pending. [Shinde 1998]
- A project symbolising development has caused deprivation to a group of people who lived beyond 'development' strategies for centuries.
- The claim is now being put forward that they have access to Government services in the resettlement sites.
- This is unjustified since they were supposed to be entitled to these services even in their original villages as these areas have been demarcated for coverage under the tribal sub-plan.
- Moreover, they are now being moved to sites which will not be similarly covered under the tribal sub-plan provision.
- With specific regard to R&R, there are problems with the policy package.
- The basic problem pertains to non-parity of the package across the three states.
- If the people from these two states do opt to resettle in Gujarat, non-availability of land in sufficient quantities is going to pose difficulties due to the magnitude of displacement in Madhya Pradesh.
- The experience of all the three States clearly reveals that land for cultivation and resettlement cannot be acquired easily.
- Claims being put forward regarding the availability of land lack authenticity, as much of this land has been proved to be non-arable.
- In Gujarat, land is now bought in the open market in small bits and pieces.
- Thus, it may be difficult to obtain land of adequate size to resettle even 30 to 40 families in one location.
- The resettlement experience of Gujarat villages is already available as evidence: families from 19 villages are resettled in over 175 locations.
- The government of Maharashtra has chosen to resettle people in the clear felled forest area.
- Private purchase of land cannot permit large-scale resettlement due to limited availability.
- Forest land cannot be a source of agricultural land for the resettled, given the magnitude of displacement caused and depleted forest reserves.
- In order to effectively operationalise the R&R policies of Gujarat, the government must account for the unwillingness of people from different cultural and linguistic backgrounds (from Maharashtra and Madhya Pradesh) to settle in Gujarat.

- For most of the displaced people, caste, religion, language and kinship, continue to play a dominant role in determining their economic and social security. [TISS nd.]

Surya Irrigation (Dam) Project

- The dam was to irrigate 14,696 hectares of land in 92 village with majority tribal population, out of which 88 come under the Tribal Area Sub-Plan.
- The dam was completed in 1984 and involved the displacement of 1458 adivasi families from 10 villages.
- Of the 1458 adivasi families displaced, only 518 families have been rehabilitated. Out of which only 381 were allotted alternate government lands.
- 904 families did not accept the alternative lands provided by the government.
- Compensation for lands acquired for canals have not been done properly.
- The project was provided with funds from the Tribal Sub-Plan and is intended for the irrigation of adivasi lands in the area. In spite of the completion of the dam and canals (except for a small portion that was held up due to clearance from the forest department) water has not so far reached most of the adivasi villages. [Singh nd.]

Koyna

- Over 30000 people lost their homes, habitat and means of livelihood.
- In the absence of a rehabilitation act or policy, people were literally driven out of their villages.
- Many started leaving only after the water had started rising.
- Only titled landholders losing land under submergence were identified as project affected, to begin with.
- Land and other productive assets were severely undervalued.
- People could not take away or claim benefits for the large number of standing tree crops on their agricultural land.
- The Dhangar community who resided in the valley and are primarily nomadic pastoralists lost out on the large expanse of grazing ground that was easily available.
- People from 105 villages were resettled in 202 different sites in Satara, Sangli, Ratnagiri, Raigad and Thane districts of Maharashtra.
- In Thane and Raigad districts, the forest land allotted to the affected people were already in a degraded state and under occupation of local tribals.
- Many people had not left the valley even after the submergence. They had merely moved up into the higher reaches and slopes.

- The Dhangars too had returned soon after, since many of them did not get land compensation as they had held service grants and were not listed as 'khatedars'.
- Within a year or so of displacement, people started returning back to the valley. [Avinash nd.]

Hirakud Dam

- The Hirakud Dam project was completed in 1956.
- Hirakud submerged less than 300 sq. miles.
- About a lakh of people were displaced.
- Although alternative land was promised to them for cultivation it could not be done.
- Only compensation was paid to the land owners.
- The under-tenants and agricultural labourers, who were about 50,000 in number, went out of employment and nothing was done for them. In return for these sacrifices, Hirakud generates electricity which is enjoyed by people who are well settled in towns and big villages. But where the displaced families are residing in the periphery of the reservoir, there is no electrification.
- Out of total 148 resettlement villages of displaced families, only in 40 villages electrification has been done so far.
- Till today there are 8,744 land losers who are yet to get compensation.
- Out of the 19,000 Hirakud uprooted families only 2103 families were resettled in 12 reclamation camps and were allotted only 6547.24 acres of reclaimed land.
- 2000 families went away on their own and tried to resettle themselves in different parts of Sambalpur district and Sundargarh district.
- Some displaced families have settled themselves in different villages of Madhya Pradesh mainly in the districts of Surguja and Raigarh.
- The remaining 15,000 families evacuated from submergible villages of Hirakud reservoir were compelled to arrange temporary settlements in the periphery areas of Hirakud reservoir.
- Compensation for land was paid at a very low rate. About 10,000 families were not paid any compensation for their land and other property. It was only in 1993, after 20 years of agitation in the Orissa Legislative Assembly, that the Government started payment of compensation.
- The state government distributed *Anabadi Abad Jogya* fallow land in different villages in Hirakud periphery area, inhabited by Hirakud displaced families.
- This fallow land allotted in different villages has not yet been settled in the name of the allottees and permanent *patta* has not yet been issued. [Majhi nd.]

Hirakud (Another account)

- There were reported to be variations in the calculation of compensation for land acquired within even the same village. For example, in Luaboga village one person received Rs.25,000 for 32 acres while the owner of a 26 acres plot got only Rs.7000.
- There was a lack of transparency in calculating compensation leading to a lot of confusion among people.
- The compensation offered was obviously inadequate as is evident from the fact that some of the people who filed cases protesting against the compensation award were able to secure upto 300 – 400 per cent greater compensation from the courts.
- Those farmers who had been cultivating their land for several generations but did not have any legal documents to prove their ownership were categorised as landless.
- There were several allegations of corruption by officials.
- While by June 1956, everybody had been displaced, only 35.5 per cent of the total compensation to be given had actually been paid. Many of the displaced people have not yet received compensation.
- There are reports of protests by the project affected persons which, however, are reported to have been put down with a heavy hand. [Viegas 1992]

Pancheswar Dam

- The locals complained that they had been kept in the dark about the proposed project.
- The representatives of the government never bothered to consult them; nor did they provide them with any authorised report about the so-called development project.
- The people said that they wanted a road constructed between Jhoolaghat – Jhaulgiri and Tanakpur.
- This would open up the possibility of trade for these border regions. [LB 1996]

Damodar Valley

- In Jaspur village, in the Maithon Dam area, the tribals were the worst sufferers.
- Although compensation was paid for the land acquired from them, the valuation was not done properly.
- Even for fertile paddy lands, only Rs. 600.00 per acre was given.
- The oustees were not able to purchase the same type of land even after paying four times this amount.
- The compensation money was not properly utilised, because of illiteracy, lack of banking facility, lack of proper guidance and some times due to the innocent nature of the tribes. [Roy and Dey nd.]

Upper Indravati Hydro Electricity Project

- The tribal people received cash compensation besides a grant of around Rs 40,000 for buying land, building houses and immediate sustenance.
- The tribals own the assets, the rest they frittered away on gambling, alcohol and weddings.
- The tribals have reason to complain. Bandhu Satua, for instance, who raised maize and millets on the nearby hill slopes, is now forced to cultivate paddy in the plains.
- About 180 tubewells and 42 open wells were sunk, 27 school buildings constructed and 67 roads made to link the rehabilitation clusters. Owing to poor maintenance, much of this lies in disrepair.
- Steps to curb malaria, and this is an endemic zone, have not been taken. [Banerjee 1995]

Salia Dam

- The displaced families were given *pattas*, but the land given to them was not demarcated and was not even leveled.
- The families who did not have any land records were neither compensated nor resettled.
- Presently, these families are working as migrant labourers and don't have a settlement of their own.
- About 27% of the families displaced are of this category. [RCDC nd.]

Srisailam Dam

- The Srisailam dam is built across river Krishna 200 Km away from Hyderabad city.
- With the completion of the main dam, over 100,000 people in 117 villages were forcibly evicted in May 1981.
- Over 107,000 acres of land were submerged.
- The affected families were asked to give a rough estimate of the market value of their land.
- In reality the amount given as compensation was five times below the average amount expected by the villagers.
- Several affected families went to lower courts against this injustice and in most cases got decisions in their favour.
- As a result of the lower fixation of compensation, the inordinate delays in payment, the money given to advocates, bureaucrats, middlemen and personal expenses incurred by them, the villagers were left with little money at the end of the operation (acquisition and compensation).

- People were driven out and entire families were hounded out in a big swoop.
- A survey of the 'resettlement' hamlets of these evictees three years later by Lokayan, revealed that from an average annual income of Rs. 9,116 per family in the old villages, their earnings had been reduced to Rs. 2,347 per year per family in the new settlements. [Dogra 1992]

Rengali Dam

- The Rengali dam in Dhenkanal district of Orissa has displaced over 50,000 people, most of whom were resettled on barren land extremely difficult to cultivate.
- The resettled villages resemble a prehistoric dwelling place without any basic amenity.
- Reports of diseases caused by malnutrition and of starvation deaths are heard periodically...
- Only those who could go to the court got adequate compensation.
- Several settlers have been forced to work as casual labourers in distant places or to collect wood and sell it in Deogarh town. [Dogra 1992]

Ukai-Kakrapar Multipurpose Project

- Over 16,000 families in 170 villages were affected in Surat and Bharuch districts of Gujarat and Dhulia district of Maharashtra by the Ukai-Kakrapar Multipurpose Project.
- In a survey of the condition of the evictees of this project a decade after their displacement, Kashyap Mankodi and Tanushree Gangopadhyay have pointed out that their impoverishment resulted in a large-scale emergence of migrant labourers from amongst them. Malnutrition worsened. Alcoholism increased.
- The tribals whose livelihood depended on gathering forest produce suffered the most. [Dogra 1992]

Bargi Dam

- Bargi has caused the displacement of about 70 thousand people living in 162 villages of Mandla, Seoni and Jabalpur districts.
- A significant number of adversely affected people were left out of the rehabilitation effort.
- Another section was given only cash compensation.
- The cash compensation was much less than the prevailing market rate of the land.
- Some persons were given resettlement land at wrongly identified places. It was later revealed that these places also fall in the submergence area of the dam.

- Several school-going children have been forced to use boats, or walk on very muddy paths, or have entirely given up going to school.
- Many of them have been forced to turn into migrant labourers.
- Several others have turned into local slum-dwellers, taking up any uncertain job like that of rickshaw pulling, which becomes available. [Dogra 1993]

Rihand Dam

- "The Rihand Dam (1961) was the first large industrial enterprise in this predominantly 'backward' region. Nearly 200,000 (official figures 55,000) people were displaced by it. To ensure evacuation with the least effort, villages were simply flooded. Wet and dazed, people sought refuge on any ground beyond the swirling waters, under the open sky."
- "Nearly 50,000 of these unfortunate people have just disappeared without a trace. Most others settled on the least desired lands – the hill slopes." [Singh 1988]

Subarnarekha Multipurpose Project

- In accordance with the revised policy, every oustee of 18 years and above who owns less than 5 acres of land will get 2 acres, or Rs. 10,000 for the purchase of land and an additional Rs. 15,000 for preparing the land for cultivation. Each oustee will also receive Rs.20,000 for the construction of a house.
- However, Kavaljit Singh, a social worker with Public Interest Research Group in Delhi, argues that the type of land bought for Rs.5,000 per acre will take at least 10 years to make fit for cultivation purposes. The money being issued for housing is also causing problems, as it will be allocated in three separate instalments making construction both difficult and expensive.
- Although the clause that every oustee over the age of 18 years should be considered as a separate family exists, the project authorities have not taken it up because it will increase the cost of the project.
- Also, 600 jobs meant for the oustees of the project as a part of the rehabilitation program have gone to non-oustees.
- There was a constant presence of local opposition and a series of marches and protests have taken place against the Subarnarekha Multipurpose Project. [Sherman nd]

Bisalpur Dam

- Land till now has been allotted to displaced 'khatedars' in Tonk and Ajmer districts. Pasture lands in these villages are converted in "siwai chak" – government lands, and allotted. According to the 'norms' of rehabilitation, price of such lands should not exceed half the rate of compensation for similar class of land. But the land is generally found to be uneven and a jungle of *babool* shrubs, which requires lot of cash and labour inputs to make it cultivable.

- The official 'norms' laid down that every major son would be considered as a separate family and every family would be allotted a house plot. Major sons were given plots in 1991-92, but this was discontinued in 1993. Only in 1996 it was restarted. This has led to a father and son getting house plots in different resettlement colonies.
- The 'Norms' clearly lay down that land would be given first and cash compensation later. In actual practice, however, quite the opposite has been the case. A family given compensation in 1990-91 was given land in 1994, 1995, etc. Many displaced peoples' land had also been submerged in 1990-91 or so. Even in the matter of houses, the same has been the case. Compensation was paid in 1990-91 and a house plot allotted only four-five years later. This has further compounded the problems arising from paltry amounts of compensation, leading to large scale homelessness.
- An organisation of displaced people – Samanvay Samiti of Bisalpur Dam—was formed to protest against the rehabilitation and have raised a demand for just rehabilitation through various representations given to the state and central governments. [BSI nd]

Wadgaon Dam (Lower Wunna Project)

- The inhabitants of the cluster of villages off the national highway leading towards Hyderabad have now launched a movement—'Lower Wunna Prakalpa Andolan'. The Maharashtra Industries Development Corporation (MIDC) had agreed to transfer the land for rehabilitation of the affected villagers in April last year, when it was pointed out that it would help in expediting the long-pending Lower Wunna Project. The farmers are expected to construct their houses within two months and shift there before the arrival of the monsoon.
- The compensation announced by ministers and government officials has not been paid to the villagers in full. The villagers complain that the paltry compensation is only for the houses and property that the state government has acquired. The authorities have so far been silent about the agricultural land. [IE 09/04/1997]

Nagarjunasagar Dam

- Reportedly many of the people whose lands were submerged are unable to sustain themselves on the small land holdings given to them as compensation and are forced to migrate in search of daily wages.
- While the project was initiated in 1955, the calculation for the value of land was done on the basis of prices prevailing in 1953.

- While people were given the option of being compensated through the allotment of land at the relocation site, this could not be implemented as provision had not been made for adequate amount of land around the relocation centres.
- Many of the amenities that were promised were actually not made available at the relocation centres. [Singh and Samantray 1992]

Ukai Dam

- Compensation for the land acquired was inadequate.
- Many of the facilities offered by the government for relocation had several strings attached to them and therefore could not be availed by several oustees.
- The facilities and amenities offered at the relocation villages were inadequate.
- Eighteen villages of Sagbara Taluka were resettled about 30 km away from their original homes. However, since their lands had not been submerged, they were not compensated for them. Similarly, people from Kukarmunda, Kondrej and Gorase were rehabilitated on the right bank but the land that was allotted to them was on the left bank, about 30 km away across the Ukai reservoir. [Mankodi 1992 and Purohit nd01]

Pong Dam

- The oustees were settled in Rajasthan, which is climatically very different from the place of original habitation in the Kangra Valley in Himachal Pradesh.
- The people who took possession of the land allotted to them in Rajasthan faced a hostile local population and an apathetic local government. Many of them have had to return to Himachal and are now landless and homeless.
- Due to lack of adequate information, many of the oustees whose villages were submerged were caught unawares and had to flee from their homes as the waters of the reservoir rose.
- The cash compensation awarded was inadequate.
- There was a great deal of variation in calculating the award for compensation.
- Many of the procedures that had to be completed in order to become eligible for receiving compensation could not be completed because they were complicated and not enough time was provided by the authorities.
- A large part of the land that was reserved for allotment to the oustees had been encroached or was disputed. Therefore, even though allotment may have been made, the oustees were unable to take possession of the land.
- The oustees were expected to pay for the land that was allotted to them. The cost of this land has over the years been revised upward several times, thereby placing it out of reach of the oustees.

- The identification of those who were eligible for allotment of land was arbitrary and unfair.
- In many cases the land that was allotted to the oustees was re-acquired by the local government in Rajasthan, for works like roads, etc.
- Many of the houses allotted were badly constructed.
- In many cases people were given land and house in two different locations.
- Many of the amenities and facilities that were promised to the oustees were not given. [Bhanot and Singh 1992]

Upper Kolab

- A displaced family was defined as a family who would lose their homestead completely. Those who lost their agricultural land but not their homes were not entitled for rehabilitation benefits. This led to a problem of what were called "marooned villages". These were villages whose land was submerged, or the road which connected them to other villages or markets was submerged.
- In many villages more land than was estimated was submerged. According to the project authorities "It was obvious that some mistakes were there in FRL marking".
- The facilities provided to oustees in relocation camps were obviously below par since many of them decided not to shift to these camps. For example the project authorities themselves admit that there was a problem of water scarcity in many of the camps and was likely to continue. [GOO 1988]

Koyna Dam

- Land was given by the government only to those whose land was submerged under the lake.
- Much of the land that had been given to the displaced people was uncultivable.
- No substitute land was offered to those whose lands were not actually submerged but were acquired for other reasons. They were paid money and left to buy land for themselves.
- Each of the resettled villages had one or more temples. All the temples except a few were administered by trustee councils. The amount of compensation for these temples was to be paid to the trustees. But there were several difficulties. For example, money for one temple in village Kushavade, which had been broken up in to several new settlements was given to only one trustee instead of being divided among all the settlements of the same village.
- The government handed over a large amount of cash to people who had never before handled money. The result was that much of this money was spent in transportation expenses, and living expenses, instead of being utilised in constructing houses.

- Earlier, the displaced people were keeping their cattle at no cost as they were living in a densely forested area and had plenty of grazing land. At present the displaced persons who have moved to new settlements have no grazing land and have to buy fodder if they want to keep cattle. [Karve and Jai 1969]

Tawa Dam

- "The oustees from the Tawa Valley were given pattas for 5 to 15 acres. These documents were not distributed systematically. Instead, sheer arbitrariness prevailed. Many of them were duplicates. Says Mangeylal of Suktva village, who now works as a labourer: 'After 20 years I have got a patta for 15 acres, but I am shocked when I realise that there is no land'."
- "Because of the Tawa Dam, 12 villages in the Bori Sanctuary have become islands, and another 7 got encircled with water immediately after the first rains." [Dharmadikari and Agarwal 1991]

Upper Indravati Project

- 30,000 people, mostly Adivasies and Harijans, to be displaced due to Upper Indravati reservoir in Orissa, have been evacuated by force or by coercion, by paying them off compensation in cash.
- Under the Land Acquisition Law, a person is to be paid compensation on the basis of immovable assets (like land and house etc.). But a flat rate of Rs. 29,575 per family was given in the earlier stages. This was raised to Rs. 40,200 per family towards the last phase. N. Ahmed, the leader of the displaced persons has shown how the amount is highly inadequate to purchase the stipulated amount of agricultural land, homestead land and housing, according to government decision.
- Compensation is never a substitute for rehabilitation. This project never had a rehabilitation programme. The assurance to ensure atleast the earlier standard of living to the displaced persons was, therefore, observed more in breach.
- The oustees tried to resettle by establishing their own clusters. Such clusters lack basic amenities like water, health, education, communication and roads.
- Many villages to be seriously affected due to the reservoir, have not been listed. So they get no opportunity of rehabilitation.
- While giving compensation, women of 18 years of age are not treated as an independent family irrespective of marital status. This is discrimination based on sex.
- The activities of Indravati Gana Sangharsa Parishad, a democratic movement launched to protect the interests of project affected persons, have been suppressed by the police by repressive methods. Activists have been jailed for months together. [OKM nd]

3.2.2 *Discussion*

It would be clear from the findings given above, that the experience of rehabilitating people displaced by large dams is by and large not a happy one. However, the basic reasons for this can only be understood if one examines the processes and institutions involved in rehabilitation.

Rehabilitation Institutions and Processes

i. Laws and Policies

At present, only two national laws pertain to the regulation of displacement and rehabilitation of persons displaced by dams. The basic law, which has guided the resettlement and rehabilitation of displaced people in India, is the Land Acquisition Act of 1894. Under this Act, the government is empowered to acquire any land for "public purpose" and to pay cash compensation determined by it according to a prescribed procedure. Up to 1978, there was no assessment of the rehabilitation package of people being displaced by dams. In 1978, the MoEF initiated a process by which all major dams had to get environmental clearance, prior to their construction, on the basis of an environmental impact assessment. As a part of the EIA, the rehabilitation packages of people being displaced by dams was also assessed. This process continued without any legal sanction till 1994. In 1994, the rules of the EPA were amended to make the seeking of environmental clearance legally binding for major dams. This continues to include the rehabilitation package.

In the last few years there has developed a practice by which proposed dam projects also submit their resettlement and rehabilitation plans to the Ministry of Social Justice and Empowerment (MoSJE), for their concurrence. However, this is not yet legally mandated.

However, all these legal and informal provisions do not seem to ensure that the basic rehabilitation packages are invariably offered and delivered.

The Land Acquisition Act specifies cash compensation, but little else. The EPA does not specify any content of the rehabilitation package but just insists on its assessment. The MoSJE also does not seem to prescribe any basic package.

There is also no national policy on resettlement and rehabilitation for people displaced by dams. Though the Planning Commission and the Ministries of Rural Development and Social Welfare have made efforts in the past to formulate such a policy, and many drafts exist, they have been unsuccessful. Therefore, the assessments and prescriptions of the MoEF and the MoSJE remain arbitrary and legally non-enforceable.

Some states, like Maharashtra and Madhya Pradesh, have state acts for rehabilitation and resettlement (R&R) and other states like Gujarat, Orissa and Karnataka are in the process of developing R&R policies. In some cases (like Sardar Sarovar), in the same inter-state project people from different states are subject to different R&R policies.

Consequently, as things stand, the legal framework in India does not require that :

- Before a project is sanctioned or undertaken, the social impacts of the project have been comprehensively and adequately assessed and the project as been found to be socially viable.
- The social costs of the project have been adequately computed and included in the cost calculations of the project before its economic viability is assessed.
- The various possible measures for preventing social costs have been planned for and implemented (like shifting the site of the project or lowering its height, etc.).
- The compensatory package offered ensures that basic principles of rehabilitation are respected including adequate provisions to ensure that people are not worse off after relocation.
- The package also ensures that they are not forced to change their way of life or profession, that adequate measures are provided to safeguard their physical, emotional and psychological well being, that their traditions and culture are respected.

The package includes compensation for all the losses, not just in cash but also in kind, and provides agricultural and homestead land to all those who want it.

As there is no comprehensive policy, these matters are also not covered under any policy directives. However, various internal departmental guidelines and memos exist and there are court orders pertaining to the R&R package and processes for some of the past and ongoing projects.

This absence of legal and policy directives make it difficult for the affected people to fight for their rights. It also makes it difficult to ensure that compensation packages are uniform across dams and regions and that they all provide at least the basic minimum.

ii. Processes and Institutions

In almost all cases, right from the start, the planning and implementation of resettlement and rehabilitation was, till recently, carried out by the government through its own agencies with no participation of the people, especially the affected people. These agencies were also not multi-disciplinary but manned mostly by engineers. The identification of areas to be submerged or otherwise affected, the determination of who qualifies for compensation, of the nature and quantum of compensation and the time frame and process by which relocation, resettlement and rehabilitation would take place, were all done by the project authorities along with other government agencies. In some cases, the district authority or the state government was made responsible for carrying out relocation, resettlement and rehabilitation (like in the Tehri Project), and in others, like in Sardar Sarovar and Indira (Narmada) Sagar, it was done by the project authorities themselves.

The concerned departments or agencies of the state or central government propose projects. The Central Water Commission and the Central Electricity Authority of the

Government of India then evaluate these, from the techno-economic angle. At this stage, the proposed financial costs on rehabilitation are included as a part of the project costs.

Once the project gets techno-economic clearance form the CWC or the CEA, it is then sent to the Planning Commission and the MoEF. The MoEF, as a part of the EIA process, assesses the rehabilitation package and either approves it as it is, or prescribes improvements.

Till 1998, the MoEF clearances were again an internal matter, though they were based on recommendations made by the EAC, which has non official members. Since 1998, it has become necessary to hold public hearings regarding a project, at or near the project site. This is aimed at ensuring that people are at least informed about the project and have an opportunity to express their views, though there is no guarantee that their views would influence the final outcome.

Finally, after MoEF approvals, the project gets investment approval from the Planning Commission. Based on this, allocations are made in the annual plans of the concerned ministry or state departments. Of course, past experience is that a large number of projects get initiated much before any of the clearances are received. As such, by the time the project comes up for final assessment, a lot of money has already been spent and the project is presented as a *fait accompli*.

Though, in recent years, rehabilitation committees have been set up for some of the projects and such committees often have non-government members, they never have any decision making powers and usually function either as advisory committees or as grievance redressal committees. In any case, the affected people are rarely associated with such committees.

This lack of participation and decentralisation leads to many problems, some of which are described below.

- Lack of information about the project

The affected people often do not know till very late that they are going to be affected by the project or, indeed, very often that a project is going to come up in their area. This leads to a lot of insecurity, rumour mongering and misinformation. It can also lead to significant economic losses as people might make investments in areas that would get submerged. It also gives an unfair advantage to those few well-connected people who get advance information about the project. The time available to the local people to prepare for displacement is also cut drastically. The lack of advance information also deprives the people of any opportunity to influence the design and planning process of the dam or to even protest about the proposed dam.

- Insensitive planning

Because the affected people are not usually involved in the planning of the project, except sometimes through the recently started public hearings, their preferences and sensitivities are usually not taken into consideration. This results in a project design that is innocent of local realities. This also results in a situation where the affected people feel alienated from the process and are, therefore, not willing to co-operate.

- Inappropriate planning

  The knowledge and wisdom that the local people have about the people, the land, the water and the ecosystem is not taken into consideration while planning the rehabilitation process. This is a serious lacuna as the local people can very often guide the planners and point them in the right direction. Though public hearings have now become mandatory their mechanism precludes, even with the best of intentions, any detailed assessment of the project design and options by the people. Besides, the hearings are usually conducted at a point when much of the planning process is already over and only the environmental clearances are awaited.

- Inadequate costing

  Developing rehabilitation packages and resettlement schedules without consulting the affected people invariably results in these being inappropriate and having to be changed when the actual implementation starts. This not only results in additional costs but also in delays, which adversely affect both the economics of the dam and the welfare of the affected people.

- Lack of transparency

  Even during the implementation of the resettlement process, the lack of transparency affects the process. The manner in which resettlement and rehabilitation is handled becomes susceptible to patronage and corruption and it becomes difficult to ensure that every affected person is treated fairly and gets his or her due.

- Poor implementation

  Because of the non-involvement of the affected people, the implementation of most of the rehabilitation schemes leaves much to be desired. In some cases, NGOs and people's movements have successfully fought to better the plight of the PAPs. However, such successes are few and far between and they mostly result in a betterment of the conditions and not necessarily in the removal of all the problems and lacunae.

3.2 Other Social Impacts

3.3.1 *Findings*

Impacts upstream

i. Reduced water availability for the people upstream

When dams are planned, a certain quantity of water is anticipated in the river, upstream of the dam. An assessment of the amount of water available is critical for establishing the dam's economic viability. In order to ensure that the flow does not fall significantly below what has been anticipated and planned for, there is sometimes a ban on any scheme that diverts water upstream of the dam. This can cause significant hardships to communities living upstream of the dam, even before construction on the dam starts.

The mention of this aspect was found in two projects, Chandil and Tehri, in the first it was predicted that there would be no adverse impacts [ORSAC & WAPCOS nd.]. For the Tehri project, no assessment of this impact was done prior to the clearance of the dam. However, the villagers of the Bhagirathi Valley complained that village water schemes were not being sanctioned because it was stated that all the water upstream would be required for the dam [Tehri 1999].

Given the tendency to over-estimate water availability and the disruption of water flows due to the degradation of the catchments, this is an aspect that needs to be studied. Unfortunately there is no information about what deprivations were faced and continue to be faced by the people living upstream of dams.

Clearly, as the economic and technological viability of a dam is based on the amount of water that reaches the reservoir, some restrictions on upstream diversion have to be imposed. In fact, battles over the diversion of water are now becoming a common feature between states within the country and within countries across the world. However, the intensity of the adverse impacts that such restrictions would cause is reducible if the water rights of the people living upstream are statutorily recognised and the estimates for water availability at the dam are made keeping these rights in mind. This does not appear to have happened in any of the dams studied, except where there were issues regarding the inter-state sharing of waters. Here, the share of the various states were demarcated (eg. The Narmada Tribunal).

ii. Impacts on forest based resources

As the forests and other vegetation in the catchment of the dam degrade, due to additional pressures put by the dam (see section on the environment for details), it becomes harder for the people dependent on these forests to gather fire-wood, fodder and other basic necessities [Dharmadikari and Agarwal 1991]. Conflicts also grow with members of the labour force building the dam, as they are also forced to use the same catchments.

Though there is a lot of information about the adverse impacts of the dam on the catchments (see section on environmental impacts), there appears to have been no cognisance of this inevitable impact on the people living in and around the catchments.

This impact can also be reduced by the proper protection and regeneration of the catchments and by the project authorities ensuring that alternate supplies of biomass are made available to the affected populations. In recent projects, the requirement to carry out catchment area treatment and to provide alternate sources of fuel-wood has been stipulated.

iii. Impacts of backwater build-up on property and agricultural fields

The build up of backwater, especially during the rainy season, poses a threat to property and agricultural land (for details of backwater build-up, see section on environmental impacts). However, no assessment of the social and economic impacts that such a build up might have were found in any of the projects studied.

The damage can be minimised if the extent and severity of possible backwaters are anticipated and populations, property and agricultural lands likely to be affected are either relocated or other protective or ameliorative methods used. In any case, where backwater damage is anticipated, there should be a policy to acquire the land possibly affected and the cost of this should be built into the project. In none of the projects studied was this aspect assessed.

iv. Social and economic impacts due to disruption of access to the opposite bank

The filling up of the reservoir disrupts access of local communities to the opposite banks. Prior to the reservoir, people could cross the river over bridges, by boat, by other means including on foot, especially during the dry season. However, the reservoir submerges the bridges and makes it difficult to get to the other side without going all round the reservoir, which might entail many kilometres of travel.

Access is also disrupted because of the filling up of tributaries, due to the backwater affect, and also due to the accumulation of silt that sometimes becomes a physical barrier between the people and their water sources.

This disruption of access can have serious economic implications, as people are cut off from their market or their places of work. It can also have serious social impacts, as neighbouring communities become distant communities.

Though this is a phenomenon that must be occurring with most large dams, it was not mentioned in any of the documents studied. The adverse impact can be reduced by ensuring the creation of alternate convenient routes, regular transportation and, where necessary, a ferry across the reservoir.

Impacts common to the sites of the dam/reservoir/canals/transmission lines

i. Suspension of development/maintenance activities

As soon as a dam is planned, many development activities get suspended in the area that would be submerged. The creation of new assets, building of roads, construction work and other investments are frozen as the area is slated for submergence. Even maintenance work is sometimes suspended. This causes immeasurable hardships to the people living in the submergence zones.

The same problem occurs with canals and transmission lines. Even before a canal or transmission line is constructed, development and maintenance activities get curtailed in the area where either is to come up. Though the impact is not as severe as in the case of a dam, it is similar in nature.

The adverse impacts of this are exacerbated because of huge delays in the completion of the dams. From the date when a dam is first planned, it might take twenty or more years for its completion.

According to the Government of India [GOI 1989] the major schemes still under construction during the seventh plan (1985-90) were:

Schemes continuing from:

I	Plan	(1951-56)	4
II	Plan	(1956-61)	5
III	Plan	(1961-66)	16
Annual Plans		(1966-69)	6
IV	Plan	(1969-74)	26
V	Plan	(1974-78)	68
Annual Plans		(1978-80)	15
VI	Plan	(1980-85)	41

If we take the starting date as the mean of the plan period, this would imply that projects had not been completed even after:

33 years for 4 projects
30 years for 5 projects
26 years for 16 projects
22 years for 6 projects
17 years for 26 projects
10 years for 15 projects

These figures give the time taken after the start of the project. However, development activities get suspended as soon as a project is planned, which can be much before its start. It must, however, be kept in mind that these are the time frames of projects and not necessarily dams. Therefore, in at least some cases it is possible that the dam was completed much earlier but the canals or other aspects of the project drag on.

This, then, is a major social cost of dams that has been mostly ignored. In only one of the dams studied was this impact acknowledged (Almatti) [GOK 1998]. In the case of Almatti the project document stated that efforts were being made not to suspend development activities. It is not known whether these efforts were successful.

In the case of Narmada Sagar, Sardar Sarovar [NCAenv] and Tehri [Tehri 1997], the people in the submersion zone have bitterly protested against the suspension of development and maintenance activities. In the case of Tehri, some of the citizens have even approached the Supreme Court because the schools and hospitals that were used by the people of Tehri town and the neighbouring rural areas have been closed and shifted to the New Tehri town much in advance of relocation and submergence. [SC Petition 1999]

These are also preventable impacts where the government has to make a policy decision regarding the continuation of at least maintenance activities during the pendency of the project. Also, in case the construction of the project drags on beyond a reasonable time frame then the affected people must all be paid compensation for lost development opportunities.

ii. Impacts on property prices and transfer of immovable property

The prices of immovable property and land, in the submergence zone, crash as soon as the dam is planned. No one wants to buy property or land that is going to be finally submerged, especially where compensation is either payable only to the original owner or is not commensurate with the real value.

This results in much hardship, especially when the construction of the dam is slow, as is usually the case in India, and compensation is paid after many years. People wanting cash for emergencies, or for marriages and other social obligations, are unable to liquidate their holdings or even borrow against them.

There are cases where the delay in implementation and compensation has made it difficult for the women in the area to get suitable grooms. This has been reported from Bargi and Subarnarekha projects, among others. [Patkar pers.comm]

These are again unacknowledged social impacts of dams. They can perhaps be minimised by having a policy that allows borrowings from anticipated compensation against land and property. Project authorities or the government can set up a special fund for this.

Again, like for dams, this is an impact, though to a lesser extent, for canals and transmission lines also. Again, it remains an unacknowledged impact.

iii. Health impacts

The dust that is raised by various dam related activities, including the movement of heavy vehicles and machinery, mining and quarrying and construction work, seriously affects the health and well being of the people living in the vicinity.

The manner in which dams are constructed and related earth works and excavations are carried out in India, results in a lot of dust pollution. Though this is a widespread phenomenon, it has almost never been acknowledged in project documents. For one project, Ramganga [CBIP 1995], it has been stated that the incidence of tuberculosis went up because of dust pollution due to dam construction. In the case of Tehri [Tehri 1997], the people living around the dam site have protested about the high levels of dust pollution, however no study seems to have been conducted on the health impacts of this.

The levels of dust pollution can be controlled if water is sprinkled at the construction and excavation sites and the trucks and dumpers used are covered. The proper paving of roads also brings down the levels of dust. Unfortunately this too remains one of the unacknowledged social impacts of dams.

The water quality of the reservoir/river deteriorates because of the dam (for details see section on environment). This deterioration affects the health of the people and of the livestock depending on these for their water supply. However, this impact has also not been acknowledged in any of the projects studied and remains a hidden cost.

The reservoir is often fertile breeding grounds for vectors, like mosquitoes. Increase in the incidence of hepatitis has also been reported. This aspect is discussed in detail in the section on environmental impacts.

Most of the health impacts seen at the site of the dam, during construction and subsequently, are also present because of canals. There are also the adverse impacts due to dust pollution during construction, due to changes in micro climate and due to the breeding of vectors. In addition, the extensive water logging that occurs due to seepage from canals and also due to interference with natural drainage aggravates many adverse health impacts.

There are many reports of such impacts. For example, for the Sirhind feeder canal in Punjab it is mentioned that the incidence of malaria has increased [Dhesi 1996]. It is also mentioned that health hazards due to the careless use of pesticides may also increase. In fact, canal irrigation and the cropping patterns that it results in have significantly increased the use of pesticides and the consequent health hazards. Whereas the benefits of the increase in productivity are taken into consideration when a costing of the project is done, the social and environmental costs of pesticide use are never calculated.

No evidence was found that in any of the dams studied the adverse impacts of canals on human health were taken into consideration while assessing the project.

iv. Impacts on fish catch

The construction of the dam and other related activities, especially pollution and the diversion of water seriously disturb the aquatic ecosystem and adversely impact on the fisheries in the area. This can have serious implications on the livelihoods of the local fisher folk and on the diet of the local people. Consequent to this, the price of fish can also go up. This impact has also not been acknowledged in most of the project reports.

The earlier mentioned disturbances also impacts fish species and, consequently, local fishery, even while the dam is being constructed. However, such impacts during the construction of the dam have not been assessed in any of the dams studied.

Subsequent to the reservoir being formed, the formation of a lake and the consequent changes in the water profile, also affect the fisheries profile. In some case, through the introduction of adaptable species, the economic value of the over-all catch can be maintained or even improved. However, in other cases, this does not work. In both cases, the species mix of fish and their natural diversity is adversely affected.

After the reservoir is filled, there is a mixed impact on fisheries. In some cases the availability of commercially valuable fish goes down. In others, especially because of artificial stocking, the availability goes up. However, even where it goes up, very often the control on fisheries is also taken over by the government or the project authorities. The fishing rights are then either auctioned or given to a few people or institutions, on the basis of a licence. This has adverse impacts on the livelihood of the local fisher folk. Instances from Pench [IIPA 1994] in Maharashtra and Madhya Pradesh, from Polavaram [Annex 3.I] and from Gobind Sagar [IIPA 1990] have been recorded. However, this is another aspect that has not been widely acknowledged and remains a hidden cost.

Post construction impact on fishery and aquatic ecosystems has been studied in only 7 of the 67 projects surveyed. Of these, 3 projects list an increase in fishery in the reservoir. These projects are (1) Chandil [ORSAC & WACOS nd.], (2) Mahi Kadana [Purohit nd.], (3) Tawa [Dharmadikari and Agarwal 1991]. A decline in diversity of fish species has been witnessed in one case (Teesta Stage V), and no change in three other cases (Isapur, Sriram Sagar and Lower Manair). [See Annex 2.IV and 3.I for sources].

Impacts of fisheries in the reservoir cannot be prevented. However, through proper management, the availability of commercially valuable fish can be enhanced in many cases. The costs of loss in fish biodiversity and of enhancing commercial fisheries must be taken into consideration while assessing the project.

v. Impacts on land productivity

Often lands lying near the reservoir are affected by water logging. This can affect the productivity of the land and lead to various other social problems relating to health, the safety of houses and other structures and to the deterioration of roads. Water logging is an aspect that has been often studied though its occurrence has also often exceeded anticipated levels.

vi. Impacts on grazing land, sources of timber, fuel wood and other non timber forest produce

The people living around the reservoir lose access to the resources that get submerged by the reservoir. These could include grazing land, sources of timber, fuel-wood, fodder and other non-timber forest resources. This can result in significant social and economic costs, with people, especially women, having to travel longer distances in order to meet these requirements and having to pay higher rates for these necessities. This impact was not acknowledged in any of the projects studied.

The imperatives of catchment area treatment and compensatory afforestation, as also the need to compensate for the loss of biodiversity because of the dam, leads to the closing up of areas for either catchment area treatment, compensatory afforestation or for setting up or expending national parks and sanctuaries. All these have an adverse impact on the access of the local people to natural resources.

vii. Impacts on life and property due to reservoir induced seismicity

As reservoirs sometimes catalyse earthquakes (see section on environment for details), such earthquakes can take a heavy toll of life, property and the well being of the people in the region. This is again an impact which is rarely computed.

viii. Impacts on health and agriculture due to micro climatic changes

The reservoir can raise humidity in the region and affect temperature. The changes in humidity levels and temperature can affect the health of local inhabitants. They can also affect agricultural productivity. Depending on the region, these impacts can be negative or positive.

Impacts specific to the canal

i. Impacts on natural drainage

Canals; both during construction and after they become operational, can interfere with natural drainage. This can result in the higher (up slope) reaches becoming waterlogged and the lower (down slope) portions becoming arid. In both cases, there can be a significant loss of productivity and even adverse health impacts, apart from other attendant hardships.

ii. Impacts of water logging and salinity

Seepage from canals has been a major source of water logging. This can result in loss of land and productivity, soil erosion, loss of property, destruction of roads and even negative impacts on human health. The extent of water logging caused has been described in the section on environmental impacts. Unfortunately, in none of the dams studied the social costs of waterlogging were taken into consideration while appraising the dam.

Where PAPs are allotted land in the command area, which subsequently becomes water logged or saline, their plight is really pitiable. Along with all the other problems of forced displacement, they also have to confront the degradation of their lands and their subsequent impoverishment.

Whereas much of the water logging is preventable in many of the commands, by better managing the water, lining the canals and by other measures, there are some commands where any canal irrigation will inevitably result in water logging. It is unfortunate that this factor is not adequately considered while designing and constructing dams and canals.

Impacts specific to transmission lines

i. Health impacts

The major health impacts are related to radiation and the hazards associated with high tension transmission lines. High voltage transmission lines can pose a hazard to people living in the vicinity, especially in the case of accidents. Also, high voltage transmission lines are known to emit radiation and thereby adversely affect the health of people. These impacts, however, remain unacknowledged.

Impacts downstream of the dam

i. Impacts on fisheries

A dam has many adverse impacts on downstream river ecology (see section on environment for details). One major impact is the disruption of fisheries downstream, both during construction and subsequently. Often the availability of fish goes down and some commercially high value fish are altogether lost (for details see the section on environmental impacts).

The data available from the dams surveyed are mixed, with some dams reporting an increase in downstream fisheries, others showing either no perceptible change or a decrease. However, the number of projects that have actually studied the fish availability downstream during or after construction is very small (only three). (Bisalpur [GOR 1995d], Ukai [Purohit nd01], Hasdeo Bango [CWC 1991]

The disruption of fisheries downstream affects the livelihoods of thousands of people. For example, for the Sardar Sarovar Project it is estimated that nearly 10,000 fish workers downstream could be affected. Yet, these people are never included in the category of project affected people. [Patkar pers.comm]

Though some attention is now paid to fisheries in the reservoir, very little is paid to fisheries downstream. This is partly because of the mistaken assumption in most projects that the waterflow downstream will improve after the dam, at least in the dry season when it really matters. However, as mentioned earlier, it is the reduction of the peak flows, when many fish breed, and of the nutrients that get trapped at the dam, which have major impacts on fisheries. Also the debris and pollution that come down the river during construction adversely affect fisheries.

The disruption of the upstream migration of certain species of fish also affects their populations downstream, though this can be partly averted by providing fish ladders or fish lifts. Though many projects in India have fish ladders, none of them have fish lifts.

Also, many projects, especially the earlier ones, limited their span of attention to the dam, reservoir and catchments and did not bother to assess impacts above or below this. Also, in many cases, the impacts are seen only gradually over time and only an in-depth study can establish how much of these are due to the dam. This, therefore, remains one of the undetermined costs of dams.

ii. Impacts due to changes in water availability downstream

A dam reduces the river flows downstream, often adversely affecting the availability of both surface and ground water. This reduction is most marked during the rainy season but can also occur during other seasons due to inadequate storage or the requirements of irrigation. Some of the water is also diverted to irrigation canals and this can be as high as 60% of the river's flow. An increased proportion of the water is lost due to evaporation from the reservoir and from canals.

All this can adversely affect the availability of surface water and the recharging of ground water sources downstream. However, it is rarely acknowledged.

iii. Health impacts downstream

Because of reduced water flows and other reasons, pollution levels in the river downstream can go up, thereby affecting the health of people and livestock. Irrigated agriculture usually results in the increased use of chemical fertilizers and pesticides. These have adverse health impacts on the farm workers who use them and on the consumers of food grown through their use. However, the residues from the fields flow straight into the river. This means that the pollution load of the river goes up while the quantity of water available for diluting the pollutants goes down.

Considering that the increase in agricultural yields in the command of a dam are at least partly due to the application of pesticides and fertilizers, and that such increases form a part of the benefits ascribed to the dam, then it is correct to also ascribe the health impacts of the fertilizers and pesticides to dams.

Also, reduced water availability can aggravate health conditions related to sanitation and environmental health.

No data were available on this aspect. This is again an unacknowledged impact.

iv. Impacts on agriculture and water availability due to possible salt water ingress

In coastal areas, reduced downstream flows can often mean that sea water ingresses upstream and contaminates both river water and ground water.[Jain 1990]. This can have serious health implications, adversely affect agricultural productivity, and cause untold hardships.

In coastal areas, where the flow of rivers is disrupted due to dams upstream, many of the traditional wells and underground aquifers have become brackish and result in serious shortages of potable water. For some more details see the environment section.

This is not assessed in any of the projects surveyed.

v. Impacts on life and property due to sudden releases of water

There are sometimes sudden releases of water from dams (operational or under construction), in order to safeguard the dam structure. Such sudden releases can take a toll of life and property, as they flood downstream areas. They also destroy agricultural fields and riverbed crops (see section on environment for details).

vi. Impacts on life and property due to dam failure

Dams the world over have been known to fail, with catastrophic results. Apart from the cost to life and property when a dam actually fails, there is the additional trauma of living downstream with the threat of dam failure constantly hanging over ones head (see section on environment for details).

3.3.2 *Discussion*

The factors responsible for this poor state of anticipation and management of the various social impacts are similar to those responsible for poor rehabilitation.

3.4 Impacts on Equity

Equity (or inequity) is always measured between two individuals or groups of people in terms of the differences between them or the gaps in their incomes, resource levels and quality of life. In the context of dams, what needs to be determined is whether the construction of the dam changed the equity ratio between the categories listed below and was this change positive (promoting equity) or negative (promoting inequity). Changes in the equity status can be measured:

- Between the beneficiary generation and future generations.
- Between human beings and other species
- Between those who lose (mainly the upstream populations) and those who gain (mainly the populations in the command and the recipients of electricity).

- Among those who lose (project affected persons or PAPs), especially between different castes, classes, gender, and age groups.
- Among those who gain (project beneficiaries or PBs), especially between different castes, classes, gender, and age groups, and between those living at different locations in the command.

3.4.1 *Findings*

Equity between those who gain and those who lose

Many social and environmental impacts that affect people upstream, in the command and downstream, of dams, have been identified in the sections on environmental and social impacts. The section on economics describes the various economic costs and benefits of dams. In order to determine the impact on equity of all these costs and benefits, it has also to be determined whether those who pay the costs are better off or worse off than those who reap the benefits.

In other words, a class-benefit analysis, or an equity impact assessment (EqIA) as Amulya K.N. Reddy calls it, determines not just whether some pay costs and others get the benefits but whether the gap between these two is, as a result, lessened or increased.

Therefore, in order to assess the equity impact of the dam between two groups, it is essential to:

- Determine their relative economic and social status prior to the dam.
- Determine the net impact (beneficial or adverse) of the dam on each group.
- From these, deduce the impact of the dam on equity.

i. Impact on equity between populations upstream (PAPs) and those downstream (irrigation beneficiaries)

Relative socio-economic status: Though data on the social profile of displaced persons, in terms of their being members of the scheduled tribes (ST) or scheduled castes (SC) are available for some of the dams, data on their economic status prior to the dam were not collected for any of the projects studied. No data on either the social or economic status of beneficiaries of irrigation are available.

Data regarding the number and proportion of members of the scheduled castes and scheduled tribes displaced by dams was compiled from for the dams for which such data were available and is given in table 3.B and 3.C below.

Together, nearly 45% of the population displaced were tribals and members of the scheduled castes. Considering their population nationally is only a little over 24.5%, clearly their representation among those displaced was disproportionately high.

For tribals, this was particularly significant as their proportion in the national population is only a little over eight percent, while their proportion among the displaced was over 47%.

Though no data were available regarding the socio- economic status of the downstream populations, it would not be unfair to assume that the proportion of tribals among them would be very small. If one further restricts the assessment to those who benefited directly from irrigation, then this would include mainly the landed classes and would, therefore, effectively exclude most tribals and scheduled castes, even if they were physically located in the command area.

Consequently, it could be safely concluded that, prior to the dam, the PAPs upstream, as a whole, were economically (in terms of monetary incomes) far less privileged than the downstream beneficiaries of irrigation.

Very often the upstream populations, mainly tribals or other forest communities, are resource rich but without high monetary incomes. The downstream populations are relatively resource poor but with higher monetary incomes. The construction of a dam takes away the resources of the resource rich community and impoverishes them, not even giving them high monetary incomes. It, on the other hand, enhances the incomes of the downstream landed class, who are already in a higher income bracket.

Table 3B : Members of the scheduled caste displaced/to be displaced

Name of the Dam/Project	*Total Number of People Displaced*	*Members of Scheduled Caste Displaced*	*Percentage of Scheduled Caste Persons Among those Displaced*
Bargi	37,725	3840	10.2%
Bisalpur	57,138	5900	10.3%
Hasdeo Bango	13,585	680	5.0%
Hirakud	75,000	10,125	13.5%
Isapur	16,940	14,399	85.0%
Polavaram	154,484	15,757	10.2%
Rengali	4,015	233	5.8%
Nagarjunasagar	24,400	1708	7.0%
Narmada Sagar (Indira Sagar)	82,120	10,090	12.3%
Sipu	5,494	495	9.0%
Sondur dam	1,510	55	3.6%
Teesta (Stage V)	1,020	25	2.5%
Tillari	4,274	183	4.3%
Upper Indravati	26,630	10,985	41.3%
Upper Wain Ganga	6,435	860	13.4%
Upper Wardha	11,817	1195	10.1%
Warna	7,906	132	1.7%
TOTAL	**530,493**	**76,662**	**14.5%**

SOURCE : Annex 3.VI & IIPA nd01.

Table 3C : Scheduled Tribe persons displaced/to be displaced

Dam Name	*Total Number of People Displaced*	*Total Number of Tribals Displaced*	*Percentage of Tribals Among those Displaced*
Balimela	60,000	5,880	9.8%
Bargi	37,725	11,430	30.3%
Bhakra	36,000	12,514	34.8%
Bisalpur	57,138	5,700	10.0%
Bodhghat	12,700	9,520	75.0%
Chandil	48,500	46,075	95.0%
Daman ganga	11,805	7,770	65.8%
Hasdeo Bango	13,585	10,910	80.3%
Hirakud	75,000	24,975	33.3%
Icha	30,800	24,640	80.0%
Inchampalli	38,100	29,063	76.3%
Jakham	335	320	95.5%
Karjan	8,025	7,970	99.3%
Koel Karo	66,000	58,080	88.0%
Konar	5,747	1,224	21.3%
Maheshwar	20,000	12,000	60.0%
Mahibajajsagar	34,875	26,017	74.6%
Maithon	28,030	15,837	56.5%
Masan	29,975	9,292	31.0%
Nagarjunasagar	24,400	8,784	36.0%
Narmada Sagar (Indira Sagar)	82,120	15,870	19.3%
Polavaram	154,484	81,722	52.9%
Pong	20,722	11,656	56.3%
Rengali	4,015	23	0.6%
Sardar Sarovar	150720	92770	61.6%
Sondur dam	1,510	1,250	82.8%
Tawa	3,070	3,070	100.0%
Teesta (Stage V)	1,020	255	25.0%
Tultuli	13,600	7,019	51.6%
Ukai	80,000	15,120	18.9%
Upper Indravati	26,630	4,285	16.1%
Upper Wain Ganga	6,435	1,835	28.5%
Upper Wardha	11,817	3,466	29.3%
Warna	7,906	93	1.2%
TOTAL	**1,202,789**	**566,434**	**47.1%**

SOURCE : Annex 3.VI & IIPA nd01.

Net impacts: It is an accepted fact that the irrigation benefits of dams flow to the downstream populations and that none of these are ordinarily shared with the upstream PAPs. In none of the dams studied were any irrigation benefits claimed for the upstream regions.

Of course, there could be a sharing of benefits if the displaced upstream populations were given a part of the irrigated lands belonging to the downstream beneficiaries, once the dam was constructed. However, this was attempted in very few of the projects surveyed. Also, where the social, climatic and geographical profile of the command was significantly different to that of the submergence area, such an arrangement might not be without its problems. One other way is to get the downstream beneficiaries to contribute to the better rehabilitation of the PAPs. However, there was also no evidence that betterment levies were being collected from downstream beneficiaries and were being transferred to the affected people.

Laxity in collecting water rates from downstream beneficiaries, which is common in India, also adds to their benefits. A revealing example is the Ukai-Kakrapar dam in Gujarat, where the arrears of water-cess collection have gone up from Rs 529 lakhs to Rs 677 lakhs between 1979-80 and 1982 [Jain 1990]. Also, cases of unauthorised irrigation have gone up from 1,781 to 6,525. Similar results have been obtained for the Mahi-Kadana project too. Thus, it is clear that these projects further subsidise the already benefited farmer in the command.

On the other hand, the adverse impacts of displacement that confront the upstream PAPs are aggravated further by tardy implementation of the rehabilitation programmes and poor efforts at preventing and mitigating environmental damage.

Environmental impacts, especially the submergence of forests and the destruction of terrestrial and aquatic biodiversity, also affect the upstream populations, especially the tribals and the rural poor. Loss of access to common property resources (CPRs), including the loss of access to forests and pasture lands, if not compensated for adequately, tends to have a higher differential impact on the poor and the landless than on the rich landed farmers. This is because the dependence of the former on CPRs for meeting subsistence needs is much greater than that of the latter.

Though direct data are not available on the loss of various other types of habitat, in the 43 dams assessed for their submergence (see section on environment), the forest area submerged was over 25% of the total area submerged. Estimates made on the basis of these and other data suggest that the total amount of forests that have or would get submerged under the completed or ongoing dams between 1980 and 2000 would be about 1.3 million hectares. Such a large submergence of forests would have a very devastating impact on the poorest segments of the society, especially the tribals, who heavily depend on these forests for their subsistence needs.

In general, with the availability of irrigation, a host of other developmental activities are also initiated in the command (for instance, Command Area Development or CAD schemes, On Farm Development or OFD schemes, Agricultural Research and Extension activities, and so on...), bringing in an even greater inflow of resources. At the same time, in the upstream area, there is a tendency to cut expenditure on development and maintenance activities of different types (welfare schemes of the government, water-use schemes for upstream areas, and so on...), owing to the fact that the area is to go under submergence. Thus there is a general rise in the resource flow to the command area, and a fall in resource flow to the upstream areas, during the period of, and in the wake of dam construction. This can have a further deleterious impact on equity between those who gain and those who lose.

Impact on equity: Given the data available, it seems clear that the net benefits went to the beneficiaries of irrigation downstream and that the PAPs upstream were net losers. It also seems clear that the losses were significant, as were the benefits. Though complete data on the relative socio-economic status of PAPs and the irrigation beneficiaries were not available, it also seems certain that the former were, even to start with, relatively disadvantaged compared to the latter, as a group.

Based on this, it cannot but be concluded that the impact of the dam on equity between the PAPs and the irrigation beneficiaries was adverse.

ii. Impact on equity between populations upstream (PAPs) and those who receive the power benefits

The distribution of power from dams is more difficult to track as the power from a particular dam does not go to an identifiable area or group. The power produced is fed into the national grid and therefore it is impossible to determine who uses the power produced by any particular dam.

Also, most of the contribution by dams to the energy sector is in terms of peaking power.

Given these constraints, the only alternative was to look at the overall use and distribution of power and to assess which class of people benefit from it.

Relative socio-economic status: The costs of the dam, as described earlier, are mostly borne by those who are relatively disadvantaged in socio-economic terms. However, in the case of power some of the PAPs could also be the beneficiaries, so the divide between the PAPs and the power beneficiaries is not as clear as it is between the PAPs and the irrigation beneficiaries.

The statistics on power consumption in the country distinguish between different categories of users:

- Urban
- Rural
- Industrial
- Domestic
- Agricultural
- Transport
- Others

Considering that very large proportions of the PAPs are from the rural areas, the first distinction that could be made for the purpose of a class benefit analysis is that of urban versus rural, including the industrial in the urban, as it only marginally benefits the very poor. Among the rural, a further distinction can be made between agricultural and domestic uses, and within domestic uses, the class that uses it in the rural areas.

Various estimates of the electricity used by each of these categories exist. The latest statistics of the Planning Commission [PC 1999] indicate the following patterns of use.

Category	*Consumption (Mkwh)*	*% of total consumption*
Domestic	57553	18.4
Commercial	15182	5.0
Agriculture/irrigation	93687	30.0
Industry	105207	33.6
Railways	6660	2.1
Outside the respective states	3642	1.2
Others	30754	9.2
TOTAL	**312685**	**99.5**

We can disregard the other categories as being irrelevant or insignificant and focus on domestic, agriculture/irrigation and industry. These three together account for 82% of the power consumed.

In assessing the profiles of the consumers, the industrial consumption can be clubbed with the urban consumption, being used primarily by the organised sector. According to the Planning Commission [GOI 1990] "Within the industry sector, only six industries viz. Iron and steel, aluminium, cement, paper, fertilisers and textiles consume about 43% of the total electricity consumption in the industry sector."

The domestic sector needs to be further sub-divided into the urban domestic and the rural domestic sectors.

Though comprehensive figures indicating the break-up of consumption between urban and rural domestic sectors was not available, the figures available indicated that by March, 1997, over 80% of the villages (491465 out of a total of 587288 villages) in the country had been electrified [PC 1999]. However, this "achievement is to be viewed with the existing definition which declares 'a village as electrified if electricity is used for any purpose within the revenue boundary of that village'. Thus, even in all these electrified villages, power connection may or may not be available on demand. A large number of hamlets and *harijan bastis* adjoining the villages are yet to be electrified" [PC 1999].

According to Reddy [1999] "India's population according to the 1991 census was 846 million. The rural population was 74.34 percent or 623 million which at 5.5 persons per household corresponds to 114 million households. 69 per cent of these households, i.e., 78.6 million households, were un-electrified."

In another study done in the Bankura district in West Bengal [Banerji et al. 1999], a stratified sample of 163 households revealed that none of the households below the poverty line used electricity as a source of non-cooking energy. The use of electricity as non-cooking energy rose sharply with the rise in the economic class of the households, doubling between the above poverty and the middle income households, and nearly tripling for the high income households.

In none of the studies was electricity recorded as a cooking fuel for rural areas. Banerji et al go on to observe that "Non-cooking energy accounts for a small proportion of the household energy use in Bankura. Non-cooking energy is predominantly for lighting. In electrified house-holds some electricity consumption is also for fans and higher income households also have other appliances like television sets etc.....Even electrified households have kerosene consumption for lighting. This is because the rural electricity supply is unreliable and there are many hours during the day when there are supply interruptions."

According to the Planning Commission [PC 1999], in 1996-97 there were 86.53 million consumers of electricity. Though these would include industries and commercial enterprises, even if we consider all of them as households then of the 173 million households in India only about half the households would be electrified. It does not need a separate study to determine that these would necessarily be the better off households.

It would, therefore, not be unreasonable to conclude that, even in the rural areas, the bulk of the domestic supply of electricity goes to the well to do families. This is partly due to the fact that, due to its unreliability, electricity in rural areas is primarily used for devices like fans and televisions, which cannot run otherwise. The poor do not own these. On the other hand, the capital cost of getting electric connection for lighting is too high for most rural families. According to [Reddy 1999] " ...the operating costs of traditional devices (e g, kerosene lamps) are a sort of upper bound for the costs of an alternate technology. From this point of view, it appears that the problem arises more with the capital costs of new technological options than with their operating costs."

A similar view is found in an action plan prepared by the Planning Commission [GOI 1990]. This plan states that " Rural electrification in the coming years will gradually, to some extent, replace kerosene as a fuel for lighting but the heavy initial investment required for electrification makes it difficult to achieve more rapid rural electrification... consequently kerosene may very well continue to be the common man's fuel for domestic lighting for years to come.".

As far as the use of electricity for agriculture/ irrigation goes, [Reddy 1999] says "Actually, subsidies granted in the name of the poor often end up going to the better off. For example, free electricity to rural areas goes primarily to farmers rich enough to own an electric pump for pumping irrigation water."

The Planning Commission [GOI 1990] also appears to concur and says "The emphasis has been mainly for rural electrification for energising agricultural pumpsets. In any case, owing to the high initial costs, it may be difficult for the low income section of the population to take advantage of the programme ...".

Again, it is self evident that the land-less and the marginal farmers would not be the owners of electric pumps and, consequently, the benefits of rural electric supply would not flow to them.

Net Impacts: Clearly the recipients of electricity are major beneficiaries of dams, whether they live in the urban or rural areas. On the other hand, those among the PAPs who are too poor or isolated to have access to electricity are the ones who pay the major costs, as already described earlier.

Impact on Equity: If a broad generalisation is made, it can perhaps be argued that the direct benefits of power go to the various classes in the following manner:

Table 3D

Class of people	*Domestic use*	*Industrial use*	*Agricultural use*	*Remarks*
Upper class/ industrialist (urban)	+++++	+++++		The electricity consumed by multiple air-conditioners and other gadgets and in large and multiple houses, and by five star hotels, and by industries owned by them.
Upper middle class (urban)	++++	++++		Domestic electricity consumed as above but to a lesser extent. Ownership of/employment in industry.
Middle class (urban)	+++	+++		Electricity consumed for, coolers, fans, and other devices. Employment in industry.
Lower middle class (urban)	++	++		Electricity consumed as above but to a lesser extent. Employment in industry.
Poor (urban)	+	+		Living in *jhuggis* or homeless, with negligible electricity consumption. Employment as labour in industry.
Big farmer/ rural industrialist (rural)	++	+	+++++	The primary user of domestic and agricultural electricity.
Small farmer (rural)	+		++	Occasional domestic and agricultural use.
Marginal farmer and the Landless			+	No domestic connection and no direct agricultural use. Employment as farm labour

Further, considering a bulk of the power produced by dams is used as peaking power to make up the shortfalls during the peak demand time, the contribution of hydro-power can be further narrowed down. The main peak demand comes from the urban domestic sector. According to [TERI 1991] " While residential electricity demands have gone up from 11 percent to 14 percent of total electricity demands (over the period 1980-81 to 1988-89), the issue of significance here is that these demands are found to coincide with the peak demand. In the case of the agricultural sector the increase in demand is largely due to the Government policy of rural electrification and thereby energisation of pump-sets. The electricity boards however adopt a number of measures to ensure that rural pump-sets do not operate during peak demand periods."

Are we then also looking at a conflict between power and irrigation demands in periods of peaking demand, especially the dry season? Is it the case that at this time of the year, less water is released from the reservoir for irrigation needs so as to maintain power generation levels at the maximum to meet peaking demand? If so, then again there is an element of inequity, between rural (irrigation) and urban (domestic) users.

The matter is exacerbated by the high rates of subsidy attached to the power sector, primarily for domestic and agricultural power. According to the Planning Commission, the subsidies to the agricultural and domestic sector in 1997-98 were a whopping Rs. 22,216 crores. [PC 1999]. The losses by the state electricity boards (without subsidy) were Rs. 10,684 crores. These subsidies and losses also come mainly out of the pocket of the common man and woman in India, but the benefits, as we have seen, go mainly to the rich in the urban and rural areas.

Added to this are the very high transmission losses in India. According to the latest figures available, the transmission losses in 1995-96 were 22.3% of the generation. It is also estimated that a significant proportion of these is losses due to theft. Considering the poorer half of the country has little or no access to electricity, a large proportion of these thefts must also be by the better off 50%.

As we have seen, much of the electricity produced by the dam goes into the grid and is then primarily used (or stolen) by the well to do populations in urban or rural areas. Consequently, the dam promotes inequity between them and the poor and disadvantaged, who receive none or little of the benefits but pay much of the price.

Among those who lose

i. Impact on equity among different categories of Displaced Persons (DPs)

Relative socio-economic status: As already described, some data are available about the socio-economic profile of the DPs. A large proportion (nearly 62%) belong to SCs or STs, and most are from rural areas.

However, there are also economic disparities within the DPs. Though no detailed data are available, there is no reason to believe that those being displaced or otherwise being affected by dams are any different to the rest of the rural population of India. Some are large farmers, many are small and marginal farmers, and others are land-less.

There are also women, children, old people and physically and mentally challenged people among them.

Net Impacts: The survey of dams reveals that at least for one category of DPs, some of the dams have had a positive impact. In those few dams where agricultural and homestead land was provided even to those who were land less, there could be a net positive impact. Also, where the marginal farmer was given land in excess of his/her original holdings, there could be a net positive impact. Of course, this is only if the land allotted was of equal or better quality than that which was lost and the other costs that the DPs had to bear did not offset the benefits of the land.

In a few recent projects, adult unmarried males were also recognised as families, and were given land. The net impact of this on their families and on the younger generation of males could be positive, provided the quantity and quality of land given was adequate and the other costs they had to bear did not offset the benefits.

In so far as the allotment of land was restricted to a maximum limit and people who owned more than the limit were only given land up to the prescribed limit, the impact on the large land holders was negative.

In all cases where the net benefits were positive but the control and ownership of the benefits vested solely with the male members of the family, the impact on women was negative as they got no special economic or social status in the rehabilitation package. In most of the dams, the ownership and control of the new land allotted or of the other benefits provided remained with the male (father/husband). In one or two of the recent projects there has been an effort to ensure that the title of land is in joint name of the husband or wife. However, this is still a proposal and has not become reality.

In one or two of the recent projects there is also a provision to treat adult unmarried daughters as a separate family unit. In such cases, there would be a positive impact on women and on the younger generation, provided the quantity and quality of the land and other compensation was adequate and the other costs were not so high that they off set this benefit.

However, where land was not allotted (as was the case in a majority of the projects) or where land was only allotted to those who already had land, the net impact on the land-less, given the various other costs they had to pay, was adverse.

In none of the rehabilitation packages studied were the special needs of children, old people or the physically and mentally challenged, explicitly addressed. Considering the other costs they had to pay as a result of the dam, the impact of the dam on them would be negative.

Also, the special problems that tribals and other forest based communities have because of displacement did not seem to be addressed in most of the projects. Whereas, all the PAPs suffered the various deprivations listed above, however those communities who had little or no contact with the outside world and with alternate lifestyles suffered these deprivations more acutely.

Given the special vulnerabilities of the land-less, the tribals or members of the scheduled castes, except in those cases, as mentioned earlier, where there was an explicit effort to compensate them at a higher level than the less disadvantaged, the impact on them would also be negative.

Impact on Equity: In those rare cases where the land-less and the marginal farmer were given an adequate amount of good agricultural land, and where the large land owners were only given land up to a ceiling, and the other costs of displacement were equitably distributed, the impact on equity between the poorer and richer DPs would be positive.

In all other cases it would be negative. This is especially so because, in most circumstances, the rich and influential among the PAPs would be able to ensure that they pay the least costs and receive the greatest benefits.

Where women were given joint title to the land and joint control over all other compensation, the impact on equity between men and women would be positive. Otherwise there would be no impact. However, where the net benefits went only into the control of men or where natural and other resources that the women depend upon more were depleted or not replaced, the impact on women would be negative.

Given the special vulnerabilities of children, old people and the physically and mentally challenged, and given that there were no special arrangements made for them, the impact on equity between them and the rest of the population would be negative.

ii. Impact on equity between those who lose upstream and those who lose downstream

There are various categories of people downstream who also suffer adverse impacts due to the dam. These include those affected by the varying water flows in the river, by the depleting fisheries, by sudden releases of water, by dam failure, by salt-water ingress, by the aggravation of floods, and due to other adverse impacts on the riverine ecology. There are also victims of reservoir induced seismicity or of the health hazards that reservoirs and canals bring.

However, very little information is available about their socio-economic profile or, indeed, about the extent and severity of their loss. Therefore, nothing can be said about the impact on equity between these and those who are the losers upstream. All that can be said is that the dam has a negative impact on the equity status between these and those who have benefited from the dam.

Among those who gain

i. Impact on equity among those who gain from electricity

Relative socio-economic status: The profile of those who gain, from the electricity produced by dams, has already been described above. The main benefits go to the richer urban and rural populations.

Net Impacts: The access to electricity in the rural areas gives large farmers a net gain. The access to electricity for domestic use also has a net positive impact on the domestic urban and rural users and on industrialists. This gives an advantage to both the urban and the rural consumer over those who do not have such access.

Impact on Equity: The ability of the large farmer to draw out large amounts of water by using electrified pumps also lowers the ground water levels in many areas. This makes it increasingly difficult for the small farmer to access water. Besides, as the small farmer does not have the ability to use the electricity, the impact on equity between the big and small farmer is adverse.

The relative advantage that the large farmer and the urban and rural consumer of electricity get over the small farmer and those without access to electricity heightens the inequity between these groups.

The electricity that industrialists receive also heightens the inequity between the industrialists and all other groups affected by the dam.

ii. Impact on equity among those who gain from irrigation

Relative socio-economic status: The socio-economic status of the beneficiaries of irrigation has been relatively better studied. The indicators that are relevant for our purpose are the land holding patterns and the location of the land holdings in the command. As elsewhere, the command contains big farmers, small and marginal farmers and the land-less. Land is also held at the edge of the canal, at the head reach and at the tail end of the canal.

Net Impacts: The net impacts among the beneficiaries of irrigation can be considered separately for seven groups: the large farmer, the medium farmer, the small and marginal farmer, the land-less, women, the head reach farmer, and the tail end farmer.

***(a)* The large, medium and small/marginal farmers**

Considering in most irrigation systems, water is released according to land holdings, the general inequitable distribution of land in the country also reflects in the consequent inequitable distribution of water in the command. Therefore, if in a command 60%of the land is owned by 30% of the farmers, it follows that, all other things being equal, 60% of the benefits of irrigation will go to 30% of the farmers.

More specifically, the distribution of benefits from irrigation projects can affect equity among the downstream population to a very significant extent. However, empirical evidence of distribution of irrigation benefits from such projects in India is extremely scanty, as has been pointed out by Wade. He, however, argues that in general, the possibility of getting access to scarce water from irrigation projects is higher for the resource-rich farmers than for the poor. Canal irrigation attempts to ration a scarce resource (namely water) among competing uses by means of a non-price, administrative mechanism. Hence, "it is likely ...that inequalities of other resources - education, money, connections - intrude into the distribution system, and are used to apply pressure on individual officers directly or indirectly... This may be expected to have large and cumulative effects on income distribution. Farmers faced with a very uncertain canal supply use a variety of tactics to reduce the effects on their income: for example, diversification to include more crops which are resistant to water stress, the use of less fertiliser and at sub-optimal times..., and keeping land unlevelled, so that if irrigation is late the crop in lower lying areas ... might survive. But all these measures lower maximum output. The worse is a farmer's standard of water service, the more he is likely to adopt these and similar measures, and therefore the greater the inequality in output between those with good water service and those with bad." [Wade 1975, p - 1745].

Technical studies of yield from canal irrigated tracts according to size of landholdings have shown that benefits from irrigation do not tend to increase with rise in size of landholding, as long as there is equality in fertilizer use between large and small farmers. In the absence of such equality (due to differential access to credit, information etc.), however, distribution of benefits would get skewed. [Dhawan 1985 p - A-128]. Thus, as long as institutional changes like land reforms and a tilt in irrigation projects in favour of small farmers are not brought about, the tendency of skewed benefit-sharing would be likely to persist, leading to worsening of inequities.

As irrigation schemes are usually constructed in the backdrop of an already skewed distribution of income and wealth, their benefits may often be disproportionately greater for large landholders than for small and marginal farmers. Many studies have shown that the landholding pattern tends to become more skewed in the wake of canal irrigation. A Planning Commission study has shown that people from outside the command area tend to buy land in this zone, due to its higher potential profitability. [Singh 1997, p.176-77]. It has also been argued that large farmers, using various means, tend to establish control over land in the head-reaches of the canal system [Thakkar 1999, p.30-31]. Others like Vaidyanathan have concluded that hardly one fifth of Indian farmers have benefited from canal irrigation, and of these, the bulk of the benefits have been concentrated on the large farmers [Thakkar, op cit, p - 31].

As seen in the case of the Jamuna Assam canal project [WAPCOS 1996c], there is a tendency towards concentration of land in favour of medium and large farmers (54 per cent) in the command area, as compared to the non-command area (25 per cent). For the Sirhind canal in Punjab [Dhesi 1996], the number of marginal farmers (0-6 ha) has swelled from 32 to 91 in the sample studied, while the number of large farmers also increased from 13 to 19, thus widening the disparities between the two groups.

Consequently, the net benefits to both the large and the small and marginal farmer are positive, except in those cases where their land gets water logged or becomes saline. However, the large farmer gets much more benefits than the small and marginal farmer.

(b) Marginal farmers and agricultural labourers

Impact on the land-less cultivators downstream can occur as a result of changes in employment opportunities. An increase in cropping frequency as a result of assured water supply can lead to higher employment generation, but a change in cropping pattern in favour of more capital intensive and labour displacing crops can reduce employment opportunities. Moreover, with an assured water supply, land-owners in the command area of a dam may find it lucrative to bring hitherto uncultivated land under the plough. They may also find it lucrative to take away the hitherto less productive land from land-less sharecroppers and cultivate it themselves. The sum total of the impact of the dam on employment opportunities available to land-less cultivators in the command area would depend on the relative strength of each of the factors outlined above.

A typical example can be seen in the Sirhind canal in Punjab [Dhesi 1996]. Here, the pattern of farm asset possession has changed significantly due to irrigation availability. There has been an astronomical increase in the numbers of mechanical/electrical, capital-intensive farm equipment held by farmers in the command area. Even more importantly, the concentration of these assets in the hands of the large farmers is bound to have a negative impact on employment generation.

It is found that for Sirhind, the number of seed drills held has changed from zero before irrigation to 2,688 after irrigation. The corresponding figures for diesel pump sets is 10 and 2,424, and for tractors is 5 and 2,244. Sirhind [Dhesi 1996] also shows that only 16 per cent of small and marginal farmers possess tractors, while the figure is 71 per cent for large farmers. The impact of this on employment would be significant, because small farmers usually tend to use family labour, and it is mainly large farmers that generate employment opportunities for the pool of agricultural labourers. This can be seen from the changes in the pattern of labour use in this area between 1954-89. The number of labourers employed per hectare of land decreased for all crops (from 69 to 48 for wheat, from 87 to 51 for American cotton, and from 96 to 49 for desi cotton).

Similar trends have been observed for the Mayurakshi project in West Bengal [WAPCOS 1996a], and the Bhadar project in Gujarat [CCPA 1996]. This fall in labour use per hectare may be partially or fully offset by the increase in area under cultivation that canal irrigation makes possible (as can be seen for projects like Sriramsagar [GOAP 1994] and Sirhind [Dhesi 1996]). However, this must be weighed against the observed trend of *decrease* in area under cultivation due to water-logging, salinity etc., as outlined in the section on environmental impacts.

The trend of marginalisation of landless labourers and small farmers finds further support from data on fall in agricultural wages, rise in number and proportion of agricultural labourers in total population, and a steady increase in land prices that puts this asset out of the reach of the poor. For instance, in the Sirhind command area, the proportion of agricultural labourers in total population has shot up from 25 per cent to 40 per cent, while the proportion as well as absolute number of owner-cultivators has declined significantly. In the same area, the average agricultural wage as a proportion of skilled wage has fallen from 70 per cent in 1961 to 52 per cent in 1981. This indicates a rising disparity in sharing of gains from canal irrigated agriculture.

Typically, the crops grown on new land brought under cultivation are wet irrigated foodgrains or cash crops like sugarcane or HYV paddy. These are usually more capital-intensive than the dry irrigated crops, and this too contributes to the observed decline in use of labour per hectare of irrigated land.

The availability of irrigation has also tended to strengthen the tendency of concentration of landholdings by raising profitability of cultivation and increasing land prices in the command area. As a result, it becomes more profitable to bring under the plough sub-marginal lands, wasteland and fallow tracts. Typically, such tracts are cultivated by small and marginal farmers, under institutional arrangements like share-cropping. With the availability of irrigation, large landowners may find it worthwhile to take over these tracts for self-cultivation. In fact, the observed trend in some areas (like the Kosi command) has been of decrease in the security of tenure of small share-croppers [Appu 1973].

Marginal farmers and the landless often engage in river-bed cultivation in the dry season to supplement their incomes. After dam construction, sudden releases of water from the reservoir can cause damage to the crops of such river-bed cultivators. A smaller flow of water in the river also reduces the annual flooding of the river that washes away silt and brings in new, fertile soil.

A study of three large irrigation projects in Gujarat traces the adverse impact of the Mahi-Kadana and Ukai-Kakrapar projects on downstream river-bed cultivation. The damming of the Mahi and Sabarmati rivers have led to a drastic decline in cultivation of vegetables and fruits in the dry river bed [Jain 1990, p 52-53]. In case of the Sabarmati river, the construction of the Dharoi dam is said to have devastated the riverbed economy of downstream villages, and specially of the Raval community (an OBC group), that previously thrived on such cultivation [Jain, op cit, p 69-70].

Consequently, the net impact on the land-less, especially the agricultural labour, can be mixed. In some cases there is an increase in the demand for agricultural labour and this is a benefit. But, in other cases the demand goes down, resulting in adverse impacts.

(c) Women

Traditionally, the role of women in the irrigation system has been ignored and irrigation planning has been done mainly by men, for men. Dams and irrigation have been planned in India in a way such that issues of equity, even in the few cases where they are explicitly addressed, have meant primarily the spatial distribution of water across the system. The fact that in India women very rarely have ownership rights over land does not necessarily mean that they do not work as farmers or users of irrigation. The traditional approach to distribution of rights over irrigation water has, however, tended to vest these rights exclusively in men, in the (misplaced) belief that it is predominantly men who are the farmers, users of irrigation water and "heads" of households in the command areas of large dams, as elsewhere. There is thus a "false, but predominant, division between water for domestic use (drinking, bathing, cooking, washing) and water for productive use (irrigation, industrial), with the former being seen, almost exclusively, as women's responsibility and the latter as men's" (Ahmed op cit).

Moreover, according to Ahmed, there is an artificial division between irrigation, agriculture and rural development in most bureaucracies, which in any case are male dominated. Whereas the contribution of women to agriculture is better documented and understood, because of this artificial division their role in planning and managing an irrigation system (which is an essential input into the agricultural system) is ignored.

Further, little attention has been paid to various socio-economic differences among users and their gender differential needs. So, for example, "women may require water for subsistence crops – typically a few vegetables grown near the homestead – while men may be more concerned that all the water goes to the fields (cash crops)" (Ahmed 1999).

As pointed out by Zvarteveen [1997], even when women farmers are using irrigation water at the same footing as men (that is, for farms run by women, or for cases where women put in regular labour on their husbands' plots), there may be many differences in the preferences expressed by men and women in the delivery of irrigation services. Often women may require timely delivery of irrigation water not just at the time of sowing the crop (which is an activity typically undertaken by men as well as women) but also at the time of weeding (typically undertaken by women). This is because for crops like paddy, there is an inverse relation between the height of standing water in the field and the growth of weeds. Moreover, women may prefer a rotational system of water delivery, while men may express a preference for an on-demand system. This is because the rotational system requires dealing or bargaining with the water guards, which women may find difficult.

However, Zvarteveen goes on to argue that some of these gender differences in pattern of preferences may themselves have arisen due to the very fact that women do not have any direct and explicitly recognised rights to irrigation water. Zvarteveen makes a strong case for the grant of individual water rights to women, arguing that this would directly increase their physical well being and reduce their risk of poverty, by giving them direct access and control of a scarce resource. It would also indirectly benefit women by increasing their bargaining strength within the household, thus making a significant impact on removing gender inequity in the command area of an irrigation project.

It is thus clear that there are many aspects of irrigation, which have a bearing on women. Unfortunately, in none of the projects studied was there any mention of granting explicit and direct water rights to women, or of differential gender requirements, nor was there any effort to address these. In fact, irrigation management through decentralised institutions like water users associations provides a good entry point for introducing gender concerns into command area development schemes. However, in none of the dams studied has any evidence been found of these concerns of gender equity having been taken on board.

Consequently, the net impact of large dams on women in the command area can be seen as adverse.

(d) Head reach and tail end farmers

An inherent conflict may exist between the protective and productive roles of irrigation projects. The former would involve maximising the spread of the irrigation network to the tail reaches, but the latter would entail intensive supplies in the head-reaches to enable farmers to switch to high value crops [Wade 1976, p - 64]. In most projects for which data were available, there has been a marked tendency for intensive irrigation to take precedence over extensive irrigation, and this has had an adverse effect on equity between head and tail-reaches.

The particular groups that may be more vulnerable to being excluded from sharing of benefits of irrigation in the command area are small and marginal farmers, the landless, and farmers in the tail-reaches of the command area.

If the downstream water availability is lower than expected, then inequity between head-reach and tail-end users can emerge [Mitra 1986, p-497].

Many studies have shown that with the availability of irrigation, farmers in the head-reach tend to switch to the production of highly water-intensive crops, especially in the initial stages of canal construction (when supply of water further downstream is minimal). However, even with the spread of the irrigation network, the powerful head-reach farmers' lobby tries to exert strong political pressures to ensure that their water supply is not reduced subsequently [Wade, op cit].

Data from the Chambal Command Area show that the yield rate of high-yielding paddy and potato is higher in the middle-reaches than in the head or tail-reaches. Panda has explained this phenomenon in terms of the excess availability of water in the head-reach, and shortages of water in the tail-reaches. An immediate solution to the problem lies in rationalising the water-flows to reduce the supply to the head-reach and enhance the supply to the tail-reaches [Panda 1986, p -530, 532-33]. However, given the strong political pressures attached to irrigation programmes, this may be easier said than done [Mitra 1986, p -754, 756]. Similar evidence has been furnished by Mitra, linking cultivation of high value, wet, irrigated crops like sugarcane and paddy with water availability in the higher-reaches, and of low value, dry crops like jowar with the lower-reaches [Mitra 1986, p 496-97]. A study of irrigation projects in Gujarat shows that there has been a dramatic increase in the percentage share of perennial crops like sugarcane in the cropping pattern. Even the report of the CAG has noted that "...the increased cultivation of perennials mainly in Kakrapar command resulted in increased use of water exceeding the maximum permissible limit of perennial crops to be grown in the command (usually 35 per cent), leading to higher water table, salinity problems etc." [Jain, op cit, p -21].

Studies of Command Area Development (CAD) Programmes of Giri [CESPL 1996], Jamuna Assam [WAPCOS 1996c], Mayurakshi [WAPCOS 1996a] and other projects show that the percentage of irrigated area to total holdings declines as we move from head to tail-reaches. A further inequity in the Giri project [WAPCOS 1996c] arises because within the tail-reaches, the large land owners manage to get some irrigation, but water availability for the marginal farmers is actually *zero*. Studies also show that the *timeliness* of water supply tends to go down as one moves from the head to the tail-reaches [WAPCOS 1996a]. This too would impact on the profitability of cultivation between these two categories, as high value (HYV) crops require assured water supply at fixed times. Thus the ability of tail-reach farmers to grow such crops and get maximum output is lower than that of the head-reach farmers.

Another factor that worsens equity between head and tail-reaches is the countrywide tendency of spreading of available financial resources among a large number of projects. As a result, for a number of projects, a severe resource crunch affects the extension of irrigation facilities to far-flung areas of the command, and expenditure on Operation and Maintenance (O&M) activities. For example, in the Malaprabha Project, according to the official consultants "Although only 70% of irrigation potential has been created so far, tail end reaches in various parts of command area are not receiving their share of water" [CCPA 1995].

Data compiled from the report of the Comptroller and Auditor General (CAG) for some major irrigation projects in Gujarat show that out of the overall targets set for 1983-84, only 33 percent of field channel construction, 73 per cent of land leveling/land shaping, and 14 per cent of canal lining activities were actually completed. The direct impact of these lapses is on the tail reach farmers, because in the absence of these crucial activities, the capacity of the canals to service tail-reaches becomes severely restricted [Jain, op cit].

Consequently, the net benefits to both the head-reach farmer and the tail-end farmer are also positive, provided again that their land does not get water logged or become saline. However, here again, as we shall discuss later, the head-reach farmer gets more benefits than the tail-end farmer does.

Impact on Equity: The impact of the dam in terms of equity between large and small farmers is invariably negative. So is the impact on equity between farmers in head-reach region and in the tail end of the command.

The impact on the equity between land-less agricultural labour and the landed farmers is mixed. In some cases, where employment opportunities increase because of irrigation, there might not be any impact. However, in other cases where employment opportunities remain constant before and after the dam, or go down after the dam, there is a negative impact.

The impact on equity between men and women is also usually adverse.

3.4.2 *Discussion*

Again, the findings given above make it amply clear that the impact of large dams, on equity, is mostly negative. However, to understand why this is so, we need to look at the processes by which large dams are assessed.

Interestingly, in India there is no process by which the equity impacts of dams are assessed. The Constitution of India declares India to be a Sovereign Socialist ....Democratic Republic and goes on to state the fundamental right to equality and the directive principle that the State shall strive to promote welfare of people by securing and protecting ...a social order in which justice — social, economic and political, shall inform all institutions of public life. Despite this, the major institution of public life, the government, has no procedure or requirement by which projects are subjected to an assessment of their impact on equity or, as it has been described earlier, a class-benefit analysis.

This absence by itself highlights the low priority that equity issues are given by the government, as far as dams go. It also means that hardly any data are available regarding the impact of dams on equity.

While conducting an economic assessment of dams, there is neither a requirement nor a practice to give weights in order of equity. None of the dams studied had any such assessment, where costs to be borne by the poor were given a higher weight than those borne by the rich, and the benefits going to the rich were given lower weight than those going to the poor. The cost benefit analysis of all the dams studied equated the costs, whoever paid them, and the benefits, whoever received them.

Also, very few independent studies are available which actually examine the equity aspect of the costs and benefits of dams, either in an economic sense or in the larger social sense.

The aspect of inter generation equity, i.e., the distribution of costs and benefits between generations has only in the last twenty years or so become a part of development thinking. Sustainable development, as it is called, implies that we do not deplete or degrade natural resources in a manner that they become unavailable or relatively scarce to future generations. Sustainable development, as an objective, is now a part of Indian policy and law.

The sustainability of dams, in this sense, has not been looked at for any of the projects being surveyed. However, the fact that many of them have adverse environmental impacts, as described in the section on environment, means that as they are currently designed and constructed they adversely affect the equity status between the beneficiary generation and future generations. As the type and quantum of environmental impacts that dams have has already been described earlier, it will not be repeated here.

The impact on equity between species is an issue that does not attract much concern in today's world. However, if one accepts, as one must, that this world does not belong to human beings alone, then all human actions must also be assessed in terms of their impact on inter species equity. The fact that dams flood huge tracts of wilderness areas and, by obstructing the flow of the river, degrade and destroy the habitats of many aquatic species, must be taken into consideration while assessing their impacts on inter generation equity.

Perhaps the destruction of some habitats is inevitable. However, efforts can be made to minimise the trauma and suffering of the animals that lived in these habitats. Unfortunately, apart from fish ladders for commercially important fish species, there has been no effort in any of the dams studied to minimise the adverse impacts on animals. Numerous living creatures continue to face the prospect of suddenly being drowned by the rising waters of the reservoirs or being cut off from their habitats and feeding grounds.

In this sense, dams contribute negatively to inter species equity. However, as this is an issue that is rarely taken seriously, no more than this mention is being made in this report.

4.0 CONCLUSIONS

4.1 Environment

The Indian experience with large dams, in terms of environmental impacts, can be summarised as follows.

Table 4A

Impacts	*Positive + Negative -*	*Level*	*Prior Assessment*	*Prevention or Mitigation*	*Remarks*
Premature cutting of trees to be submerged	–	M	N	N	
Degradation of catchment	–	H	N	P	Though CAT has been undertaken in many of the more recent projects, it has not been properly done. In many of the recent projects, fuelwood depots have been proposed.
Mining/quarrying in the catchment	–	M	N	N	There is no stipulation about the prevention of this, except in a few recent projects.
Reservoir siltation	–	H	P	P	The fact that in a large number of reservoirs the assumed rate is much lower than the actual rate of siltation suggests that this aspect was only partly studied , costed and planned for.
Water availabilty	–	H	P	P	The continuing degradation of catchments has meant that water flows into the dam have become erratic in many projects. Post construction data also confirm this.
Catchment Area Treatment .	+	M	P	NA	CAT has become a part of recent projects and its cost is included in project costs. However, the extent of treatment is inadequate.
Backwater build up	–	L	N	N	Not studied in most projects
Dust pollution at dam	–	M	N	N	In none of the projects surveyed has any action been taken to prevent or mitigate this.
On aquatic ecosystems at reservoir	–	H	N	N	Not studied prior to clearance in any of the dams. No action possible subsequently.
On wetland ecosystems	+	M	Y	NA	The creation of a reservoir provides a habitat for some wetland species, especially water birds.

Table 4 A (Contd...)

Table 4 A (Contd...)

Impacts	*Positive + Negative -*	*Level*	*Prior Assessment*	*Prevention or Mitigation*	*Remarks*
Fish at reservoir	_	H	N	N	Fish species always adversely affected by the formation of the reservoir.
On other fauna and flora at reservoir	_	H	P	N	Only in recent projects has this been studied. However, costs have not been added to the project costs and no realistic mitigation planned or implemented.
On forests at reservoir	_	H	P	P	Since the statutory requirement for forest clearance, the impacts on forests are being assessed. However, the cost of loss is not computed and only compensatory forest in recent projects is being taken up,
On cultivated biodiversity in submergence zone	_	M	N	N	The environmental loss due to this is never assessed.
On grazing land and domesticated biodiversity in submergence zone	_	H	N	N	No effort to assess or mitigate
On local biomass availability	_	L	N	N	No effort to assess or mitigate
Rim stability	_	H	P	P	Only in recent projects has this been studied and some efforts at mitigation initiated.
Health in the submergence zone	+ & _	H	P	P	The adverse impacts are assessed in only a few projects. The mitigative measures proposed are weak.
Water quality in reservoir	_	H	N	N	Hardly any comprehensive studies, especially prior to appraisal.
Reservoir Induced Seismicity	_	M	N	P	No evidence of prior assessments or of strengthening structures
Micro climate at reservoir	_	L	N	N	
Water logging at canal/command	_	H	P	P	The fact that so much water logging has taken place is an indicator of poor assessment and preventive action.
Terrestrial biodiversity at canals	_	M	N	P	Only in some recent projects has there been an attempt to minimise this impact.

Table 4 A (Contd...)

Table 4 A (Contd...)

Impacts	*Positive + Negative -*	*Level*	*Prior Assessment*	*Prevention or Mitigation*	*Remarks*
On natural drainage by canal	–	M	N	N	
Health at canal site	–	M	N	P	Only some ineffective preventive and curative methods are proposed.
Dust pollution at power lines	–	L	N	N	
Terrestrial biodiversity at power lines	–	L	N	N	
Radiation at power lines	–	M	N	N	
Aquatic ecosystem downstream	–	H	N	N	Only concern seems to be for commercial fisheries
Fish downstream	–	H	P	P	Only mitigative measures are fish ladders or breeding programmes for a few species
Sudden water releases	–	H	N	P	Some efforts are being made to ensure that sudden releases are not inevitable
Of rehabilitation activities	–	M	N	P	In recent times there has been a ban on the diversion of forest land for rehabilitation.
Downstream water availability	–	H	N	N	There is usually an unfounded assumption that the water availability downstream would necessarily improve because of the dam.
Water pollution downstream	–	M	N	N	There is an unfounded assumption that this does not happen.
Salt water ingress	–	M	N	P	This is a serious problem in many river basins.
Coastal and marine ecology	–	M	N	N	No studies were seen.
Dam failure	–	H	P	P	There is a tendency to down play the risk.
Decommissioning of dams	–	H	N	N	This is a major future cost that is ignored

H = high; M = medium; L = low. Y = yes; P = partly; N = no; NA = not applicable

It is clear from the table above that for most of the dams there was no assessment carried out for most of the impacts. The reasons for this are many and have been discussed earlier.

To draw any final conclusion on the impact of dams on the environment becomes difficult because there are no standards prescribed, specifying what levels of environmental deterioration are acceptable. How much of the environment can be allowed to be destroyed, and for how much of irrigation or power? These questions have not yet been answered in India.

However, what does emerge clearly is that:

- Most of the possible environmental impacts of dams were not assessed adequately in the past and even today, though things have improved, much still needs to be done.
- Even in retrospect, there has been no effort to assess the actual impacts that dams have had on the environment, for most of the parameters.
- The adverse impacts of dams on the environment, judging from international experience and the few case studies available in India, are significant and mostly irreversible.
- The preventive and mitigative measures that could have been taken to safeguard the environment have mostly not been taken.
- Certainly the financial, economic and social costs and benefits of the environmental impacts of dams have not been computed while assessing the economic viability of most projects, including recent ones.

Lessons to be learnt

Perhaps the major lesson that should be learnt is that projects should not be initiated before a comprehensive environmental impact assessment has been carried out and the project has been determined to be environmentally, socially and economically viable. If projects are initiated without such an assessment, there should be a legal provision to prosecute the concerned individual who has allowed the construction to start. A similar provision exists in the Forest (Conservation) Act of 1980 where the concerned forest officer can be imprisoned if he allows the diversion of forestland without the clearance of the Government of India.

Another lesson that should be learnt is that there need to be clear and transparent standards prescribed for the assessment of projects. In the absence of such standards, even where environmental impact assessments are carried out the determination of the viability of the project becomes a matter of arbitrary opinion.

Whereas for air and water pollution, standards have been fixed and one can assess whether an activity or project is viable from the point of view of pollution, the same is not true for most other aspects of the environment.

It is not that standards cannot be fixed. For example, one can list the ecosystem types and the species that are threatened in regions, nationally and globally, and prohibit any activity that further degrades them. One can also develop a land use plan where, region by region, areas are demarcated for various uses and dams can only be made if they keep within the limits set by the regional land use plan. This would also reward those regions that have maintained their ecosystems well.

There is also an effort to do natural resource accounting and put monetary values on at least some of the elements of the environment. Once this is done, then the economic viability of the dam must be established taking into consideration the monetary costs of the environment it destroys. One such attempt was made in the mid 1980s by the Ministry of Environment and Forests, Government of India, with regards to the Narmada (Indira) Sagar Project in Madhya Pradesh. Using FAO norms, the Forest Research Institute and Colleges (FRI as it was then known) estimated that the cost of the forests to be submerged by the Narmada Sagar Project were Rs 30, 923 crores for a 50 year period. Considering the total cost of the project at that time, excluding these forest costs, was Rs. 6000 crores, if one added the forest costs, the project clearly became uneconomical. For obvious reasons, this estimate was not acceptable to the Government of India and the whole approach was shelved. [DoEF 1987]

There are many pitfalls in accepting the assumption that all of nature and natural resources can be correctly valued in monetary terms. It is not an approach, notwithstanding the Narmada Sagar case, that will safeguard the environment.

What perhaps is required is a two pronged approach. First, basic standards of sustainability must be formulated. They follow from the avowed policy of the government of India to pursue a sustainable path of development.

These can involve the setting of physical limits to the utilisation or diversion of natural resources. For example, the carrying capacity of each river system can be determined and it can be worked out what is the minimum flow required at all seasons for the ecosystem to remain healthy. Dams can be designed to use only the surpluses available over this minimum ecological flow has been ensured.

Similarly, the minimum viable populations for species and the minimum unit area for each ecosystem type can be determined. Species and ecosystems can be prioritised and given weightage. No project can be allowed to reduce any species or ecosystem below its minimum viable population or area, locally, regionally and nationally.

A trade off mechanism can be designed. Subject to the parameters already described, the inevitable environmental degradation caused by a project must be compensated elsewhere by regeneration of degraded ecosystems or heightened protection.

Secondly, all possible environmental impacts, beneficial and adverse, need to be fully assessed prior to the clearance of the project. All those adverse impacts that can be mitigated or reduced, must be so planned for, and the cost of mitigation and reduction taken into account while appraising the project. In addition, the costs of regenerating and protecting the areas agreed on as a part of the trade off, must also be included in the cost of the project.

The monitoring of environmental parameters must be rigorously undertaken during and after construction. Any unanticipated costs or additional costs due to the ineffectiveness of the mitigative or preventive measures must also be borne by the project and channelled to environment regeneration and protection. Similarly, all unanticipated benefits must be credited to the project account. All these conditions must operate without compromising the basic principles of sustainability, as described earlier.

What remains to be assessed is which of the dams made or under construction would still be economically viable if the costs of preventing and mitigating environmental damage and the cost of the remaining environmental damage were taken into consideration.

It also remains to be assessed whether large dams would still be a viable technological option if all the inevitable environmental costs, which cannot be prevented or made up for, are taken into account.

4.2 Displacement

Based on the findings described earlier, it could be concluded that in order to minimise adverse social impacts due to displacement, some principles need to be followed. These include the following.

(i) Project need and optimality must first be assessed and established according to the process described in the concluding section. Where, through such a process, the need for a large dam is established and it is the best of all possible options, then its social viability must be assessed. Some of the principles involved in assessing its social viability are listed below.

(ii) The "project affected persons" (PAPs) must not, with the project, be worse off, in any tangible terms, than they were prior to it. In fact, they must invariably be better off, so that they are at least partly compensated for all the intangible and non-quantifiable losses.

(iii) Whatever their status prior to the project, they must, in economic terms, be above the poverty line with the project.

(iv) While determining compensation, replacement value at the operative market rates must invariably be the basic principle. This must be at the market rates that actually operate, and at the time of purchase, and not just those that are officially recorded. Also, paying of depreciated value is manifestly unfair for it often leaves the PAP without adequate means to replace a critical need. For example, if a poor person was paid only the depreciated value of his or her house, he or she would be unable to buy or build a new house and would become homeless. The person's house, however old or ramshackle it might be, is providing shelter. When it is forcefully acquired, it must be ensured that the compensation is enough to provide an alternate and equal shelter.

(v) Also, not only should lost property and assets be compensated for, but lost livelihoods and lost opportunities should also be compensated for. Communities must be adequately and appropriately compensated for common amenities and assets lost because of the project. Also, all those amenities and

assets required for fulfilling basic needs must be provided. This is especially important in order to prevent conflicts with host communities, whose common resources would otherwise be under pressure from the PAPs.

(vi) However, it is not enough to just pay cash compensation, various other principles must be followed to ensure that social costs are minimised. For one, payment of large sums of cash might not be in the best interests of those PAPs who are unused to handling large amounts of money.

(vii) The principle of 'land for land' must be followed scrupulously and each PAP who loses land must be given land of equal size and of at least equal productivity. The principle of giving land to PAPs in the command area of the dam is a sound one as it not only gives those who have paid the major costs a part of the benefits, it also lessens the inequities between the upstream displaced persons and the downstream beneficiaries.

(viii) Usually the project authorities must also construct or have constructed appropriate replacement housing for the PAPs. However, in cases where the PAPs would prefer to construct their own houses, like among some tribal communities, they must be given the freedom to do so. Within the allocated resources, the design and location of the houses to be constructed by the project authorities must be decided in consultation with the PAPs.

(ix) The process of selecting rehabilitation sites and lands must involve the PAPs and their preferences must seriously guide the final selection.

(x) Agricultural land must be consolidated, as far as possible, and communities kept together, after displacement, so that their social and cultural identities are safeguarded.

(xi) As far as possible, displacement should not be forced and people should be made to feel that, despite inevitable losses, they are on the whole going to be better off and therefore should not resist displacement. There is also a growing demand that prior informed consent of the community is taken before any project, including a dam project, is approved.

(xii) Wherever the people are not willing to shift, the fault is either in the package being offered or in the approach to the displaced communities. Alternatively, it could be because the implementation of resettlement and rehabilitation programmes is so unsatisfactory that the affected people do not feel confident of receiving what they have been promised. In any case, this must be recognised as a failure of the rehabilitation process.

(xiii) The time frame for the displacement process should be sensitively determined and people given enough time to adjust to their new locations and life styles. It is a good practice to allot land to the PAPs at least two years before they are to be displaced so that they can get used to cultivating this land even while they continue to live in their original homes. This makes the process of

displacement more gradual and humane. In any case, all compensation must be paid before a person is displaced. Delays in the rehabilitation process and its various components can cause major hardship. Time frames must, therefore, be finalised well in advance and adhered to. Delays must be looked at very seriously and invite serious consequences for the functionaries responsible.

(xiv) Even delays in finalising the policy related to rehabilitation and other aspects of dams, and delays in initiating the planning process can seriously affect the wellbeing of the affected people. These must also be done according to a pre-determined time frame that statutorily gives adequate time for the concerned persons to give inputs and intervene in the process of policy formulation and planning.

(xv) Whereas it must be ensured that PAPs are not forced to change their occupations and professions, there must, of course, be the flexibility to allow individual PAPs to choose from among other viable alternatives. Some might not like to go back to the land and might prefer to pursue other professions. They must be helped to do so.

(xvi) The PAPs must also have a first right to get employment in the project. The need for trained and experienced personnel should not be a constraint as training should be organised for interested PAPs even before the dam construction is initiated and the trained PAPs sent to other projects to get the experience they need. In fact, the availability of sufficient trained PAPs should be a precondition to the construction of the dam. Where necessary, even basic literacy lessons must be organised for the PAPs and they should be properly equipped to make the most of the opportunities being presented to them.

(xvii) The PAPs must also have the first right to irrigation waters from irrigation projects and to power from hydro-electric projects, and to both in multi-purpose projects.

(xviii) The definition of PAPs who are entitled to receive compensation must include the landless, those who are tenants, agriculturists, adult unmarried daughters and sons, adult married sons, and widows, divorcees and women abandoned by their families. All those affected by any of the works or activities related to the dam must be treated as PAPs.

(xix) Rehabilitation packages and processes must be gender sensitive. Land and other assets should be provided in the joint names of both spouses. Consultations with the PAPs must also be done keeping in mind the need to consult both men and women, the aged and the young, and members of all castes and communities.

(xx) The special needs of particularly vulnerable communities, like isolated tribal groups or other marginalised groups, must be catered for.

(xxi) The plight of those who have been affected by earlier dam projects must be recognised and they must be properly rehabilitated and compensated on a priority basis before any further dislocation and displacement is effected.

(xxii) The provisions of an enlightened rehabilitation and compensation policy, as and when formulated, must have legal backing so that not only the concerned agencies of the government but affected and interested citizens can ensure enforcement and legal intervention. A recent Supreme Court ruling on another matter, that the agency that seeks to intervene has the onus to prove that its intervention is beneficial, needs to be applied to the case of large dams.

4.3 Other Social Impacts

Large dams have many social benefits, including direct and indirect economic benefits. However, they also have many social costs. The fact that most of the costs have to be paid by those who do not get to directly share the benefits raises some difficult questions.

Where, after the payment of compensation and the rehabilitation of project affected persons, they still remain worse off than what they were prior to the project, there is the question of justice. Is it just to penalise a group of innocent people just because it is considered to be in the larger public interest to do so? Most enlightened societies reject such a trade-off, even where the number of people benefiting might be larger than the number being penalised.

Perhaps the only exception that enlightened societies make is in the interest of equity. In most enlightened societies, you can deprive one group in order to benefit another, if this deprivation leads to a more equitable distribution of wealth or resources. Starting from variable tax rates, where the relatively rich pay a higher rate than the relatively poor, this principle has also been used to redistribute rural or urban land more equitably. However, evidence suggests that large dams promote inequity rather than diminish it. Therefore, there seems no justification for the imposition of costs on millions of innocent tribals and other rural people, who lose even the little they have in order to benefit those who already have more than them.

But, then, what is the alternative? As is often remarked, "you have to break eggs to make an omelette". But what is often forgotten is that it is not the making of the omelette that is by itself important. What is important is, whose eggs do you break to make an omelette and for whom. Therefore, development cannot merely be a blind and reckless passage towards economic growth and productivity. It must measure the price of such growth and productivity, both in absolute and relative terms. Large dams must not only be assessed comprehensively for their social costs but must only be implemented if they also serve the cause of equitable distribution of resources, wealth and opportunities. And such an assessment must be done in the context of simultaneously assessing all the other alternatives that are available to us for enhancing availability of water and energy, for enhancing the availability of food and incomes, and for enhancing empowerment and justice.

4.4 Equity

From the findings and discussion it is clear that for most categories of people, dams tend to promote inequity rather than equity. Part of the problem lies in the fact that while determining the costs and benefits of dams, the equity factor is almost never taken into consideration. If, as has been suggested earlier, appropriate weightage was given for the impacts on equity, while conducting the cost benefit analysis for dams, most of the existing or ongoing dams would be found wanting.

However, irrigation systems can be designed in a manner such that they promote equity. In projects undertaken by NGOs in Bihar, engineers sensitive to equity concerns designed distribution networks starting from the tail end, i.e., from the fields of small farmers onwards up to the head-works [Jain, pers. Comm.]. Similarly, in the minor irrigation projects taken up by the Association of Voluntary Agencies for Rural Development (AVARD), the small farmers were at the centre of the plan for the distribution network. Contour mapping was done for levelling land, where necessary, to ensure that small farmers actually received their share of the benefits of irrigation.

Similarly, the planning of irrigation systems can involve women to ensure that their design and operation is not gender insensitive.

The use and distribution of electricity can also be rationalised to be far more sensitive to equity concerns. For one, subsidy to the domestic and agricultural sector can be curtailed as it clearly serves the relatively well-to-do. The savings from such a cut in subsidy can be used to expand the network of electricity users to those segments of the society that could not earlier afford it. Considering the major costs are the initial investments, the government would much better spend its money providing house-hold connections to the weakest segments of the society and community pumps for use by the small farmer, rather than supporting those who can afford to pay for themselves.

Instead of building dams to meet peaking demands, mainly from the urban domestic sector and industry, variable, time dependent, tariffs would go a long way in flattening the peak demand curve. Also, tariffs linked to the slab of consumption, rising steeply as consumption levels rise, would encourage conservation and prevent waste.

Focus on demand side management, especially by prescribing energy use standards for industry, would also cut down on the profitability of using obsolete, energy inefficient, machinery and processes in order to produce goods and services.

However, the inequities between those who are displaced or otherwise adversely affected by dams, upstream, and those who benefit downstream and at the end of the electric line, are difficult to remove. Therefore, it becomes doubly important to ensure that displacement and other adverse social impacts are kept to a minimum, are properly costed and are only allowed in the rarest of rare cases.

There is a view that it is not fair to blame large dams for distributing costs and benefits inequitably, for inequity is inherent to the Indian society. Even though that might be so, the evidence presented above seems to suggest that large dams are not just passively affected by the inequities prevalent in the society but actively contribute to their maintenance and exacerbation. In so far as they do that, they must be seen as one of the causes rather than the victims of inequity.

In conclusion, the impacts of large dams on equity can be tabulated as follows.

IMPACT ON EQUITY BETWEEN	*Beneficiary generation*	*Future generations*	*Human beings*	*Other species*	*Up-stream losers*	*Down-stream gainers*
Beneficiary generation	Negative The rich gain more than the poor	Negative Future generations lose				
Future generations	Negative	Negative The poor lose more than the rich				
Human beings			Negative Some gain more than others	Negative Other species lose		
Other species			Negative	Negative Some are affected more than others		
Upstream losers					Negative The poor lose more than the rich	Negative upstream loses/ downstream gains
Downstream gainers					Negative	Negative The poor gain less than the rich

4.5 Overall Conclusions

The planning of a dam cannot and should not be done in isolation. It has to be a part of the larger economic, social and environmental plan for the region and the country. The process for deciding whether a dam should be built in a particular location and with particular specifications, should be a part of the process for deciding how to provide goods and services to the people of a region and to help solve some of their main problems.

Much before the dam is even thought of, there must be a study of the social, economic and environmental situation of a country, and within a country of each state and region and an identification of the major assets, potentialities and challenges. A development plan must, therefore, be built taking into consideration the existing assets, for using the existing potential to meet the existing challenges.

At the national level, some of the relevant challenges might include the challenge of providing drinking water to all the citizens, of increasing incomes and agricultural production and productivity, of preventing floods and the devastation they cause, and of providing power to homes and industries. They might also include the challenge of protecting the people, especially the poor, from social and economic insecurities, from injustice and from environmental degradation. For specific regions and areas, some challenges might be more important than others. For example, in a semi-arid and industrially underdeveloped region, there might be a great need to improve agricultural productivity. In a fast growing industrial belt there might be a great demand for power.

However, the first step must be to determine what the needs are of the area being planned for. In this case, some of the relevant needs could be to:

- enhance income levels
- enhance water availability
- enhance the availability of energy
- protect from floods

Next, for each of these needs, a detailed assessment of the various options must be made. For example, should enhancement of income levels be attempted through the agricultural sector or through other means. If through the agricultural sector, should it be through irrigated agriculture or through rain-fed or dry land farming, or by effecting land reforms. If it is to be through the provision of irrigation, should this be through ground or surface, and if surface, through storage projects or through some other methods. If it is to be through storage projects, should they be ponds, or barrages, or small dams or large dams, or a combination of some or all. At each step, the costs and benefits (social, environmental, financial and economic) of each of the alternatives must be assessed, along with their technological feasibility.

A similar process should be followed to determine the best method of meeting any of the other needs.

Once the best method has been determined, then this must be integrated into the larger plan. So, for example, if in an area the best method for enhancing incomes has been considered to be through non-farm sectors, then the backward and forward linkages of such a strategy must be interfaced with the larger area (regional, state or national) plan. The optimality of the chosen strategy, must again be reviewed in light of such an interface.

Once the optimal strategy has been determined, then it must be assessed for its viability. Even if it is the least costly and most beneficial of possible strategies, is it still viable? In other words, does it impose costs that are unacceptable, especially in social and environmental terms? This is particularly important because most social and environmental costs cannot be quantified in monetary terms and therefore cannot be captured by the traditional methods of cost benefit analysis. Besides, some social and environmental costs are such that they are not subject to a trade-off and must be considered by themselves. There are levels of social trauma and suffering that cannot be justified, whatever the economic returns. Therefore, if the project is only possible, or viable, if it inflicts such costs, then the project is clearly not viable. The same is true for some environmental costs.

The final development strategy that might thus emerge would certainly be a mix of many things. Perhaps there would be a much greater stress on 'demand side management', on the more efficient use of what we already have, on the cutting down of waste and opulence, and on alternative methods of irrigation and energy production. Of course, in such a scenario there might also be a place for large dams. But this would be a place that is deserved on the basis of a comprehensive assessment that establishes not only the social, environmental and economic viability of the large dam but also its optimality, in the face of all other alternatives.

ANNEXURE - 1.I

Terms of Reference for the Case Study

The consultant will prepare a national paper for India on certain aspects of dams. Key components to be addressed are given below.

Social and Environmental Issues in Large Dam Projects

The analysis of the key components listed above will follow planning and project cycle approach. A tentative Terms of Reference (TOR) enumerating the issues to be considered is given below for reference and further clarification of key issues to be addressed.

SOCIAL ASPECTS

Beneficiaries and Affected People

Social impacts include all social, cultural and economic consequences to people by dams that alter the ways in which people live, work, relate to one another, organise to meet their needs, and generally cope as members of society. Creation of large dams have had positive and negative implications to various categories of people.

Analysis of social impact includes: positive impacts (such as increases in irrigated land, food production, employment opportunities, wage level, improvements in nutritional and health status of the population; local and regional economic development, etc.) and negative impacts (such as position of small and marginal farmers, land concentration, loss of access to common goods, traditional knowledge, social cohesion, cultural impacts, health impacts, etc.) downstream, upstream and in command areas will be attempted. This analysis will also include impacts at regional and national level (food production, food security, population's nutritional status change, poverty alleviation, etc.). A better framework for understanding of distribution of costs and benefits across social and economic groups and areas/regions is one of the main objectives of this review.

One of the key impacts of dams is displacement of people from lands, livelihood and other resources. Among the affected, the consequence depends upon the nature of impact: full submergence of land and homestead leading to total displacement; partial submergence; loss of livelihood by those who had been providing supplies and services to people living in the submergence area; people affected to different degrees by the construction of the canal system; people living downstream of the dam and affected by the altered flows; and so on. The following aspects will require consideration: determination of all the categories of people affected by the project, and remedial or compensatory or rehabilitation measures put in place for each category of affected people; nature of the policies and packages; nature of the machinery for implementation, and its actual effectiveness in functioning.

Given the fact that awareness about mitigation measures to deal with social and environmental impacts have changed over time, this analysis will also examine how the nature and extent of social impacts and mitigation measures to deal with them have changed. Some of the key issues to be reviewed are outlined below.

(1) Analysis of the nature of positive and negative impacts of large dams (including hydropower dams) on households and communities located at downstream, upstream and command area.

- how social impacts have been identified and managed: assessment of impact, compensation/mitigation measures and their implementation; adequacy of the instrument in capturing *(i)* impacts at individual, household and community level; regional and national level; *(ii)* developing, implementing and monitoring measures to deal with negative impacts;
- strengths and weaknesses of current policy, legal and institutional frameworks and in securing the rights of affected people: land and water rights, land tenure, minority rights, common goods, etc.
- how downstream impacts are taken into consideration in the planning, construction and operation of large dams.

(2) There is the question of equity as between those who bear the 'costs' of the project (i.e., those who are affected in one way or another by the project) and those who enjoy the benefits arising from the project (irrigation, power, etc). We need to ask to what extent the project has tried to mitigate the inequity. From a broad review of large dam projects in India, specify:

- Gains (gainers) and losses (losers) in the context of large dam projects.
  How far have those who pay the costs received a share in the benefits of large dams?
  Who were the beneficiaries of the project at local, regional and national level?
  Who were negatively affected people at the local, regional and national level?
  How did land ownership patterns change in command area?
  How have the patterns of landlessness change in large dam project impact areas?
- Underlying causes for the situation that some groups are less prepared/unfavourably positioned to benefit from large dams. Identify good practices and mechanisms that facilitated a more balanced distribution of costs and benefits of dam projects.

- Review the way large dam projects have affected gender imbalances, and gender roles and relationships; analyze changes in nature of access and control women have on resources in the context of large dams projects

(3) Management of resources and conflicts:

How was access to new resources controlled and managed?
Relationship between host communities and resettled populations
Ways of dealing with human rights issues in project implementation, land and water expropriation
How did different stakeholders perceive project after implemented?

(4) How large dams have contributed to food security and poverty alleviation at the local, regional and national level (analysis may be restricted to local and if possibly, to regional level depending on availability of research work); How did the level of poverty change at the local and regional level as a consequence of large dam projects? What were health impacts caused by project?

(5) Cost of dealing with social impacts: In the projects reviewed for cross-check survey, and on the basis of information available from other sources, examine:

what were the projected and actual cost of land acquisition?
what were the projected and actual costs of resettlement?
what costs were incurred due to loss or removal of cultural heritage/patrimony?
what were the predicted and actual costs of health impacts?

(6) Lessons from India through articulation of good practices related to:

Legal, policy, regulatory and institutional framework that facilitated comprehensive assessment of social impacts, and planning, implementation and monitoring of mitigation measures; good practices related to access to benefits to affected people;
how current approaches are being modified to respond to the interests of women, minority groups, young and old people, etc.

ENVIRONMENTAL ASPECTS

Large dams in India, as in other countries of the world, have been accompanied by significant alterations in the upstream and downstream physical and biological environment.

These are of diverse kinds: submergence of land; loss of forests; impact on flora and fauna, and loss of bio-diversity; impact on fish populations; changes in downstream river regime because of reduced flows (impacts on aquatic life, water quality, groundwater recharge, estuarine conditions, etc); emergence of water-logging and salinity conditions in the command area after some time; etc. There could be benefits to environment like increased area under vegetation, forest around rim of the reservoir etc. Some of the positive environmental impacts include alleviation of water scarcity, improvements in health standards of peoples due to availability of potable water and improved food availability, greening of barren lands, increased fish availability due to reservoir fishery, creation of habitats for waterbodies. Many of India's bird sanctuaries are located on and around reservoirs.

This section is to analyse India's approach to assessing and dealing with environmental impacts of large dam projects. Analysis would cover the following aspects:

- How environmental laws, policies, practices and institutions have evolved in India to guide planning for water and energy resources development and management, assessment of environmental impacts (at the dam and basin level), choice of projects and mitigation measures have evolved;
- What has been India's experience in implementation and outcome of mitigation measures implemented?
- What are the key lessons learned to guide future in relation to laws, policies, practices, institutions and regulatory mechanisms?

Some of the key issues to be analysed are:

- environmental impacts of dams and effectiveness of environmental mitigation measures
- impact on ecosystem dynamics and species abundance
- bio-diversity within river basin, downstream water quality and water supply issues;
- sedimentation, salinity and water-logging associated with dam projects and how these issues are addressed at different points in project cycle.
- draining and desalinization of irrigation service area.
- fisheries issues and how reservoir fisheries and fish ladders compensated for lost downstream fisheries.
- changes in hydrology of rivers over a period of time and its impact on dams. How changes in-stream flows altered predicted projected benefits.

How the planning process in recent years dealt with cost of environmental impacts; clearance process, monitoring of implementation, etc.

ANNEXURE - 1.II

Possible Environmental Impacts

	1. Upstream	2. At dam/reservoir	3. Command/ Rehabsites and Canal	4. Power lines	5. Downstream
A. Prior to construction		i. Premature cutting of trees	i. Premature cutting of trees	i. Premature cutting and lopping of trees	
B. During construction	i. Impacts on the catchment ii. Impacts on water availability iii. Impacts of mining/ quarrying for construction materials	i. Dust Pollution ii. Impacts on the aquatic ecosystem and biodiversity iii. Impacts on fisheries iv. Impacts on terrestrial biodiversity v. Impacts of mining/quarrying for construction materials	i. Dust Pollution ii. Impacts on terrestrial biodiversity iii. Impacts on natural drainage iv. Impacts of mining/ quarrying for construction materials iv. Impacts of activities related to the rehabilitation of project affected persons	i. Dust Pollution ii. Impacts on terrestrial biodiversity	i. Impacts on aquatic ecosystem and biodiversity downstream ii. Impacts on fisheries downstream iii. Impacts of sudden releases of water from dam
C. After construction	i. Impacts on catchment ii. changed water availability iii. Impacts of backwater build-up	i. Impacts on rim stability ii. Impact of the breeding of vectors iii. Impacts on the aquatic ecosystem and biodiversity iv. Impacts on fisheries v. Impacts on the water quality, including mineral contamination of water vi. Impacts on flora and fauna vii. Impacts on agricultural land viii. Impact on grazing land ix. Impacts on sources of local fuel wood and other non timber forest produce x. Reservoir induced seismicity xi. Impacts on micro climate xii. Impacts on weeds	i. Impacts on water logging and salinity ii. Impact of the breeding of vectors iii. Impacts on natural drainage iv. Impact on micro climate v. Impacts of chemical pesticides and fertilisers vi. Impacts on weeds vii. Impacts of activities related to the rehabilitation of project affected persons	i. Impacts of radiation ii. Impact of tree lopping	i. Impacts on aquatic ecosystem and biodiversity downstream ii. Impacts on fisheries downstream iii. Impacts on water availability downstream iv. Impacts on water pollution levels downstream v. Impacts of possible salt water ingress vi. Impacts on coastal and marine ecology vii. Impacts of sudden releases of water viii. Impacts of dam failure ix. Impacts of decommissioning

ANNEXURE - 1.III

Possible Social Impacts

	1. Upstream	*2. At dam/reservoir*	*3. Canal*	*4. Power lines*	*5. Downstream*
A. Prior to construction	i. Impacts on people upstream of changed water availability	i. Impacts of suspension of development/ maintenance activities ii. Impacts of change in property prices and of saleability of immovable property	i. Impacts of suspension of development/ maintenance activities		
B. During construction	i. Impacts on forest based resources due to state of the catchment ii. Impacts on water availability for the people upstream.	i. Impacts on health ii. Impacts on fish catch due to disturbance and impoundment iii. Impacts of human displacement, including: iv. Impacts on common property resources v. Impacts on cultural heritage sites and monuments vi. Impacts of loss of home and hearth vii. Impacts of loss of familiar social and geographical surrounds viii. Impacts of loss of preferred or familiar sources of livelihood ix. Trauma, uncertainties and insecurities x. Impacts on living standards xi. Impacts of social alienation from, and conflicts with, host communities xii. Impacts on infrastructure and access to common property resources	i. Impacts on health ii. Impacts on productivity due to Interference with natural drainage iii. Impacts of human Displacement, as listed in 2Biv to xiii	i. Impacts on health ii. Impacts of human displacement, as listed in 2Biv to xiii	i. Impacts on fisheries due to the Impacts on aquatic ecosystem and biodiversity downstream ii. Impacts due to changed water availability downstream iii. Health impacts due to changed river regime downstream iv. Impacts on agriculture and water availability due to possible salt water ingress v. Impacts on life and property due to sudden releases of water vi. Impacts on life and property due to dam failure

Annexure I.III (Contd...)

Annexure LIII (Contd...)

	1. Upstream	2. At dam/reservoir	3. Canal	4. Power lines	5. Downstream
C. After construction	i. impacts on forest based resources due to state of the catchment ii. Impacts of changed water availability for the people upstream. iii. Impacts on property and agricultural fields of backwater build-up iv. Social and economic impacts due to disruption of access to the opposite bank V. Impacts on river bed cultivation due to backwaters	i. Health impacts ii. Impacts on the local economy due to submergence of grazing land, sources of timber. Fuel wood and other non timber forest produce iv. Impacts on life and property due to reservoir induced seismicity v. Impacts of changes in the micro climate	i. Impacts on land and productivity due to water logging and salinity ii. Health impacts due to vector breeding iii. Impacts on land and productivity due to interference with natural drainage iv. Impacts on health and agricultural productivity due to micro climatic changes	i. Impacts on health and vegetation due to radiation and other hazards	i. Impacts on fisheries due to the changes in the aquatic ecosystem and biodiversity downstream ii. Impacts due to changed water availability downstream iii. Health impacts due to changes in water pollution levels downstream, especially due to changed river regime iv. Impacts on agriculture and water availability due to possible salt water ingress v. Impacts on life and property due to sudden releases of water vi. Impacts on life and property due to dam failure vii. Impacts on equity due to the distribution of costs and benefits.

ANNEXURE - 1.IV

List of all the Dams Looked at for the Study

Sno.	*Name of Dam/Project*	*State*	*Year of Completion*
1.	ALANDI	MAHARASHTRA	Ongoing
2.	ALIYAR	TAMILNADU	1962
3.*	ALMATTI	KARNATAKA	Ongoing
4.	AMARAVATHI	TAMIL NADU	1958
5.	AMARJA	KARNATAKA	Ongoing
6.	ANER	MAHARASHTRA	1978
7.	AVALANCHE	TAMIL NADU	1961
8.	BADUA	BIHAR	1965
9.	BAGH		Ongoing
10.	BAIRA	HIMACHAL PRADESH	1981
11.	BALIMELA	ORISSA	1977
12.	BAREWADI	MAHARASHTRA	1982
13.*	BARGI	MADHYA PRADESH	Ongoing
14.	BARIARPUR	MADHYA PRADESH	Ongoing
15.*	BARNA	MADHYA PRADESH	1976
16.	BEAS (PANDOH)	HIMACHAL PRADESH	1977
17.*	BEAS (PONG)	HIMACHAL PRADESH	1974
18.	BENNITHORA	KARNATAKA	Ongoing
19.*	BHADAR	GUJARAT	1984
20.	BHADRA	KARNATAKA	1963
21.*	BHAKARA	HIMACHAL PRADESH	1963
22.	BHATGHAR	MAHARASHTRA	1927
23.	BHATSA	MAHARASHTRA	Ongoing
24.*	BISALPUR	RAJASTHAN	Ongoing
25.	BOMMANAHALLI	KARNATAKA	Ongoing
26.	BURAI	MAHARASHTRA	1984
27.	CHAKRA	KARNATAKA	Ongoing
28.	CHAMARAJA SAGAR	KARNATAKA	1934
29.*	CHAMERA	HIMACHAL PRADESH	Ongoing
30.*	CHAMPAMATI	ASSAM	1997
31.	CHANDAN	BIHAR	1972
32.*	CHANDIL	BIHAR	1995
33.*	DAMANGANGA	GUJARAT	1989
34.	DANTIWADA	GUJARAT	1965
35.	DHAMNI	MAHARASHTRA	Ongoing
36.	DHANEGAON	MAHARASHTRA	Ongoing

Annexure 1.IV (Contd...)

* These dams/projects (67) were the ones that were studied in detail and the data pertaining to them included in the main database.

Annexure 1.IV (Contd...)

Sno.	Name of Dam/Project	State	Year of Completion
37.*	DHAROI	GUJARAT	1978
38.	DHOM	MAHARASHTRA	1978
39.	DIMBHE	MAHARASHTRA	Ongoing
40.	DONKARAYI	ANDHRA PRADESH	Ongoing
41.	DUDH GANGA	MAHARASHTRA	1989
42.	EMERALD	TAMIL NADU	1961
43.	ERAVANGALAR	TAMIL NADU	1978
44.	FOREBAY DAM	ANDHRA PRADESH	1978
45.*	GANDHI SAGAR DAM	MADHYA PRADESH	1960
46.	GATANA	TAMIL NADU	1974
47.	GIRNA	MAHARASHTRA	1970
48.	GLENMORJAN	TAMIL NADU	1930
49.	HARANBARI	MAHARASHTRA	1980
50.	HARANGI	KARNATAKA	1981
51.*	HASDEO-BANGO	MADHYA PRADESH	1992
52.	HEMAVATHY		Ongoing
53.	HERAN/LALPUR	GUJARAT	Ongoing
54.*	HIDKAL DAM	KARNATAKA	1979
55.	HIGH WAYS	TAMIL NADU	1978
56.	HIMAYATSAGAR	ANDHRA PRADESH	1927
57.*	HIRAKUD	ORISSA	1957
58.	IBADOH		Ongoing
59.	ICHARI	UTTAR PRADESH	1975
60.*	IDUKKI	KERALA	1974
61.*	ISAPUR	MAHARASHTRA	1983
62.	ITIADOH	MAHARASHTRA	1977
63.	JAISAMAND TANK	RAJASTHAN	1730
64.	JAKHAM	RAJASTHAN	Ongoing
65.	JALAPUT	ANDHRA PRADESH	1961
66.	JAMRANI	UTTAR PRADESH	1982
67.	JAWAHAR SAGAR	RAJASTHAN	1973
68.	KABINI	KARNATAKA	1974
69.*	KADANA	GUJARAT	1979
70.	KADDAM	ANDHRA PRADESH	1965
71.	KAKETO	MADHYA PRADESH	1934
72.	KALYANI	ANDHRA PRADESH	1977
73.	KAMTHIKHAIRY	MAHARASHTRA	1977
74.	KANGSABATI-KUMARI	WEST BENGAL	1975
75.	KANHER	MAHARASHTRA	Ongoing
76.	KANHOLI	MAHARASHTRA	1978
77.	KARANJWAN	MAHARASHTRA	1975
78.*	KARJAN	GUJARAT	Ongoing
79.	KARUPPANADHI	TAMIL NADU	1977

Annexure 1.IV (Contd...)

Annexure 1.IV (Contd...)

Sno.	*Name of Dam/Project*	*State*	*Year of Completion*
80.	KATEPURNA	MAHARASHTRA	1973
81.	KAYADHU		Ongoing
82.	KELO IRRIGATION PROJECT	MADHYA PRADESH	Ongoing
83.	KHADAKWASLA	MAHARASHTRA	1879
84.	KODAYAR DAM I	TAMIL NADU	1972
85.	KODAYAR DAM II	TAMIL NADU	1972
86.*	KOLAR	MADHYA PRADESH	Ongoing
87.	KOLKEWADI	MAHARASHTRA	1975
88.*	KOLLIMALAI	TAMIL NADU	Ongoing
89.*	KONAR	BIHAR	1955
90.*	KOTESHWAR	UTTAR PRADESH	Ongoing
91.*	KOYNA	MAHARASHTRA	1961
92.	KRISHNARAJA SAGAR DAM	KARNATAKA	1932
93.	KUTTIYADI	KERALA	Ongoing
94.	LAKHWAR	UTTAR PRADESH	Ongoing
95.*	LOKTAK	MANIPUR	1979
96.	LOWER BHAWANI	TAMIL NADU	1955
97.	LOWER NIRAR	TAMIL NADU	1982
98.	LOWER WUNNA	MAHARASHTRA	Ongoing
99.	MACHHUNDRI	GUJARAT	1984
100.	MAHANADI	MADHYA PRADESH	1979
101.	MAHI BAJAJ SAGAR	RAJASTHAN	Ongoing
102.*	MAITHON	BIHAR	1957
103.*	MAJALGAON	MAHARASHTRA	Ongoing
104.	MALAMPUZHA	KERALA	1966
105.*	MALANA	HIMACHAL PRADESH	Ongoing
106.*	MALAPRABHA	KARNATAKA	1973
107.	MANALAR	TAMIL NADU	1978
108.	MANCHANABELE RESERVOIR	KARNATAKA	Ongoing
109.	MANI	KARNATAKA	Ongoing
110.	MANIKDOH	MAHARASHTRA	1983
111.	MANIMUTHAR	TAMIL NADU	1958
112.	MASSANJORE	BIHAR	1955
113.	MATATILA	UTTAR PRADESH	1958
114.*	MAYURAKSHI	WEST BENGAL	1955
115.	MEJA	UTTAR PRADESH	1989
116.*	MELTHUR	TAMIL NADU	Completed
117.	METTUR (STANLEY)	TAMIL NADU	1934
118.*	MIDDLE VAITARNA DAM	MAHARASHTRA	Ongoing
119.	MUKURTHI	TAMIL NADU	1938
120.	MULA	MAHARASHTRA	1974
121.*	NAGARJUNASAGAR	ANDHRA PRADESH	1974
122.*	NARAYANPUR	KARNATAKA	1982

Annexure 1.IV (Contd...)

Annexure 1.IV (Contd...)

Sno.	*Name of Dam/Project*	*State*	*Year of Completion*
123.	NARIHALLA RESERVOIR	KARNATAKA	Ongoing
124.	NATUBARI	MAHARASHTRA	1984
125.	NEYYAR	KERALA	1973
126.	NIRGUNA	MAHARASHTRA	1977
127.*	NIZAM SAGAR	ANDHRA PRADESH	1931
128.	OBRA	UTTAR PRADESH	1972
129.	OSMAN SAGAR	ANDHRA PRADESH	1920
130.	OZARKHED	MAHARASHTRA	Ongoing
131.	PAITHAN	MAHARASHTRA	1976
132.	PALAR PORANDALAR	TAMIL NADU	1978
133.	PALKHED	MAHARASHTRA	Ongoing
134.*	PANCHET HILL	BIHAR	1959
135.	PAPAVINASANAM	ANDHRA PRADESH	1985
136.	PARAMBIKULAM	KERALA - TAMIL NADU	1967
137.	PARAPPALAR	TAMIL NADU	1974
138.*	PARAPPAR	KERALA	Ongoing
139.	PARSONS VALLEY	TAMIL NADU	1966
140.	PAWNA	MAHARASHTRA	1976
141.	PEECHI	KERALA	1959
142.	PEECHIPARAI	TAMIL NADU	1906
143.	PEGUMBAHALLA	TAMIL NADU	1965
144.*	PERIYAR	KERALA - TAMIL NADU	1897
145.	PERUNCHANI	TAMIL NADU	1952
146.	PHAGNE AND UJJANI	MAHARASHTRA	1975
147.	PILLUR	TAMIL NADU	1967
148.	PIMPAR	MAHARASHTRA	1985
149.*	PIPAI (RIHAND)	UTTAR PRADESH	1962
150.*	POCHAMPAD	ANDHRA PRADESH	Ongoing
151.	POCHARAM	ANDHRA PRADESH	1922
152.*	POLAVARAM	ANDHRA PRADESH	Ongoing
153.	PORTHIMUND	TAMIL NADU	1966
154.	PUS	MAHARASHTRA	1972
155.*	PUYAMKUTTY	KERALA	Ongoing
156.	PYKARA	TAMIL NADU	1935
157.	RADHANAGRI	MAHARASHTRA	1954
158.*	RAJGHAT	UTTAR PRADESH AND MADHYA PRADESH	1995
159.	RAMANADHI	TAMIL NADU	1974
160.*	RAMGANGA	UTTAR PRADESH	1978
161.	RANA PRATAP SAGAR	RAJASTHAN	1967
162.	RAVAL	GUJARAT	1978
163.*	RENGALI	ORISSA	1989
164.*	SALAL	JAMMU & KASHMIR	1987

Annexure 1.IV (Contd...)

Annexure 1.IV (Contd...)

Sno.	*Name of Dam/Project*	*State*	*Year of Completion*
165.	SANDY NALLAH	TAMIL NADU	1963
166.	SATHANUR	TAMIL NADU	1958
167.	SAVEHAKLU	KARNATAKA	Ongoing
168.	SERLUI	MIZORAM	Ongoing
169.	SERVALAR	TAMIL NADU	1986
170.	SHARAVATHI (LINGANAMAKKI)	KARNATAKA	1965
171.	SHARAVATHI (TALAKALALE)	KARNATAKA	1964
172.	SHETRUNJI	GUJARAT	1964
173.	SHOLAYAR	TAMIL NADU	1971
174.	SIDHESHWAR	MAHARASHTRA	1968
175.*	SIPU	GUJARAT	Ongoing
176.	SIRPUR	MAHARASHTRA	1975
177.	SOHIRA		
178.	SONDUR	MADHYA PRADESH	1989
179.*	SRINAGAR	UTTAR PRADESH	Ongoing
180.*	SRIRAMSAGAR AND LOWER MANAIR	ANDHRA PRADESH	1985
181.*	SRISAILAM	ANDHRA PRADESH	1984
182.	SUKTA	MADHYA PRADESH	1985
183.*	SUPA	KARNATAKA	1987
184.	TANAJI SAGAR	MAHARASHTRA	1971
185.	TARAKA RESERVOIR	KARNATAKA	Ongoing
186.*	TAWA	MADHYA PRADESH	1975
187.*	TEESTA (STAGE III)	SIKKIM	Ongoing
188.*	TEESTA (STAGE V)	SIKKIM	Ongoing
189.	TENUGHAT	BIHAR	1981
190.	THAMBRAPARANI	TAMIL NADU	1943
191.	THANDAVA	ANDHRA PRADESH	1974
192.	THEIN	PUNJAB	Ongoing
193.	THIRUMURTHI	TAMIL NADU	1967
194.*	TILAIYA	BIHAR	1953
195.*	TILLARI	MAHARASHTRA AND GOA	1998
196.*	TIPAIMUKH	MIZORAM	Ongoing
197.	TOTLADOH	MAHARASHTRA	Ongoing
198.*	TUNGABHADRA DAM	KARNATAKA	1953
199.	UJJANI	MAHARASHTRA	1980
200.*	UKAI DAM	GUJARAT	1972
201.	UPPER BHAWANI	TAMIL NADU	1965
202.*	UPPER GODAVARI	MAHARASHTRA	Ongoing
203.*	UPPER INDRAVATI	ORISSA	1993
204.*	UPPER KOLAB	ORISSA	1986
205.	UPPER MULLAMARI RESERVOIR	KARNATAKA	Ongoing
206.	UPPER PENGANGA	MAHARASHTRA	Ongoing

Annexure 1.IV (Contd...)

Annexure I.IV (Contd...)

Sno.	*Name of Dam/Project*	*State*	*Year of Completion*
207.*	UPPER WAIN GANGA	MADHYA PRADESH	1990
208.*	UPPER WARDHA	MAHARASHTRA	Ongoing
209.*	URI	JAMMU & KASHMIR	1995
210.	VAIGAI	TAMIL NADU	1959
211.	VANI VILASA SAGAR DAM	KARNATAKA	1908
212.	VIR	MAHARASHTRA	1965
213.	WAGHADI	MAHARASHTRA	1978
214.	WAGHUR	MAHARASHTRA	Ongoing
215.*	WARNA	MAHARASHTRA	Ongoing
216.	WEST VARAHAPALLAM	TAMIL NADU	1967
217.	WESTERN CATCHMENT NO. 2	TAMIL NADU	1966
218.	WILSON	MAHARASHTRA	1926
219.	YELDARI	MAHARASHTRA	1968

ANNEXURE - 2.I

MoEF Guidelines for Data Collection for Impact Assessment

The following data shall be collected to study the above environmental aspects of the project. The sources from where the data is to be collected and whose opinion is to be sought and incorporated within the project report are listed below:

Notation Department

1. State Forest Department
2. Indian Meteorological Department
3. State Fisheries Department
4. Zoological Survey of India
5. State Wildlife Department
6. State-Health Department/ State Public Health Department
7. Botonical Survey of India
8. Geological Survey of India

Note:- For preparation of this Chapter, Department of Environment may be consulted as and when required.

1. Basic Information

 1.1 Existing land-use in the catchment upto the source of the river or 100 km upstream of the structure whichever is less
 (a) Agricultural land (ha.)
 (b) Forests
 (i) Reserved
 (ii) Unreserved
 (c) Barren land etc.

 1.2 Submerged Area (Ha.)
 (a) Cultivated land
 (b) Forests
 (c) Shrubs and fallow
 (d) Wet lands
 (e) Area under ponds and tanks etc.
 (f) Other uses
 (g) Total

1.3 Forests types in the catchment and submerged area (types of trees, sparse or thickly wooded and other details).

(ii) Extent and nature of forest in the area proposed to be cleared for construction of roads, colonies and other uses of the project.

1.4 Proposed period of construction.

1.5 Labour

(a) Estimated strength (peak)

(i) Total

(ii) Skilled and Semi-skilled (separate)

(iii) Un-skilled

(b) Availability of labour from the affected area

(i) Total

(ii) Skilled

(iii) Un-skilled

1.6 Population density (per sq. km.)

(a) Catchment

(b) Submerged Area

(c) Command

1.7 Villages affected and population displaced

(a) Number of villages

(b) Population

(a) Scheduled Caste

(b) Scheduled Tribe

(c) Others

(d) Occupation of the affected People

(i) Agriculturists

(ii) Agricultural Labour

(iii) Industrial Labour

(iv) Forest Labour

(v) Artisans

(vi) Any other

(e) Land Ownership

(i) Marginal farmers	(0-1.0 ha.)
(ii) Small farmers	(1-2.5 ha.)
(iii) Medium farmers	(2.5-5.0 ha.)
(iv) Big farmers	(Over 5.0 ha.)

1.8 Resettlement
- *(a)* Details of rehabilitation committee, if any
- *(b)* Exiting guidelines for resettlement, and compensation in cash and / or kind, if any
- *(c)* Compensation proposed to be paid
- *(d)* Resettlement plans for oustees (number of persons and families)
  - *(i)* In existing villages
  - *(ii)* At new villages sites
  - *(iii)* Plan of the new village
  - *(iv)* Facilities being provided (school, post office, bank, panchayat ghar, police station, roads, drainage, water supply, vocational training etc.)
- *(e)* Proposals to provide vocational training and employment to oustees.

1.9 Details of development activity in the affected area
- (a) Drought-prone Area Programme
- *(b)* Small Farmer Development Agency
- *(c)* Rural Development
- (d) Tribal Development
- *(e)* Other programmes

1.10 Sedimentation of the reservoir
- *(a)* Expected rate of siltation
- *(b)* Proposed/existing soil conservation programme/measures in the catchment
- *(c)* Problems of slips and slides on the periphery of the reservoir and proposed remedial measures.

1.11 Present flood situation in the command

1.12 Wind rose diagram, wind speed (maximum average) direction (seasonal) etc. at the headworks site

1.13 Frequency of occurrence of tornadoes, cyclones, hurricanes (maximum and minimum wind velocity)

1.14 Ground water (command)
- *(a)* Depth and seasonal variations (pre and post monsoon)
- *(b)* Quality-potable, fit for irrigation/ industry
- *(c)* Present use
  - *(i)* Area under irrigation
  - *(ii)* Extent of industrial use

(d) Interaction between the altered surface water patterns and under ground water recharge etc. (based on the experience of similar projects)

2. Environmental Status

2.1 Known sources of pollution in the region
- (a) Industrial units
- (b) Thermal Power House
- (c) Mining Operations etc.

2.2 Industrial development in project area
- (a) Present status
- (b) Future plans (10 years)

2.3 Broad details of the aquatic life (fish, crocodiles etc.) supported by the area. If economically viable, indicate the breeding grounds in the river tributary(s) / area(s) coming under submergence.

2.4 Wild animals and birds
- (a) Existence in the area
- (b) Rate/dying species (number), if any
- (c) Breeding/ feeding area(s)
- (d) Migration routes
- (e) Is the area a potential wild life sanctuary?

2.5 Flora, fauna in the submerged area 5&7
- (a) Broad details of the rare/dying species
- (b) Number of affected valuable wild life
- (c) Measures proposed to salvage/rehabilitate

2.6 Tourism
- (a) Is the area a tourist resort?
- (b) Broad details of religious, archaeological and recreational centre, wildlife sanctuaries, national parks, likely to be affected by the project etc.

2.7 Broad details of endemic health problems due to soil and water borne diseases.

3. Environmental Impact

3.1 Proposal to develop the site to attract tourism (recreation, water sport, picnic sites etc.)

3.2 Effect of the storage in flood mitigation

3.3 Changes in salinity of underground water expected and remedies, if required.

3.4 Expected waterlogging problems and remedies.

3.5 Aquatic Life.

(a) Existence of migratory fish life and proposals for fish ladder, if any.
(b) Proposals for fisheries development and crocodile farming, if any.
(c) Loss in aquatic production up or downstream, if any

3.6 Broad details of mines, mineral, commercial timber and other natural resources coming under submergence with estimated loss.

3.7 Broad details of injurious minerals coming under submergence.

3.8 Effect of water body in enhancement of water borne disease.

3.9 Broad details of likely growth of weeds (salvinia, water hyacinth etc.) intermittent host vectors life snails, mosquitoes and proposed remedial measures.

3.10 Effect of project on climatalogical changes (temperature, humidity, wind and precipitation including modification to micro and macro climate).

3.11 Measures to prevent animal over grazing and cultivation of fore-shore of reservoir to prevent premature silting.

3.12 Likely impact of reservoir loading on seismicity.

3.13 Likely impact of population pressure on (during construction)

(a) Felling the trees for fire wood
(b) Forest fires
(c) Overgrazing leading to depletion of pasture lands
(d) Visual pollution and damage to scenary

3.14 Arrangement made for

(a) Fuel requirement of the labour force during construction period to prevent indiscriminate felling of trees for fire wood (fuel depots)
(b) Compensatory afforestation
(c) Enforcing off anti poaching laws
(d) Control of sediments and pollution

4. Proposals for observance and monitoring of suggested safeguards and mitigative measures etc. during and after construction of the project.

ANNEXURE - 2.II

Environmental Impacts Upstream: Impact of the Dam on the Catchment

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Barna	Y	N	Y	N		Incidental statement regarding reduction in irrigated area shows that there has been degradation of the catchment.	REDECON 1996
Bhakra Nangal	Y			Y.		Soil conservation measures to be undertaken at Rs. 200/acre. Afforestation at Rs.150/acre. Grassland management, Gully plugging, Check damming at Rs.25/acre	Khungar 1957
Bisalpur	Y	Y		Y		Deforestation due to wood-felling by construction labourers(about 70-80 headloads of wood used daily by construction labourers). Greater pressure due to easier access after road construction. Quarrying for construction. Mitigation also planned for catchment area improvement through watersheds, reclamation of quarries	GOR 1995b
Champamati	Y	Y		Y		Compensatory afforestation programme and engineering programmes scheduled. River bank planting along Bhur and Dholpani in the lower catchment covering an area of 2000 ha. Has been proposed. Also, canal bank planting for an area of 100 ha; and social forestry for 100 ha. have been proposed. Other measures like gully control structures for arresting gully erosion have been suggested for high priority Milli watershed, enrichment plantation, patch protection etc.	Cham nd.
Chandil	Y	Y	Y	Y		Under the CAT plan, 5863 ha. - very high priority, 4587 ha. is high priority. The forest department has started a soil conservation and afforestation program in 2866 ha.	GOWB 1993
Idukki	Y	Y	Y			There is sharp reduction in forest cover, especially evergreen forest in Idukki area after construction of dam. Clearing of vegetation around reservoir has promoted soil erosion.	CBIP 1995
Kollim-alai	Y	Y.		Y.		CAT plan of degraded areas to be taken up. Firewood to be supplied to the contract labourers free of cost.	ERRC 1996
Malana	Y	Y		Y		About 3000 ha. could be afforested from project funds towards catchment area treatment (cost = Rs.33 lakh)	WAPCOS 1994
Middle Vaitarna Dam	Y					Enrichment of ground water body in catchment area due to generation of phreatic and perched aquifers along the flanks of gorges by creation of several water spreads in place of natural sink holes.	Badrinath et al. 1991

Annexure 2.II (Contd...)

Annexure 2.11 (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Ramganga	Y	Y		Y		The centrally sponsored soil conservation scheme was initiated in 1962 in the Ramganga catchment covering an area of 42000 ha. up to 1988. An area of 34508 ha. of non agricultural land was treated with afforestation works alongwith the treatment of 7416 ha. of agricultural lands and 2338 ha. horticultural land in the catchment.	Goel 1993
Teesta (Stage V)	Y	Y	N	N		Due to deepness of valley and widening of river bed there would be no significant impact on catchment.	GOS nd01

Note for all the tables that follow:

1. While a database was compiled for 67 dams, only the dams for which information was available for a particular aspect were listed in the table dealing with that aspect.
2. A blank cell in the table indicates that information was not available.

ANNEXURE - 2.III

Environmental Impacts Upstream: Impacts of Catchment on Dam: Siltation

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Siltation*	*Source*
Almatti	Y	Y				Assumed rate of siltation – 2750000 cu. m per year. Government claims no impact presently or in the future.	GOK 1998
Beas	Y	Y	Y	N		Assumed : 2462.46 ha.m. per annum, Actual : 3183.18 ha.m. per annum, Percentage increase : 29.27	GOI 1991
Bhadar	Y	Y				Expected rate of siltation is - 1.31ha.m per 100 sq.km. Per year.	CCPA 1996.
Champ-amati	Y	Y		Y		Upper catchment free from slope or jhum cultivation and does not pose any serious problem or run off or soil erosion. Treatment plans have been proposed to ensure control of soil erosion, restoration of hydrologicial balance, flood protection and preservation of biological measures.	AFCL 1997
Chandil	Y	Y	Y	Y		Actual rate of siltation is 1749800 ha.m. per annum. Siltation predicted to decline due to treatment	CWC 1991
Dharoi	Y	Y	Y			1. The rate of siltation was predicted to be 19.57acre feet/annum but it occurred at a rate of 52.64 acre feet/annum/100sq.km.of catchment area.The yearly rate of siltation goes on reducing because there has already been a lot of siltation. It was 157.92 acre feet/100Sq.km.in 1990. Loss in live storage after 30 years is 7.9%	KICONS 1996
Gandhi-sagar	Y	Y	Y			Assumed : 29.36 ha.m.per annum, Actual : 41.37 ha.m.per.annum. Percentage increase in siltation is 41.	CBIP 1987a
Hasdeo Bango	Y	Y	Y			Siltation would increase because of open cast coal mines in the catchment area, Silt deposit and weed growth has started due to faulty operation procedure on the left bank. Measurement of discharge of various points are not done properly on the right bank.	CWC 1991 and REDECON 1996a

Annexure 2.III (Contd...)

Dam Name:	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Siltation*	*Source*
Hirakud	Y	Y	Y	Y	N	Assumed : 1201.20 ha.m.per annum, Actual : 2599.10 ha.m. per annum, Percentage increase : 116.00 It was expected in the Khosla Report of 1947 that 2/3 to 1/2 of the silt inflow will be cleared but only 27.36% has been cleared during 1957- 67	CWINC 1947
Idukki	Y	Y	Y			Silting is not a cause for alarm because only top 130 ft. of the 500 ft. is live storage.Soil erosion is severe. It is essential to see that it is stopped for reasons of slope stability.	CBIP 1995
Isapur	Y	Y	Y	Y		Assumed rate of siltation - 65 cu. m per square km per year; actual rate of silatation - 651 cu.m per sq.km per year. Percentage increase – 901. A drainage system has been planned.	GOM 1994
Kadana	Y	Y	Y			1. Construction of reservoir has stopped the process of silting up of the Industries near Surat & Cambay. 2. At the time of designing of the project a siltation rate of 1.3 ha.m.per 100 sq. m per year was assumed, but the sedimentation surveys of Mahi Kadana reservoir (pp. 21) shows the actual siltation rates to be 4.93 ha.m. per 100 sq.km.per year in the first survey (1980-81) and 4.6 ha.m.per 100 sq.km.per year in the second survey (1984). Percentage increase in siltation - 266.	CBIP 1995
Kollima-lai	Y			Y		Quantum of silt carried even during monsoons is low. CAT plan of degraded areas to be taken up.	ERRC 1996
Loktak	Y	Y		Y		The assumed rate of siltation =4.5 ha. m per 100 sq. km., Actual siltation = 6.36 ha. m per 100 sq. km., Percentage increase = 41. 50% of the total soil loss retained every year and thereby reducing the capacity of the lake. Compensatory afforestation of catchment done to prevent siltation.	Kumar et al. nd.
Maithon	Y	Y	Y			Assumed rate of siltation is =9.05 ha.m.per 1000 sq. km., Actual siltation =12.39 ha.m.per 1000sq. km. Percentage increase = 37.00	Silt nd.
Malapr-abha	Y	N	Y	N		Assumed rate of siltation is 94.00ha.m.per annum. Actual siltation = 786.00 ha.m.per annum, Percentage increase = 736	CCPA 1995

Annexure 2.III (Contd...)

Annexure 2.III (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Siltation*	*Source*
Mayura-kshi	Y					Main canals, Branch canals, distributaries, minors,subminors have been silted up.clearance of the silt deposit cannot be taken up every year. Scouring of the site is also a common feature in the command area. The main canals are silted up by 60-90 cm.in most reaches.	WAPCOS 1996a
Middle Vaitarna	Y	Y				Expected sedimentation is not very high in comparison to observed rates of other dams.	Badrinath et al. 1991
Nagarju-nasagar	Y		Y			Decreases in storage capacity of the reservoir by 25% in initial 30 Years due to Silitation. Decrease in useful life of reservoir estimate from 500 years to 350 years	Jauhari nd.
Naraya-npur	Y	Y	Y			Actual rate of siltation is 88 ha.m.per annum.	GOK 1988
Nizams-agar	Y	Y		Y		1.The silt expected = .65 M.cm./year 2.The silt storage = 4100M.cu.ft.	GOAP 1965
Panchet	Y	Y	Y			Assumed rate of siltation =6.67 ha.m.per 1000 sq. km., Actual siltation =10.48 ha.m.per 1000 sq.km. Percentage increase = 57	Silt nd.
Periyar - Vaigai	Y		Y.	Y.	Y.	1. The rate of silt deposit in Vaigai fell from 35.51 acre feet/annum in 1976 to 32.12 acre feet/annum in 1983. 2. The sedimentation problem in reservoirs would cease to exist if watershed erosion control is fully implemented and grazing is taken care of.	KICONS 1996a
Puyamk-utty	Y	Y	Y			Rate of soil erosion is very high. Due to population pressure and deforestation on the catchment, rate of sedimentation is further worsened.	Swaminathan nd.
Ramga-nga	Y	Y	Y			Sedimentation in 1988 was 5.91 M.Cu.m. It was claimed to be low. Various development activities in the region, particularly construction of road have also been causing soil slips.	Goel 1993

Annexure 2.III (Contd...)

Annexure 2.III (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Siltation*	*Source*
Srinagar	Y			Y.		There is a proposal to support a catchment study over a 5 years period:The main features of the study will be a) analysis of existing remote sensing imagery of 21373 sq.km. of Ganga catchment upstream of Rishikesh.b) To identify sites needing priority treatment and to establish a monitoring system in order to quantify changes in catchment quality and efficiency of catchment treatment.	Goodland 1987
Teesta (Stage III)	Y	Y				The volume of siltation is likely to reduce the storage capacity to the tune of .00003209 Mm^3	NEERI 1991
Teesta (Stage V)	Y	Y		Y		The reservoir is likely to be filled up during monsoon months with silt. Flood flushing is suggested.	GOS nd01
Ukai	Y	Y	Y			1. A survey by Gujarat Engineering Research Institute shows that 493.41 mm^3 of silt got deposited between 1972-79 that brings the reduction in the reservoir capacity to 0.83 % p.a. 2. Rate of siliting is higher than that assumed during project preparation. It has increased to 8.07 ha. m / 100 sq. km. p.a. Accepted rate of siliting by CWC is 4.57 ha. m / 100 sq. km.	Purohit nd01
Upper Indravati	Y	Y	Y	Y		As mitigative measures, direct inlets were being provided into main canal thereby draining out silt and stone. No further inlets are provided in the main canal. Dry, random rubble masonary barriers will be constructed in upstream of inlets to arrest the silt.	CWC 1998
Upper Kolab	Y	Y		Y		If afforestation is not taken-up in the entire catchment area, life of the reservoir will be considerably reduced because of silt inflow to the reservoir. A scheme is planed by the Director, Soil Conservation and is submitted to the Govt. of India, amounting to Rs.32 crore, but it is yet to be sanctioned.	GOO 1988

ANNEXURE - 2.IV

Environmental Impacts at the Dam and Reservoir: Impacts on Aquatic Biodiversity

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Champ-amati	Y			Yes. Since fish gates are provided, the barrage will not affect the migration of aquatic species.			AFCL 1997
Chandil	Y.	Y				Impact of project predicted to be positive because Subarnarekha thought to be seasonal and therefore unable to support aquatic life prior to construction of barrage.	GOWB 1993
Isapur	Y	Y				No change in fish catch. The document claims that there is no change in the aquatic life.	GOM 1994
Ramga-nga	Y	Y	Y			The aquatic life has been enhanced.	Goel 1993
Sriram-sagar & Lower Manair	Y	N		N		No change in fish catch.	GOAP 1994
Teesta (Stage III)	Y	Y		N		The reservoir is likely to remain oligotrophic with very little chances of algal blooms.	NEERI 1991
Teesta (Stage V)	Y	Y	Y	Yes. Artificial fish seed production farm proposed and habitat improvement work to be taken up.		Fish catch decrease. Decrease in the diversity of fish species.	GOS nd01

ANNEXURE - 2.V

Environmental Impacts at the Dam and Reservoir: Impacts on Terrestrial Biodiversity

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Almatti	Y	Y				532.31 ha. forest land submerged. Project is unlikely to have an adverse impact on fauna.	GOK 1998
Barna	Y	N				Project is unlikely to have an adverse impact on fauna and flora.	REDECON 1996
Bhadar	Y	N					CCPA 1996
Bisalpur	Y	Y		Yes. Plan for compen-satory afforestat-ion.	No. Land for compensatory afforestation found unsuitable.	358.00 ha. forest land submerged. Project is unlikely to have an adverse impact on fauna and flora. Positive impact: Creation of artificial wetland, proposed to be declared sanctuary. Negative impact: greater accessibility would increase pressure on forests (habitat destruction).	CWC 1996 and GOR 1995b section 2.2
Cham-era	Y	Y	Y	Yes. Double the number of trees submerged to be planted		982.70 ha. forest land submerged.	Naidu 1994
Champ-amati	Y					Project is unlikely to have an adverse impact on fauna and flora.	AFCL 1997
Chandil	Y	Y		Yes. Afforest-ation of 2.1186 ha.		In the entire Subarnarekha Project, 10,000 acres of forest land is expected to be lost. No endangered species present. Indiscriminate dumping of excavated earth witnessed in construction areas. EMC has suggested restoration activities.	ORSAC & WAPCOS nd, Sherman nd, CWC 1991, GOWB 1995, CWC 1996
Hasdeo Bango	Y	Y				No major impact on wildlife. Positive impact, creation of two islands which will be developed as bird sanctuary.	CWC 1991
Hirakud	Y		Y			28000 ha. of forest land submerged.	CWINC 1947
Idukki	Y		Y			Sharp reduction in evergreen forest cover. Clearing of vegetation around the reservoir has promoted soil erosion. Denudation of land and existence of the open lake makes wind movement possible. Delicate flowers and large insects have been adversely affected.	CBIP 1995

Annexure 2.V (Contd...)

Annexure 2.V (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Isapur	Y	Y	Y	Yes. Arbori-culture.		32 migratory birds, (4 endangered). 11 species of endangered animals. 5 species of endangered reptiles. 8 rare plants (endangered) among 53 submerged.	GOM 1994
Kadana	Y		Y	Yes. Planting of trees along canals.		4000.00 ha. of forest land submerged.	CBIP 1995 p – 248
Kollimalai	Y					No endangered species present. Rare vegetation and herbs to be affected.	ERRC 1996
Kotesh-war	Y		Y			379.00 forest land submerged. Submergence of pasture land =77.28 ha.	Kot nd.
Loktak	Y			Y		60 ha. of forest land submerged and 15 number of fauna affected.	GOM nd. And GOM 1992
Malana	Y		Y	Yes. Compen-satory affores-tation in 108 ha.		18 ha. of forest land submerged. 36 ha. forest land diverted for project other than submergence.	WAPCOS 1994
Middle Vaitarna Dam	Y.	Y.		Yes. Compensatory afforestation.		528.305 ha. of forest land submerged. 8 species of endangered animals affected. Loss of wildlife habitat and forest vegetation. Tansa Wildlife Sanctuary falls within project area.	Badrinath et al.1991
Nagarjuna-sagar	Y	Y.	Y			5000 ha. of forest land submerged. 1400 ha. of forest land used for rehabilitation.	Jauhari nd. and Rao 1979
Naranyanpur	Y					Submergence area devoid of tree cover.	GOK 1998
Periyar – Vaigai	Y	Y.	Y.	Y.			KICONS 1996a
Polavaram	Y	Y.				3540 ha. of forest land submerged. The species affected by the reservoir include many endangered ones like tiger, bison, blackbuck etc.	Rao et al. nd.
Puyamkutty	Y	Y		Y		5000 ha. of forest land submerged. Puyamkutty region is the best breeding place for the endangered asiatic elephants which will be affected by the proposed dam. It also is a threat to existing bird sanctuary at Thattekadu. The forest to be submerged, most of which consists of rain forest and the best reed forest, will be affected. 400 Sq. km. of forest land will be destroyed due to lack of protection. Pinavoor Semi Evergreen Forest will be destroyed. Further deforestation can produce higher sedimentation and premature siltation of reservoir.	Zacharia nd. and Swaminathan nd.

Annexure 2.V (Contd...)

Annexure 2.V (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Ramganga	Y	Y	Y			3134 ha. of forest land submerged. The number of wild animals like tiger, panther, elephant and cheetal has actually increased. The Flora is claimed to be enhanced by the project.	Goel 1993
Srinagar	Y.	Y.		Y.		The submergence area is devoid of forest cover, hence no wildlife will be affected. However, 65.9 ha of RF was to be acquired and compensatory afforestation was planned.	Goodland 1987
Sriramsagar & Lower Manair	Y		Y			83.96 ha. of forset land submerged.	GOK 1998 and GOAP 1994
Tawa	Y		Y			Trees are dying out due to constantly stagnant watertable.	Choudhauri nd.
Teesta (Stage III)	Y						NEERI 1991
Teesta (Stage V)	Y	Y		Y		Adverse impact on wildlife habitat may be high if constant monitoring is not organised.	GOS nd01
Tipaim-ukh	Y					19000 ha. of forest land submerged. 1000 ha. of forest to be cut. No endemic or endangered species of fauna.	GOI 1995
Ukai	Y	Y	Y			31000 ha. of forest submerged. Much of fauna lost.	Purohit nd01
Upper Indra-vati	Y	Y		Yes. 2500 ha for compensatory afforestation.	No. Only 270 ha planted, soil conservation neglected.	1665 ha. of forest land submerged. Reservoir submerged one of the best and most dense forests	CWC 1991
Upper Wardha	Y		Y			1181.30 ha. of forest land submerged.	CWC 1996
URI	Y			Y	60% of the trees planted survived.	No animals species of particular interest in the forest adjacent to project area. Himalayan herbivores such as deer and carnivores such as bears are found many kms. away from the project. 4000 trees affected. Construction affects 54 ha. forest area.	UHPP 1989
Warna	Y.		Y.			753 ha. of forest land submerged.	

ANNEXURE - 2.VI

Environmental Impacts at the Dam and Reservoir: Impacts on Human Health

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Almatti	Y	Y	Y	N	N	Vector breeding is reported. No change in water quality reported. Gastro-enteritis and liver diseases reported	GOK 1998
Barna	Y					Water availability is better in the upper reaches of the command area. Other areas have shown a decline. Likelihood of waterborne diseases spreading.	REDECON 1996
Bhadar	Yes. No change is reported to have occurred on health aspects.	N	N				CCPA 1996
Bisalpur	Y	Y		Yes. Argued that existing medical facilities in all affected areas are sufficient.Financial allocation made.		Vector breeding is reported.	GOR 1995d Chapter 3 section 7 and GOR 1995e p 3-6
Champ-amati	Y					No change in water quality. Water is free from hardness and chemicals like flouride, Iron Chloride etc. it is suitable for irrigation and consumption.	AFCL 1997
Chandil	Y		Y			Vector breeding is reported. Rise in water borne diseases.	ORSAC & WAPCOS nd.
Hasdeo Bango	Y	Y	Y			Vector breeding is reported. Malaria and Schistoso-miasis on rise. Water availability is worse.	CWC 1991
Idukki	Y		Y			Vector breeding is reported Malaria and filariasis on rise. No change in water quality.	CBIP 1995
Kadana	Y		Y			Vector breeding is reported. Rise in Malaria. Water quality is better. Water availability is better.	CBIP 1995 p - 248
Kollimalai	Y					Water availability is better.	ERRC 1996
Loktak	Y					No vector breeding reported. No change in water quality.	GOM 1992

Annexure 2.VI (Contd...)

Annexure 2.VI (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Malaprabha	Y	Y				No vector breeding reported. Water quality is better.	CCPA 1995
Middle Vaitarna	Y		Y	Y		Dust pollution is reported. Water quality is worse. Water borne diseases on rise.	Badrinath et al. 1991
Nagarjunasagar	Y	Y	Y	Y		Vector breeding of malaria is reported. Water quality is worse. Increase in incidence of fluorosis	Jauhari nd.
Nizam-sagar	Y	Y	Y	Y		Vector breeding of malaria is reported.	GOAP 1965
Pipai (Rihand)	Y			Y		Vector breeding is reported.	GOUP 1947
Polavaram	Y	Y				Vector breeding is reported. Out break of communicable diseases feared. It is also feared that extensive use of fertilizers and pesticides would degrade the soil and increase its floride content.	Rao et al. nd.
Srinagar	Y.	Y.				No vector breeding since it is a run of the river project and situated at an altitude of 1500 metres	Goodland 1987
Sriramsagar and Lower Manair	Y	Y		N		Vector breeding is reported.	GOAP 1994
Tawa	Y		Y			Vector breeding of malaria is reported. Water quality is worse. Hepatitis has become endemic.	Choudhauri nd.
Tipaimukh	Y		N.			No change in water quality.	GOI 1995
Upper Indravati	Y		Y	Y		Vector breeding of malaria reported. Water quality is worse. Water and soil borne diseases occur.	CWC 1991
URI	Y	N		N		Due to climatic conditions no vector breeding reported.	UHPP 1989

ANNEXURE - 2.VII

Environmental Impacts at the Dam and Reservoir: Seismicity

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Beas	Y					Impact of earthquake studied	CBIP nd01
Idukki	Y		Y.	N.		Frequency distribution of the shocks in the Idukki area shows a gradual increase in micro seismic activity. General magnitude of tremors recorded are below 2.5. A maximum of 3.8 was recorded in August 1978.	CBIP 1995
Koyna	Y		Y	Yes. Dam strengthened by concrete backing.		The dam was damaged due to the earthquake. Reservoir induced seismicity is alive since 1962 and medium size quakes continue to occur. An earthquake of magnitude 4.6 occurred on Nov 14,1984. On Dec11, 1967 a quake of magnituded 6.5 damaged the dam.	Anonymous 1968
Middle Vaitarna Dam	Y.					The proposed dam is located in seismic zone- III.	Badrinath et al.1991
Puyamkutty	Y	Y				Eco catastrophe of immense magnitude may occur if more dams are built. Idukki has experienced successive tremors in the past.	Zacharia nd.
Ramganga	Y					No reservoir induced seismicity was found and the Dam is monitored continually	Goel 1999
Teesta (Stage V)	Y	Y	N	Y		Suitable seismic facts have been taken into consideration while designing the various components of the project.	GOS nd01
Tipaimukh	Y	Y				An earthquake of magnitude 7-7.25 may occur any time during lifetime of the structure.	GOI 1995
Uri	Y					Maximum credible seismic ground motion at the site might be characterized by peak ground acceleration as great as 0.35 g. & category I structures should be analysed. It may not be necessary to classify the barrage as a category I structure.	UHPP 1989

ANNEXURE - 2.VIII

Environmental Impacts at the Dam and Reservoir: Water Table

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks.*	*Source*
Barna	Y		Y.			Yes. A rise has been reported.	REDECON 1996
Gandhisagar	Y	Y	Y			Yes. Rise of 3 metres over 176000 ha.	WAPCOS 1996b
Tawa	Y		Y			Yes. In the wells of the area.	Choudhauri nd.

ANNEXURE - 2.IX

Environmental Impacts Downstream : Impacts on Aquatic Biodiversity

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Almatti	Y	Y	N	N		No change in fish catch.	GOK 1998, GOK 1998b
Bisalpur	Y	Y		N		Fish migration may be affected partially	GOR 1995b section 2.2
Chandil	Y	Y				Growth of weed feeding fish. Aquatic weeds will be controlled because of flow of water. Increase in the resident habitat of breeding species.	GOWB 1993 and ORSAC & WAPCOS nd.
Isapur	Y	Y				Fish catch is expected to increase.	GOM 1994
Middle Vaitarna	Y	Y.				Proposed construction of dam may attract significant number of aquatic birds.	Badrinath et al.1991
Naray-anpur	Y	Y	N	N		No change in fish catch.	GOK 1998 and GOK 1998b
Nizam-sagar	Y	Y		Y			GOAP 1965
Polavaram	Y	Y				The main acquatic life that would be affected are hydrilla plamogeton along with fishes like labeo, cerrihina etc.	Rao et al. nd.
Teesta (Stage III)	Y	Y.				Interruption of migration routes of fish. No impact anticipated on biodiversity. Decomposition of the suspended load at reservoir bottom. Displacement of natural river habitat. Increase in plankton and benthic habitats. Increase in aquatic growth at reservoir edges.	NEERI 1991
Uri	N					Jhelum has 5 fish species not found outside Kashmir area and some of the Molluscs are also endemic therefore impact of dam/barrage should be studied and design of the fish ladder and its location should be carefully planned. No water will pass through the barrage during dry spells. The report recommends that minimum water should be allowed to flow through the barrage before more detailed data on aquatic ecosystem becomes available.	UHPP 1989

ANNEXURE - 2.X

Environmental Impacts Downstream: Impacts on Terrestrial Biodiversity

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Mayurakshi	Y			Y		An area of 8000 ha.has been selected mainly on road sides for afforestation.Water courses have been grazed to the ground in some areas. Out of the 2.26 ha.of the command area around 6% is covered.	WAPCOS 1996a
Tawa	Y					Compensatory afforestation has been planned for command area. Also trees are to be grown along canals and roads. Social forestry development has been planned.	CBIP 1995
Teesta (Stage V)	Y	N	N	N		There would be no significant vegetation/forest loss in this area. Presence of forest cover and also cardamom cultivated area.	GOS nd01

ANNEXURE - 2.XI

Environmental Impacts Downstream: Impacts on Water Availability and Quality

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Bhadar	Y	N	N			Situation unchanged after construction implying no impact.	CCPA 1996
Gandhis-agar	Y	Y				Water quality has improved	WAPCOS 1996b
Hasdeo Bango	Y		Y			Negative impact on water quality due to increase in flouride content.	CWC 1991
Kadana	Y					Drinking water is supplied to Kadana & Dimada villages, Gujarat refineries and Vadodara municipal corporation.	Purohit nd. p - 88
Middle Vaitarna	Y	Y				The proposed project can lead to improvement of quantity of water supply.	Badrinath et al. 1991
Ukai	Y		Y.			Water is being supplied to households as well as industries.	Purohit nd01

ANNEXURE - 2.XII

Environmental Impacts Downstream: Impacts of Dam Failure

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Bhadar	Y	Y		Y		Planning for appropriate surplussing arrangement for flood control under consideration	CCPA 1996
Hirakud	Y	Y	N			Cracks appeared in the concrete dam in 1971, though it became public only in 1985	Subakar nd.
Malapr-abha	Y	N	N			The dam and appurtenant works are in good conditions. No threat suspected.	CCPA 1995
Mayura-kshi	Y			N		Out of the 2440 structures in the project only few of them which control the system and may bring danger due to failure are maintained properly. Others are not in a good condition due to paucity of funds. To control seepage loss, there is an urgent need to install measuring devices so as to acquire control on the flow of water.	WAPCOS 1996a.
Nizams-agar	Y	Y		Y		Provision for outlet of 475000 cusecs of water made. Max. flood expected = 525000 cusecs.	GOAP 1965

ANNEXURE - 2.XIII

Environmental Impacts Downstream: Impacts of Rehabilitation

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Chandil	N	Y				Forest land may be converted for resettlement in Bihar.	WB nd.
Nagarjun-asagar	Y		Y			14000 ha. agricultural land used for rehabilitation.	Jauhari nd. and Rao 1979
Srirams-agar & Lower Manair	Y	Y	Y	Y	N	209.90 ha. of forest land used for rehabilitation. 1. Project work continuing even without submission of EIA report to MoEF. 2. Allocation of Rs. 40 lakhs for improving agro-forestry in command area and Rs.450 lakhs for eco-restoration and development of degraded forests. 3. Land allotted for compensatory afforestation (159.92 ha.) is less than what is being diverted for rehabilitation (209.9 ha.). Also canal bank tree planting is not being done.	Kothari 1994a.
Tawa	Y					Compensatory afforestation has been planned for command area. Also trees are to be grown along canals and roads. Social forestry development has been planned.	CBIP 1995
Teesta (Stage V)	Y	N	N	N		There would be no significant vegetation/forest loss in this area. Presence of forest cover and also cardamom cultivated area.	GOS nd01

ANNEXURE - 2.XIV

Environmental Impacts of Canals: Water Logging

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Bisalpur	Y	Y		Yes. Through lining of canals, higher ground water use for irrigation, better drainage.		8450 ha. of area affected by water logging.	GOR 1995d. Ch. 3 section 3
Champamati	Y	Y		Yes. Conjunct-ive use of ground and surface water.		It is estimated that in post irrigation periods depth of water table will increase raising the depth during post monsoon indicating serious water logging.	AFCL 1997
Chandil	Y	Y		Yes. Preventive measures have been planned i.e. scheduling irrigation efficiency and drainage.		Areas prone to water logging to enlarge and low lying lands in the SW and SE ends of the GCA to be affected.	GOWB 1993 and ORSAC & WAPCOS nd.
Dharoi	Y		Y			Serious waterlogging will occur due to excessive canal seepage, wasteful use of water etc. It is seen that hardly 69% of the total command area is suitable for seasonal irrigation.	KICONS 1996
Gandhisagar	Y	Y	Y	Yes. Horizontal and vertical drainage planned to reduced salinity.	Yes. Waterlogging has reduced greatly	3000 ha. of area affected by water logging.	WAPCOS 1996b and Afroz and Singh 1987

Annexure 2.XIV (Contd...)

Annexure 2.XIV (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Hasdeo Bango	Y	Y	Yes. Due to accumu-lation of excess canal water nalas get choked and perennial and wild weeds grow. Sudden rainfall causes flooding at tail	Y	Y	Negative impact due to water logging on crops.	REDECON 1996a. and CWC 1991
Hirakud	Y	N	Yes. The water-logging problem is due to the lack of a proper drainage system.	Y	N		Subakar nd.
Isapur	Y	Y	Y	Yes. Drainage system is proposed		95 ha. Waterlogging along Right Bank Canal increased from 39 to 63 ha. And decreased along Left Bank Canal from 64 to 32 ha.	GOM 1994
Kadana	Y	Y	Y	Yes. Drainage master plan with outlay of Rs. 30.95 crores.		20000 ha. of area affected by water logging.	CBIP 1995 p – 264
Malana	Y	No. No Impact of water logging or salinity expected as the water conductor system is a lined tunnel.					WAPCOS 1994
Malap-rabha	Y	Y	Y			Continuous problem of water logging being faced. No drains constructed.	CCPA 1995
Mayurakshi	Y					No waterlogging reported in the area.	WAPCOS 1996a.
Middle Vaitarna	Y	Problems due to water logging and salinity are not anticipated.					Badrinath et al.1991

Annexure 2.XIV (Contd...)

Annexure 2.XIV (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Nagarjunasagar	Y		Yes. Water-loging caused by poor drainage, reduced demand from ground water sources, increase in cultivation of irrigated wet crops like paddy and seepages.			25000 ha. of area affected by water logging.	Jauhari nd. p – 185
Periyar - Vaigai	Y		No. The water table is well below the ground level as there are more than 7052 wells in the command area. Thus water logging and salinity have not been noticed.	Yes. Canal lining.			KICONS 1996a.
Polavaram	Y	Y				Command area is likely to be subjected to waterlogging.	Rao et al. nd.
Ramganga	Y	Yes. No district is said to suffer from water logging or salinity of soil and the gradients are sufficient enough for natural drainage.					Goel 1999 & Afroz and Singh 1987
Sriramsagar & Lower Manair	Y	No. No adverse impact like water logging is predicted.	Y.	Yes. Provision of surface and sub-surface drainage, lining of canals and provision of Rs.600 per ha. in command area		150 ha. of area affected by water logging.	GOAP 1994

Annexure 2.XIV (Contd...)

Annexure 2.XIV (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Tawa	Y	Y	Yes. Water-logging has occurred due to increase in watertable.	Yes. Conjunc-tive use of irrigation and ground water.		250 ha. of area affected by water logging.	CBIP 1995
Teesta (Stage V)	Y	No. Water logging problems not anticipated in the area as reservoir water will be diverted through well construc-ted concrete and steel lined tunnels.	N	N			GOS nd01
Tungabhadra	Y					33900 ha. of area affected by water logging.	Afroz and Singh 1987
Ukai	Y	Y	Yes. Water logging is on the rise and 35% of the command area (1,17100 ha.) has high water table.	Y		8000 ha. of area affected by water logging.	EAC Jan1991 & Afroz and Singh 1987
Upper Indravati	Y	Yes. It was apprehended that a large area will be affected by water logging.					OKM nd.

ANNEXURE - 2.XV

Environmental Impacts of Canals: Salinity

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Bisalpur	Y	Y		Yes. Through lining of canals, higher ground water use for irrigation, better drainage, chemical treatment on salt-affected land etc.		Entire command area prone to salinity.	GOR 1995d. Ch. 3 section 3
Chandil	Y	Y		Yes. Preventive measures have been planned i.e. scheduling irrigation efficiency and drainage.		There is little risk of salination.	GOWB 1993 and ORSAC & WAPCOS nd.
Dharoi	Y		Y			Serious salination will occur due to excessive canal seepage, wasteful use of water etc. It is seen that hardly 69% of the total command area is suitable for seasonal irrigation.	KICONS 1996
Gandhisagar	Y	Y	Y	Yes. Horizontal and vertical drainage planned to reduced salinity.	Yes. Water logging has reduced greatly	25000 ha. of area affected by salinity.	WAPCOS 1996b and Afroz and Singh 1987
Hasdeo Bango	Y	Y	Yes. Due to accumulation of excess canal water nalas get choked and perennial and wild weeds grow. Sudden rainfall causes flooding at tail	Y	Y	Negative impact due to salinity on crops.	REDECON 1996a. and CWC 1991

Annexure 2.XV (Contd...)

Annexure 2.XV (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Hirakud	Y	N	Yes. The salination problem is due to the lack of proper drainage system.	Y	N		Subakar nd.
Isapur	Y	Y	Y	Yes. Drainage system is proposed		Salination increased from 1 to 42 ha. along Right Bank Canal (Left Bank Canal not studied)	GOM 1994
Kadana	Y	Y	Y	Yes. Drainage master plan with outlay of Rs. 30.95 crores.		30000 ha. of area affected by salinity.	CBIP 1995 p – 264
Malana	Y	No. No Impact of salinity is expected, as the water conductor system is a lined tunnel.					WAPCOS 1994
Middle Vaitarna	Y	Problems due to salinity are not anticipated					Badrinath et al. 1991
Periyar - Vaigai	Y		No. The water table is well below the ground level as there are more than 7052 wells in the command area. Thus salinity has not been noticed.	Yes. Canal lining.			KICONS 1996a.
Polavaram	Y	Y				Command area is likely to be subjected to water logging leading to alkalinity and salinity.	Rao et al. nd.

Annexure 2.XV (Contd...)

Annexure 2.XV (Contd...)

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Ramganga	Y	Yes. No district is said to suffer from salinity of soil and the gradients are sufficient enough for natural drainage.					Goel 1999 & Afroz and Singh 1987
Teesta (Stage V)	Y	No. Salinity problems not anticipated in the area as reservoir water will be diverted through well construc-ted concrete and steel lined tunnels.	N	N			GOS nd01

ANNEXURE - 3.I

Social Impacts at the Dam, Reservoir, Due to Canals etc. : Fisheries

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Champ-amati	Y					The river does not bear any economic fisheries.	Cham nd.
Chandil	Y	Y				Increase in fisheries production likely. 40 more fishermént to get employment. Benefit to the tune Rs. 3.39 million.	ORSAC & WAPCOS nd.
Kollim-alai	Y					Potential for fresh water fishing occupations.	ERRC 1996
Mahi-Kadana	Y	Y	Y			700 families of tribals engage in fishing and earn around Rs. 900-1000 per month for about 10 months in an year. The project authorities reportedly also put fish seeds of catla, rohu and mrigal into the reservoir.	Purohit nd.
Polava-rum	Y	Y				Many tribals will lose access to fishing due to the project.	Rao et al. nd.
Tawa	Y	Y.				Increase. Annual expected fish yield of 5000 metric tonnes.	Dharmadikari and Agarwal 1991, CBIP 1995
Tipaim-ukh	Y	Y				Project area will be used for development of fisheries. Aquatic life to be enhanced by fish farming in the reservoir.	GOI 1995

ANNEXURE - 3.II

Social Impacts at the Dam, Reservoir, Due to Canals etc. : Health

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Vector breeding (increase/ decrease/ no change)*	*Remarks*	*Source*
Almatti	Y	Y		Y		Increase	Mitigation programme planned. No details.	GOK 1998
Bisalpur	Y	Y		N			The document says that existing health facilities are sufficient for meeting additional health hazards if any.	GOR 1995e.
Malana	Y			Y			A provision of Rs. 6 lakhs has been made in the project to set up a health centre for the 4000 workers during the construction phase. Proper sanitation and human waste disposal system proposed.	WAPCOS 1994
Ramganga	Y	Y	Y				Air and Noise pollution was tremendous. Dust increased occurrence of T.B.	CBIP 1995
Sriramsagar & Lower Manair	Y	Y	Y	Y		Increase	Rs. 120 lakhs allocated for mitigating adverse health impacts.	GOAP 1994
Teesta (Stage V)	Y	Y		Y			Vectors of dengue fever, malaria, gastroenteritis etc.likely to spread.	GOS nd01
Ukai	Y		Y	Y		Increase	Due to bad maintainence and improper management the incidence of water borne diseases like malaria, filariasis and viral hepatitis is very common.	Purohit nd01
Uri	Y					No change	The area is at an altitude and latitude which results in a climate unsuitable for possible disease vectors.	UHPP 1989

ANNEXURE - 3.III

Social Impacts at the Dam, Reservoir, Due to Canals etc. : Climate

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Impacts, if any, of micro climatic changes*	*Source*
Champamati	Y					No adverse climatological changes because of non- impounding of flowing water	Cham nd.
Mahi-Kadana	Y		Y			Increase in average minimum temperature - 0.5^0 C. Decrease in average maximum temperature - 0.25^0 C.	Purohit nd.
Malana	Y					No adverse climatic changes expected.	WAPCOS 1994
Sriramsagar and Lower Manair	Y	Y				Improvement in climate is predicted.	GOAP 1994
Ukai	Y	Y	Y			Mean minimum temperature, relative humidity, rainfall have increased. Mean maximum temperature has fallen.	Purohit nd01
Uri	Y		N				UHPP 1989

ANNEXURE - 3.IV

Social Impacts Downstream: Agricultural Productivity

Dam Name	*Studied (yes/no)*	*Predicted (yes/no)*	*Occurred (yes/no)*	*Mitigation planned (yes/no)*	*Mitigation effective (yes/no)*	*Remarks*	*Source*
Barna	Y		Y			Increased cropping intensity is reported from the Right Bank Canal, while decreased cropping intensity is reported from the left bank canal.	REDECON 1996
Bisalpur	Y	Y				Agricultural productivity not changed and there aren't any commercial crops grown downstream.	CWC 1996 and GOR 1995d.
Mayura-kshi	Y		Y			1. Water use efficiency is very high for paddy crop. The yield of paddy has gone up by over 3 times since 1949-54. 2. Project efficiency at project head is 79.5% and gross irrigated area is 97% of the command area.	WAPCOS 1996a.
Nagarju-nasagar	Y		Y			Agricultural productivity increased in the command area between 1980-90.	Jauhari nd.
Parap-par	Y	Y				Agricultural productivity increased. Additional rice output = 3.17 lakh tonnes. Additional straw = 2.8 lakhs tonnes.	Kabra nd.
Ram-ganga	Y	Y	Y			7500 ha.of low land on both sides are now relieved of floods and can be double cropped.	CBIP 1995
Tawa	Y		Y			In the Tawa command area, irrigation has resulted in lower crop yields.The application of irrigation in the area accentuates soil erosion and drainage problems during kharif season.	Choudhauri nd.
Ukai	Y		Y			Agriclutural productivity increase as well as decrease. 1.Out of about 3 lakh ha. of coastal saline lands (Khar) 22000 ha. lie in the command area of the project and assured water supply can develop 18300 ha. out of that. Under the special employment programme reclamation of Khar lands has been under taken through 3 pilot projects. 2. Due to flood routing at the dam the water flow during monsoon has decreased, and water regulation has adversely affected river bed cultivation and communication across the river 3. The irrigated area comes out to be only 20430 ha., only 5.29% of the expected 386000 ha.	Purohit nd01

ANNEXURE - 3.V

Official Rehabilitation Packages

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
1.	Nizam Sagar	Andhra Pradesh	1931	67445	Total cost of land compensation for the entire project was Rs.350 lakhs. [IIPA nd02]
2.	Tilaiya	Bihar	1953	13455	1. DVC has been following the policy of 'land for land' and 'house for house' for those who opt for them, the rest get cash compensation. Rehabilitated villages have been provided with amenities like roads, pucca wells, community centres, school etc. 2. Houses affected =629. Out of them (a) paid in cash for =500, (b) replaced = 129. 3. Families (a) house for house - 161 (b) given cash for house - 618 (c) given land for land - 847 (d) given cash for land -1065 [Chakravarty 1994]
3.	Tunga-bhadra Dam	Karnataka	1953	54452	Land for colonies was acquired at a cost of Rs.2.86 lakhs. One site not exceeding 0-10 cents for every family for construction of houses, and 0-5 cents for each agriculture family, for a brick yard, was granted free. A subsidy of Rs.1.45 lakhs was sanctioned for construction of schools in rehabilitated colonies. Temples were also constructed. Drinking water facilities have been provided in all the colonies by digging wells at a cost of about Rs.3.32 lakhs. For cultivators who lost lands in the project, 5 acres of government land was granted free wherever available. The scheme cost Rs.1.66 lakhs and the total acreage of land granted to date is 5,763 acres. Lands for burial grounds are being provided at a cost of Rs.27,500. Building material worth Rs.1.16 lakhs has been given free to deserving families. Temporary sheds for poor people were provided at a cost Rs.83,600. Personal effects and other articles of the rehabilitated persons, including building material, have been moved at a cost of Rs.1.68 lakh. [IIPA nd02]
4.	Konar	Bihar	1955	5747	All the four dams Konar, Tilaiya, Maithon, Panchet Hill (D.V.C. Project), when completed, will displace about 78,000 people, 80,000 acres of land and 5,000 houses. In implementing the Rehabilitation Scheme, the Corporation has been following the policy of "land for land" and "house for house", and has arranged for land and houses for those who have opted for them. In other cases cash compensation has been paid. Unfortunately, inspite of every effort, the people affected by the Maithon dam refused to exercise their option for a long time. Fresh efforts were made and a final date was fixed for recording their choice. By that date only 650 families out of a total no. of 4,602 opted for land. Out of these 491families refused to accept the reclaimed land and wanted the same from reserve forests and other areas. The remaining 3,952 families will take cash compensation. Efforts to obtain option from the people affected by the Panchet Project have not borne fruit. [Chakravarty 1994]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	Dam Name	State	Year of Completion	Total Population Affected	Brief Description of The Rehabilitation Package
					Out of a total of 7,365 families only 49 families opted for lands reclaimed by the Corporation, 587 families for culturable waste land to be reclaimed by themselves, 636 families have asked for compensation in kind and the remaining families will be paid outright cash compensation. All the affected families have opted for cash compensation for their houses. Rehabilitated villages have been provided with amenities like roads, pucca wells, community centers, places of worship, schools, playgrounds and parks for children. [Chakravarty 1994]
5.	Lower Bhawani	Tamil Nadu	1955		6732 acres of forest area cleared for resettlement. Land for agricultural purpose may be granted to families equal in extent to the land acquired from them subject to a minimum of 30 acres, of which 5 acres was to be free of cost and the rest on payment. [IIPA nd02]
6.	Hirakud	Orissa	1957	75000	Compensation rates per acre – Bahal type I Rs.600 to 1000, type II Rs.500 to 700, Berna type I Rs.300 to 500, type II Rs.250 to 350, Mal Rs.200 to 350, Bari Rs.300 to 400, Barcha Rs.400 to 600, others Rs.50 to 150. For houses submerged, Rs.3000. According to another source : Area reclaimed for resettlement =10,221 acres, Reclaimed area allotted to settlers = 4,000 acres, Villages in which displaced people have settled = 33, No. of families resettled = 1419 [IIPA nd02]
7.	Maithon	Bihar	1957	28030	The people were offered compensation in kind or cash, according to their preference. The displaced families of Maithon submergence area opted for outright compensation both for their houses and lands. In addition to compensation, 2286 acres of land and one village was set up for rehabilitation. [Chakravarty 1994]
8.	Panchet Hill	Bihar	1959	41461	A total area of 19,296 acres of land was acquired for the Panchet project. In this area, no family opted for replacement of their houses or wanted reclaimed lands in replacement of their cultivated lands. According to another source, almost all have been resettled at a cost of Rs.2.33 crore. [Chakravarty 1994]
9.	Gandhi Sagar Dam	Madhya Pradesh	1960	51514	Cash compensation was awarded for all the properties to be acquired. People who did not want land for land took cash and shifted themselves. A few model villages with all the essential amenities are also being put up for the benefit of the displaced people. [IIPA nd02]
10.	Koyna	Maharashtra	1961	30000	Land of value equal to land acquired for submergence was given from government reserve forest and government waste lands. Oustees were allowed to remove salvageable material from their houses, though acquired and paid for, on a nominal payment of 5% of the salvage value of the acquired houses. Transport charges were given to each family to shift to the new places of resettlement. Facilities for free technical education in polytechnics were extended to promising boys from the affected villages, with assurance of employment on the project. Highest priority was given to affected people for employment on the Project. Amenities like drinking water, primary school etc. were given at Project cost to the new settlements. [IIPA nd02]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
11.	Pipai (Rihand)	Uttar Pradesh	1962	55000	Of the persons dislocated, a large number will be absorbed in the industries in the near and around the dam site. For others, suitable cultivable land available from the govt. estates and other areas in Mirzapur distt. will be cleared. Their houses will be constructed and the cost will be met as far as possible from the compensation due to them for their immovable properties in the reservoir area. Attempts to introduce irrigation and other agricultural facilities e.g. machines, seeds, etc. will be made for new colonies. [GOUP 1947]
12.	Bhadra	Karnatak a	1963	140	Formation of 15 new colonies with well laid out roads, sites, wells, schools, community buildings and temples has been taken up for rehabilitating the displaced villagers. Arrangements have been made to shift the villages free of cost. Villages that get affected due to the seepage water from the canals from the dampness of irrigated lands will also be shifted as an anti-malaria measure. [IIPA nd02]
13.	Bhakara	Himachal Pradesh	1963	36000	Land for land. Those who did not want land were paid partly in cash and partly in land compensation, e.g., houses and trees were paid for in cash. [IIPA nd02]
14.	Shetrunji	Gujarat	1964	8200	Compensation rate of Rs.250/- per acre. Adequate provision for land compensation and rehabilitation was made. The new village sites have been provided with all the necessary amenities like schools, wells, village roads. The rehabilitation is nearly complete. [IIPA nd02]
15.	Vir	Mahara-shtra	1965	6000	Compensation rate - land Rs.729 per acre, Rs.3226 per house. The villages have been shifted above the lake level and all facilities, such as schools, village water supply and public buildings, have been built for the displaced population in addition to payment of normal costs of compulsory acquisition of lands and houses. Alternative lands in lieu of those submerged have been allotted to the affected cultivators. [IIPA nd02]
16.	Ukai Dam	Gujarat	1972	80000	Over Rs.7 crores paid to people as compensation. Out of 170 villages affected, sites of 138 villages were shifted and rehabilitated in 17 groups. They lost social contacts with their relatives living in the unaffected villages. In all, 16,000 families were affected - 8776 agriculture and 7224 non-agriculture. Of the agricultural families, only 5034 received agriculture land. 18 villages of Sagbara taluka were required to be shifted and rehabilitated about 30 km from their original places. But their agricultural lands did not come under submergence. Similarly, agriculturists of villages Kukarmunda, Kondrej and Gorase were rehabilitated on the right bank but land distributed to them were on the L-bank and about 30 km away across the Ukai reservoir. Remaining 3742 agricultural families were not eligible to get agricultural lands at their rehabilitated village sites as either their other lands were saved from submerged or they had availed themselves of adhoc grants for the lands. [IIPA nd02, Purohit nd01]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
17.	Nagarjuna Sagar	Andhra Pradesh	1974	24400	Compensation for houses, structures and agriculture lands. 10% house plots free of cost at the Rehabilitation Centre Agriculture lands at the following scales: (a) Families living by cultivation for 3 years before July'59 and having 2.07 ha. or less, given 2.07 ha (5 acre) free of cost. (b) Families having 2.0 to 4.14 ha. (5 to 10 acre) given 2.07 ha. Free of cost and 1.03 ha. (2.5 acre) at market value. (c) Families having 4.14 to 8.28 (10 to 20 acre) given 2.07 ha. free of cost and 2.07 ha. At market value. (d) Families having more than 8.28 ha. (20 acre) were given 5.15 ha. (12.5 acre) at market value. Ex-gratia compensation for houses and structures submerged, transport charges or free transport by government lorries, loans and grants for the reclamation of the new lands to pattardars of less than 4.14 ha. (10 acre) were provided. An area of 14840 ha. of R.F. dereserved, out of it 6718 ha. (16257 acre) of cultivable land selected for assignment. Facilities provided at the cost of the Project: Drinking water wells at the rate of one well for 50 families, internal roads, approach roads, school,temple. [Rao 1979] The lake (285 sq.km.) displaced 4,824 families (population 24,400) in 44 villages. The area mostly consisted of forest lands and uncultivable tracts. The compensation for land was paid at the market value of the land on the date of the publication of notification and for houses as per the Public Works Department schedule rates during the period. Reserve forests were selected for establishing the rehabilitation centres. Twenty-four rehabilitation centres were established, nine in Guntur district on the right side of the Krishna and the rest in Nalgonda district on the left. The centres were located on hill slopes and on the top of hills particularly to suit the life of tribal families like Lambadas and Chenchoos, who had herds of cattle and sheep. The work of rehabilitation started in 1958 and was completed in 1967. [Rao 1979]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
18.	Pong	Himachal Pradesh	1974	150000	Compensation rate of Rs.1,000 per dwelling, Rs.250 per family. Government decided to set apart an area of 1.32 lakh ha (3.25 lakh acre) in the Rajasthan Canal Command for the resettlement of persons displaced by the Pong dam. The ceiling of allotment will not exceed 6.32 ha (15.62 acre) for a displaced family, artisans labourers, land-less tenants, and the like would be given house sites within the *abadi* areas. The evacuees of the Pong dam in the hills of Himachal were asked to settle in the desert district of Gangangar in Rajasthan. [PDOA 1988 and Mittal 1977]. 77,319 acres acquired between 1961 and 1978 in Punjab and HP at Rs.51.15 crore (March 1978) for the Beas Project (Pandoh and Pong). To rehabilitate the affected families (32,090) 37 colonies (6 in HP and 31 in Rajasthan) were constructed at the cost of Rs. 174.94 lakhs including provision of facilities like drinking water, terracing of lands, irrigation, footpaths and roads, schools, dispensaries, seeds stones, shelter huts. Under Rajasthan Colonisation (Allotment of government land to Pong dam oustees in the Rajasthan Canal Colony) Rules, 1972, a displáced land owner having land upto 20 standard acres or more than 20 standard acres of which 30% or more than 50 per cent or more respectively, had been acquired, was eligible for allotment of 15.625 acres of land at concessional rates. Out of 17,200 eligible displaced persons (16,100 from HP and 1,100 from Punjab), 9,169 allotees, 6,828 actually took possession. The delay in allotment of land and its non-occupation was attributed to : (1) Non-finalisation of allotment rules and criteria of eligibility. (2) Suspension of allotment work between Feb.1975 and Nov.1976 due to non-availability of land. (3) Lack of enthusiasm among displaced persons to shift to Rajasthan. [IIPA nd02]
19.	Phagne and Ujjani	Maharashtra	1975		Compensation rates - *Pawna - Bhagayat* land Rs. 1600, *Jarayat* land Rs. 700, Wasteland Rs. 50 per acre. Rs. 3400 per house submerged. *Ujjaini* - culturable land Rs. 485, Wasteland Rs. 40 per acre. [IIPA nd02]
20.	Tawa	Madhya Pradesh	1975	3070	Rs.500 per acre for cultivation. Rs.150 per acre for uncultivated land. Submergence liabilities involved compensation of Rs.19.36 lakhs against immovable property and Rs.28.68 lakh against government property like forest roads, forest buildings: It forms only 1.6 per cent of the cost of the head works. 599 families were affected and shifted. They were paid rehabilitation grant of Rs.100 per family. Further there is a provision of Rs.51 lakhs for construction of new model villages for rehabilitating them. [IIPA nd02]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
21.	Balimela	Orissa	1977	60000	For cultivation, reclaimed land is given to displaced persons to the extent of 5 acres/family. The land is reclaimed at government cost. In addition a grant of Rs100 / family is given for opening the agricultural land. Oustees are resettled in new villages containing 40 families. Each family is allotted 0.20 cents of land for homestead purpose. In addition, a grant of Rs.3000 is given per family for house building. Shifting-charges for resettling the displaced persons are to be borne by the project. Each new village for resettlement of displaced persons is provided with (1) One school building and one teacher's quarter (2) one recreation centre (3) one tank or well and (4) link roads. [IIPA nd02]
22.	Kamthi-khairy	Maharas-htra	1977	889	Compensation rate - forest land Rs.500/ha. , cultivated land Rs.1200/ha. , Houses - 10% @ Rs.2000, rest @ Rs.500, Wells - Rs.3000. [IIPA nd02]
23.	Pandoh	Himachal Pradesh	1977	150	Same as Pong Dam above.
24.	Aner	Mahar-ashtra	1978		No villages except a few hutments at Malapur were affected. Affected persons to be provided with employment on project works and rehabilitated in the project colony. [IIPA nd02]
25.	Kadana	Gujarat	1979	28470	Land granted upto 2ha. [CBIP 1995]
26.	Loktak	Manipur	1979		Compensation for land (1 ha. Per family), standing crops, ex-gratia etc. given [Kothari 1994]
27.	Narayan-Pur	Karna-taka	1982	48125	Compensation for land was given as follows: (a) Rs. 60,000+.02 ha. house plot to each family having .25 ha. To 3.5 ha., (b) Rs. 40,000+.03 ha. house plot to each family having 3.5 to 6.75 ha., Rs. 20,000+.04 ha. house plot to each family having 6.75 to 10 ha. No additional compensation to families having more than 10 ha. Landless given .5 ha irrigated or 1 ha unirrigated land+house plot of .01 ha. Each family given an ex-gratia amount of Rs. 22,000. Partially displaced families left with less than 1.5 ha. of irrigated land or 3 ha. Of unirrigated land given upto Rs. 20,000, those left with more than 1.5 ha. of irrigated land or 3 ha. of unirrigated land given ex-gratia upto Rs. 5,000 to meet upto 25% of the unit cost of an Income Generating Scheme (IGS) + Bank loan upto Rs.7,500 to meet upto 75% of the unit cost of IGS. Other ex-gratia payment : Family with more than 10 ha. Rs.30,000 for purchase of 1.5 ha. of agricultural land, between 10 to 0.25 ha. Rs.10,000 for purchase of pipe+genset, Dept. of Animal Husbandry to give fodder at cost and Foodgrains for six months to the affected families in resettlement centres at cost. [GOK 1988]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
28.	Bhadar	Gujarat	1984		1. The compensation of land going under submergence paid as per rules fixed by the Dy. Collector. 2, A benefit of min 5 acres cultivable land or cash compensation @ Rs, 2000 per acre to be given to the oustee whose land affected is more than 1/4 of his total land. 3. Farm plots were given to 30 of the total eligible oustees and cash compensation (@Rs.2000 per acre) was paid to 29 of the total eligible oustees. Truck services for transporting salvageable material, durable goods, occupational tools and other miscellaneous household articles was provided [CCPA 1996]
29.	Srisailam	Andhra Pradesh	1984	2342	Compensation rates: Rs.100/acre for wetland, Rs.200 for dryland, Rs.2000 for house, Rs.40 per person displaced. No compensation for parambokes including river parambokes, village sites and forest area. Land equal to the land acquired from oustees but subject to a maximum 5 acres of dry land or 2 acres of wet land given free of cost. Minumum 2 ha. for ST families. Eligibility of only those living on cultivation for 3 years prior to the development. In addition, a subsidy for reclamation of land at Rs.100 per family. Rehabilitation centres provided by the government. At such centres, 10 cents of land for house building given free per family to those whose lands acquired and 5 cents per family to those whose lands not acquired. Transport charges for shifting paid at specified mileage rates. Wells, approach roads, internal roads, drains, school buildings, temples, etc. are provided in the rehabilitation centres. No compensation paid to those cultivating govt. wastelands. While an acre of wetland fetched Rs.14000, the govt. paid Rs.2332, Dryland fetched Rs.5000 but the govt. Paid Rs.932. In some cases the displaced received as low as Rs.600 for wetland. [Source: IIPA nd02 and Choudhry et al. 1985]
30.	Sriram-sagar and Lower Manair	Andhra Pradesh	1985	75090	(A) Physical rehabilitation method (PRM) - Followed in initial stage of project (provided only to 17% of oustees) : 1. Each displaced family (DF) shall be granted , free of cost, land equal to the extent acquired, subject to a maximum of 2 ha. of dry land or 0.8 ha. Of wet land. No further land would be assigned. even on payment of market value. 3. The DFs wishing to resettle in the govt. rehab. centres will get 10 cents of land there, free of cost, as house site (landed) and 5 cents (for landless). 4. Those DFs who want to resettle. elsewhere would get cash grant of Rs. 500 per family. In cases where lands but no properties were acquired, a cash grant equivalent to 50% of the property compensation, subject to a minimum of Rs.500 and a maximum of Rs.2000. (B) Cash grant method (GM) – followed after 1978. (C) None of DFs of the lower Manair dam got physical rehabilitation. (D) Other facilities provided : Drinking water, community hall, temple, school building and free transport for shifting men and material to rehab. centres. [GOAP 1994]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
31.	Upper Kolab	Orissa	1986	8475	2173 families from 40 villages displaced with a population of 8475. Village with low cost, but good houses were to be set up with all modem amenities like hospitals, schools, community centres etc. The houses were to be first constructed by the project and later sold to the displaced persons at the construction price. Each village was to be connected to the nearest major road by all weather roads. Land cost was taken from the actual sale deed in the locality on or before the 4(I) notification. Additional market value of land @12% per year for 3 years was included in the estimate. 30% extra was taken towards solatium in the estimate. Land rent for 25 years was also added in the estimate. The cost of compensation of different trees was paid to the displaced families. Miscellaneous unspecific species having firewood value were paid on the basis of cart loads. Besides land, compensation paid for houses, wells, tanks etc. submerged. The norms followed for Rengali Project made applicable to Upper Kolab Project. 18,995 acres of forest land was submerged in the reservoir in 27 villages. Each displaced family given homestead land to the extent of 0.30 acres free of cost depending on the availability of land. The cost of development of the house sites and village layout to be borne by the Government. Subsequently ceiling raised to 0.50 Acres. Oustees eligible to get 3.00 acres irrigated or 6.00 acres unirrigated land if they were landless or possessed land upto 6.00 acres. For land over 6.00 acres option given to take compensation or reclaimed land free of salami in lieu thereof, subject to ceiling under the Land Reforms Act. For allotment of land in lieu of compensation, 1.00 acre of irrigated land was to be taken as equivalent to 2.00 acres of unirrigated land. This principle extended to recorded encroachers. Cost of reclamation of land borne by Government upto max. Rs. 960.00 per acre, excluding compensatory afforestation. Land to be allotted free of salami but 50 % reclamation cost to be borne by oustees upto max. Rs. 300.00 per acre for submerged land for which compensation paid. If oustee got more than Rs. 50,000.00 as compensation, he was to pay the full reclamation cost. Further, if the reclamation cost exceeds Rs. 960.00 per acre, the extras were to be paid by the displaced persons. Displaced families who opt for resettlement in existing revenue villages were to be allotted 6.00 acres of unirrigated land including reclamation cost of Rs. 300.00 per acre if required. Displaced families were to be provided facilities of free transportation of building materials, which could be salvaged to the new colonies. House building materials were to be supplied by the Forest Department form the near by Khesra or reserved forests at single royalty at tenants rate applicable for Khesra forests. Necessary guidance to build low cost houses with fireproof roofing was to be provided.

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
					Facilities of loans under low income group housing/village housing scheme were also to be extended to new resettlement colonies. Common facilities e.g. village roads, schools, drinking water wells, tanks for general purpose use, community buildings, etc. were to be provided at project cost. Facilities for Gochar, community facilities and electricity were to be provided in the rehabilitation colonies. In calculating compensation, there was to be no deduction towards depreciation on buildings, wells and tanks. Compensation for fruit bearing mango trees was to be Rs. 150.00 including 15% solatium charges. Compensation was to be paid for structures of other departments on government land if they were submerged, since these were to be rebuilt in the rehabilitation areas. No compensation was to be paid for the land. Drinking water wells and tanks were to be constructed as per the following: upto 44 families – one well, 45 to 70 families - two wells, 75 to 100 families - three wells. One tank was to be constructed for each village irrespective of number of families. Where the families were of smaller sizes, smaller tanks would be constructed. It was also decided by Government to provide the following scale of common facilities in respect of schools and club houses to the displaced persons in the colonies: a) One two roomed school for the villages with less than 50 families, b) each village was to have a club house. Preliminary assessment also revealed that about 25% people would be interested to move in to rehabilitation camps.. Out of the total land handed over for rehabilitation camps, 7000 acres were forest land handed over by Divisional Forest Officer, Nowrangpur. i. For 830 families in 16 camps = Rs 45,62,025.00, ii. For 500 families in 10 camps = 27, 78,750.00. Total families (i+ii) = 1330 in 26 camps (i+ii) , Total Rs. (i+ii) = 73,40,775.00. As these provisions were found to be inadequate revised estimates were submitted to Government for approval. Revised administrative approval was accorded by Government for Rs. 1,25,78,780.00 for 1185 families in 7 camps out of which 6 were in Batasana and one in Nuagoan circle. Administrative approval was also accorded by Government for Rs. 40,00,000.00 for 400 families in 6 camps in Boriguma circle. However, these works were to be taken up only if needed. Actual reclamation works were initially started by an organisation of government of India, Reclamation and Rehabilitation Organisation, who were working in the Dandakaranya area. But they could complete reclamation work in only 1348 acres between May 1979 and June 1980. As their unit was transferred elsewhere, the balance works were executed manually through various agencies. The rehabilitation advisory committee recommended to government to pay full cash grant @Rs.2160.00 per acre for 6.50 acres

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
					amounting to Rs. 14040.00 per family as it was felt that most of the families would opt for self rehabilitation. Previously, government had accepted the principle of full cash grant in Rengali Project where Sufficient land was not available for reclamation and rehabilitation partial cash grant and partial land allotment was also recommended as a workable solution. The landless families were to be allotted 1.25 acres of irrigated or 2.50 acres of unirrigated land. For displaced families losing land upto 6.00 acres, the allotment was to be 75% land lost subject to a minimum of 1.25 acres of irrigated land or 2.50 acres of dry land and maximum of 2.50 acres irrigated and 4.50 acres dry land. It was seceded by Government to pay full cash grant @Rs. 14040.00 per family to those persons who opted for self rehabilitation, and for those villages who were located within EL 850.00 m. Total villages affected = 49, Total families affected = 2897, total land located 1026.18 to 378 family, total amount paid Rs.3,69,61,632.00 to 2509 families, Total families Benefited 2889. Seven rehabilitation camps were earmarked to accommodate 1125 families by reclaiming forest land. Even though a number of tanks, wells and tube wells were dug, the problems of water scarcity remained in some camps particularly in camp no. 4 where maximum numbers of displaced families were residing. Most of the tanks and wells in the rehabilitation camps were going dry by February-March every year. In camp no.4, special arrangements were made for providing water supply arrangements by installing a diesel pump on the bank of river Indravati, which is only 2 km. away from the camp. Attempts are to be made for digging 2 to 3 tube wells in this camp but not successful due to low water table. May succeed after a few trials. Similar tube wells are also required in camp no. 7. The water scarcity problems are likely to continue for some more years till the irrigation canals in the vicinity are commissioned to provide irrigation to the ayacut. Some displaced families lost their land located above the F.R.L. of the reservoir after shifting to other areas but compensations were not paid for such land. [GOO 1988]
32.	Upper Indravati	Orissa	1993	26180	1. Affected family given 1 ha. Of irrigated land or 2 ha. of unirrigated land or Rs. 18250. The compensations for fully and partially displaced were equal. 2. A total of Rs.19.05 crores have disbursed by 31/01/1994. 3. Out of 5236 families, 3150 families have received maintenance allowance, totalling to Rs. 1.09 crores till 31/01/1994. 4. The resettlement areas totally dry, hilly and unsuitable for cultivation. 5. Valuation of land was not based on replacement value. 6. Tribals survive on shifting cultivation and natural resources. No compensation for them. 7. 14 villages deprived of benefits. 8. Other compensation is Rs.500 per month per family for one year. [UPIND nd]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
33.	Almatti	Karnataka	Ongoing	200000	Same as Narayanpur above
34.	Amarja	Karnataka	Ongoing	1560	Compensation at the rate of Rs. 100 per house and Rs. 1000 per acre land. [IIPA nd02]
35.	Bagh		Ongoing		Suitable lands for locating new villages would be fixed in the command area. As far as possible displaced people would be given land for land. Compensation rate - Rs. 175 per acre. [IIPA nd02]
36.	Bargi	Madhya Pradesh	Ongoing	37725	Rehabilitation grant of Rs. 2700 to each family. In addition, 1. Employment to 8000 to 10000 displaced persons on the project. 2. Financial assistance for self employment under IRDP, ILEG, JRY etc. 3. Grant of fishing rights in the reservoirs to the oustees. [IIPA nd02]
37.	Bisalpur	Rajasthan	Ongoing	57138	1. Cash compensation for agricultural land upto a max. 1.6 ha. Oustees with more land to be given land in the command area of the IGNP upto 6.32 ha. River bed cultivators would be given double the land cultivated. 2. The cash compensation for homestead: Rs. 10,000 maximum (actual compensation between Rs. 15,000 to Rs. 22,000). Free house plots given to each family along with cash. 3. Provision made for creating grazing land at rehabilitation colonies. 4. Provision for constructing cultural/ religious sites at rehabilitation colonies using compensation paid for existing structures, through panchayat. 5. Proposal for civic amenities like roads, schools, hand pumps etc. at rehab. Colonies. 6. Compensation for wells between Rs. 10,000 and 15000 (average taken). 7. Free transportation of household goods for oustees whose property costs less than Rs. 25,000. 8. Loans and grants-in-aid for land development. [Bsl nd]
38.	Chamera	Himachal Pradesh	Ongoing		Each family paid Rs. 20,000 for agricultural land and Rs. 35,000 for houses. A grant for land development of Rs. 10,000 to each family. Compensation for houses and structures and other immovable properties given at prevailing market rates. [Naidu 1994]
39.	Isapur	Mahara-shtra	Ongoing	16940	Agricultural land Rs.600 per acre. [IIPA nd02]
40.	Jakham	Rajasthan	Ongoing	335	No compensation for government forest land. Oustees would be rehabilitated in the culturable wasteland available in the command area. [IIPA nd02]
41.	Majal-gaon	Mahara-shtra	Ongoing	65296	1. Total cash compensation paid = Rs. 1642 lakhs. Average compensation for agricultural land to each family = Rs. 11500, for houses Rs. 105. Housing loans of Rs. 5000 per family to land holders. Rs. 2000 per family to landless. 2. Other facilities provided (a. free transport, (b. concessional rates for cement bags and CGI sheets, (c. Installation of *gobar gas* plants and free plantations under social forestry, (d. loans for IGS. [CWC1996]

Annexure 3.V (Contd...)

Annexure 3.V (Contd...)

Sno.	*Dam Name*	*State*	*Year of Completion*	*Total Population Affected*	*Brief Description of The Rehabilitation Package*
42.	Ozarkhea	Maharashtra	Ongoing	1354	Cost of shifting to new location Rs.50 per head and Rs.10 for revenue establishment charges. Compensation rates – *bagayat* land: varying from Rs.330 to Rs.1750 per acre depending on location, *jerayat* land: varying from Rs.37 to Rs.52 [IIPA nd02]
43.	Pochampad	Andhra Pradesh	Ongoing		The Govt. has agreed to provide a max. of 5 acres of dry land or 2 acres of wetland free of cost to the displaced families, subject to the limit of their earlier holdings. In addition, free land for house sites, free transport facilities for shifting and cash payment for land levelling are also provided. Construction of school, panchayat ghar , roads, wells and places of worship is also being provided at new centres, at project cost. [Reddy 1970]
44.	Rengali	Orissa	Ongoing	4015	1. Out of 9585 families affected, govt. has rehabilitated 9384 families in 61 large and 92 small villages. 104 ponds, 205 wells, 151 tubewells, 81 primary schools, 33 higher primary schools, 6 high schools, 69 community clubs, approach roads, weekly markets and shops constructed in these villages. 2. Land encroached by the displaced people settled in their favour and compensation paid. 3. Valuation of houses done on the basis of original costs of construction without considering depreciation. 4. Permanent trees and other immovable properties compensated. 5. All displaced people rehabilitated in groups of households in nearby vacant govt. land in their respective home districts. Due weightage given to their option in selection of sites for rehab. 6. Compensation paid in cash for land, house and other immovable properties submerged. 7. But as land for all displaced persons could not be found, 2499 families were paid Rs.14040/- each in lieu of 0.5 acres of homestead land and 6 acres of unirrigated or 3 acres of irrigated agricultural land. [Behura 1987]
45.	Srinagar	Uttar Pradesh	On going	343	Cash compensation for land, structures and all other assets+ provision of one job/family.(i.e.59 jobs) [Goodland 1987]
46.	Tipaimukh	Mizoram	Ongoing		1. As plain land in hill districts of Manipur is scarce, horticulture land @ 5.34 ha in place of 1.5 ha agricultural land was provided 2. Atleast one medical sub-centre to be provided for each rehabilitated village 3. All acquisition to be done upto EL 174 metres, beyond which submergence will not exceed. All villages situated below EL 180 metres will be rehabilitated. [GOI 1995]
47.	Warna	Maharashtra	Ongoing	7906	Compensation rates: Waste land Rs.50, Jirayat land Rs.300, Bagayat lands Rs.1000, Tari land Rs.800, land under submergence at Weir site Rs.300, per acre. House and temple Rs.500 per number. [IIPA nd02]
	Total			1216789	

ANNEXURE - 3.VI

List of Large Dams with Population Affected and Area of Submergence

S.No.	*Dam Name*	*State*	*Year Of Completion*	*Total Area Submerged (Hectares)*	*Forest Area Submerged (Hectares)*	*Total Population Displaced*	*Additional Forest Land * (Hectares)*	*Source*
1.	Alandi	Maharashtra		440				CBIP 1979
2.	Aliyar	Tamil Nadu	1962	650				CBIP 1987b
3.	Almatti	Karnataka		79,020	532	200,000		GOK 1998, IIPA nd01
4.	Amaravathi	Tamil Nadu	1958	850				CBIP 1987b
5.	Amarja	Karnataka		641		1,560		CBIP 1979, IIPA nd01
6.	Aner	Maharashtra	1978	800	690			CBIP 1987b, IIPA nd01
7.	Avalanche	Tamil Nadu	1961	806				CBIP 1987b
8.	Badua	Bihar	1965	850				CBIP 1987b
9.	Bagh			3,900	1,640	1,374		IIPA nd01
10.	Baira	Himachal Pradesh	1981	15				CBIP 1998
11.	Balimela	Orissa	1977	16,900		60,000		CBIP 1987b, IIPA nd01
12.	Barewadi	Maharashtra	1982	22				CBIP 1998
13.	Bargi	Madhya Pradesh		30,860	8,478	37,725		CWC 1996
14.	Bariarpur	Madhya Pradesh		3,078	119	3,000		CWC 1996
15.	Barna	Madhya Pradesh	1976	7,700				CBIP 1987b
16.	Bennithora	Karnataka		2,132		3,000		CBIP 1979, IIPA nd01
17.	Bhadra	Karnataka	1963	11,700	11,000	140		CBIP 1987b, IIPA nd01
18.	Bhakara	Himachal Pradesh	1963	16,835	5,750	36,000		CBIP 1987b, IIPA nd01
19.	Bhatghar	Maharashtra	1927	3,800				CBIP 1987b
20.	Bhatsa	Maharashtra		2,700	2,460	665		CBIP 1979, IIPA nd01
21.	Bisalpur	Rajasthan		21,836	358	57,138		GOR 1995, GOR 1995b
22.	Bodhghat	Madhya Pradesh				12,700		CWC 1996
23.	Bommanahalli	Karnataka		1,900				CBIP 1979
24.	Burai	Maharashtra	1984	243				CBIP 1998
25.	Chakra	Karnataka		1,150				CBIP 1979

Annexure 3.VI (Contd...)

* Used for the project, excluding area submerged.

Annexure 3.VI (Contd...)

S.No.	Dam Name	State	Year Of Completion	Total Area Submerged (Hectares)	Forest Area Submerged (Hectares)	Total Population Displaced	Additional Forest Land ' (Hectares)	Source
26.	Chamaraja Sagar	Karnataka	1934	647				CBIP 1987b
27.	Chamera	Himachal Pradesh		1,270	983			Naidu 1994
28.	Chandan	Bihar	1972	1,080				CBIP 1987b
29.	Chandil	Bihar	1995	17,409	1,060	48,500		Upadhyay 1994
30.	Damanganga	Gujarat	1989	4,368	1,199	11,805		CWC 1996
31.	Dantiwada	Gujarat	1965	4,200				CBIP 1987b
32.	Dhom	Maharashtra	1978	2,400		19,735		CBIP 1987b, IIPA nd01
33.	Dhamni	Maharashtra		1,615				CBIP 1979
34.	Dhanegaon	Maharashtra		4,390				CBIP 1979
35.	Dharoi	Gujarat	1978	10,745				CBIP 1987b
36.	Dimbhe	Maharashtra		2,272	70	6,824		CBIP 1979, CWC 1996, IIPA nd01
37.	Donkarayi	Andhra Pradesh		2,806				CBIP 1979
38.	Dudh Ganga	Maharashtra	1989	4,030				CBIP 1998
39.	Emerald	Tamil Nadu	1961	806				CBIP 1987b
40.	Eravangalar	Tamil Nadu	1978	2,900				CBIP 1998
41.	Forebay Dam	Andhra Pradesh	1978	137				CBIP 1987b
42.	Gandhi Sagar Dam	Madhya Pradesh	1960	72,300	3,302	51,514		CBIP 1987a, CBIP 1987b, IIPA nd01
43.	Gatana	Tamil Nadu	1974	80				CBIP 1987b
44.	Girna	Maharashtra	1970	5,483				CBIP 1998
45.	Glenmorjan	Tamil Nadu	1930	17				CBIP 1998
46.	Haranbari	Maharashtra	1980	514				CBIP 1998
47.	Harangi	Karnataka	1981	1,900		40		CBIP 1987b, IIPA nd01
48.	Hasdeo-Bango	Madhya Pradesh	1992	21,279	10,250	13,585	42	CWC 1991, CWC 1996
49.	Hemavathy			8,500		11,600		IIPA nd01
50.	Heran/Lalpur	Gujarat		17,720	200	21,210		IIPA nd01
51.	Hidkal Dam	Karnataka	1979	7,100		31,133		CBIP 1987b, IIPA nd01
52.	High Ways	Tamil Nadu	1978	2,850				CBIP 1998
53.	Himayatsagar	Andhra Pradesh	1927	20				CBIP 1998
54.	Hirakud	Orissa	1957	72,700	28,000	75,000	14600	CBIP 1987b, CWINC 1947, IIPA nd01
55.	Ibadoh			6,020	3,840	2,258		IIPA nd01
56.	Icha	Bihar				30,800		Upadhyay 1994
57.	Ichampalli					38,100		CWC 1996

Annexure 3.VI (Contd...)

Annexure 3.VI (Contd...)

S.No.	Dam Name	State	Year Of Completion	Total Area Submerged (Hectares)	Forest Area Submerged (Hectares)	Total Population Displaced	Additional Forest Land* (Hectares)	Source
58.	Ichari	Uttar Pradesh	1975	100				CBIP 1987b
59.	Idukki	Kerala	1974	6,000				CBIP 1987b
60.	Isapur	Maharashtra		9,830		16,940		CBIP 1979, GOM 1994, IIPA nd01
61.	Itiadoh	Maharashtra	1977	6,350				CBIP 1987b
62.	Jaisamand Tank	Rajasthan	1730	7,200				CBIP 1987b
63.	Jakham	Rajasthan		10,150	6,460	335		IIPA nd01
64.	Jalaput	Andhra Pradesh	1961	9,113				CBIP 1987b
65.	Jamrani	Uttar Pradesh	1982	450	176	1,500		EAC 1990
66.	Jawahar Sagar	Rajasthan	1973	2,258		610		CBIP 1987b
67.	Kabini	Karnataka	1974	6,100	2,690	11,250		CBIP 1987b, IIPA nd01
68.	Kadana	Gujarat	1979	16,600	7,750	28,470		CBIP 1987b, IIPA nd01
69.	Kaddam	Andhra Pradesh	1965	2,500				CBIP 1987b
70.	Kaketo	Madhya Pradesh	1934	890				CBIP 1998
71.	Kalyani	Andhra Pradesh	1977	225				CBIP 1998
72.	Kamthikhairy	Maharashtra	1977	2,330	2,330	889		CBIP 1987b, IIPA nd01
73.	Kangsabati-Kumari	West Bengal	1975	13,500				CBIP 1998
74.	Kanher	Maharashtra		2,014		7,080		CBIP 1979, IIPA nd01
75.	Kanholi	Maharashtra	1978	333				CBIP 1987b
76.	Karanjwan	Maharashtra	1975	1,820		1,600		CBIP 1979, IIPA nd01
77.	Karjan	Gujarat		3,994	1,405	8,025		CWC 1996
78.	Karuppanadhi	Tamil Nadu	1977	50				CBIP 1987b
79.	Katepurna	Maharashtra	1973	1,200				CBIP 1987b
80.	Kayadhu			7,530		8,857		IIPA nd01
81.	Kelo Irrigation Project	Madhya Pradesh		3,116	708	7,336	93	EAC Aug1990
82.	Khadakwasla	Maharashtra	1879	1,554				CBIP 1987b
83.	Kodayar Dam I	Tamil Nadu	1972	830				CBIP 1987b
84.	Kodayar Dam Ii	Tamil Nadu	1972	4,180				CBIP 1987b
85.	Koel Karo					66,000		CWC 1996
86.	Kolkewadi	Maharashtra	1975	167				CBIP 1987b
87.	Konar	Bihar	1955	2,800		5,747		CBIP 1987b, Chakravorty 1994, IIPA nd01
88.	Koteshwar	Uttar Pradesh		456	379		77	Kot nd

Annexure 3.VI (Contd...)

Annexure 3.VI (Contd...)

S.No.	Dam Name	State	Year Of Completion	Total Area Submerged (Hectares)	Forest Area Submerged (Hectares)	Total Population Displaced	Additional Forest Land * (Hectares)	Source
89.	Koyna	Maharashtra	1961	11,535		30,000		CBIP 1987b, IIPA nd01
90.	Krishnaraja Sagar Dam	Karnataka	1932	12,900		15,000		CBIP 1987b, IIPA nd01
91.	Kuttiyadi	Kerala		1,100				CBIP 1979
92.	Lakhwar	Uttar Pradesh		965				CBIP 1979
93.	Loktak	Manipur		257	27			GOM 1992
94.	Lower Bhawani	Tamil Nadu	1955	7,876				CBIP 1987b
95.	Lower Nirar	Tamil Nadu	1982	52				CBIP 1987b
96.	Lower Wunna	Maharashtra		6,275	131	12,650		EAC Aug1990
97.	Machhundri	Gujarat	1984	447				CBIP 1987b
98.	Mahanadi	Madhya Pradesh	1979	9,500				CBIP 1987b
99.	Maheshwar	Madhya Pradesh				20,000		CWC 1996
100.	Mahi Bajaj Sagar	Rajasthan		13,300	450	34,875		CBIP 1979, IIPA nd01
101.	Maithon	Bihar	1957	10,700		28,030		CBIP 1987b, IIPA nd01
102.	Majalgaon	Maharashtra		8,080		65,296		CBIP 1979, IIPA nd01
103.	Malampuzha	Kerala	1966	2,483				CBIP 1987b
104.	Malana	Himachal Pradesh		18	18		36	WAPCOS 1994
105.	Malaprabha	Karnataka	1973	12,950				CBIP 1987b
106.	Manalar	Tamil Nadu	1978	31				CBIP 1998
107.	Manchanabele Reservoir	Karnataka		328				CBIP 1979
108.	Mani	Karnataka		5,700				CBIP 1979
109.	Manikdoh	Maharashtra	1983	18,430				CBIP 1998
110.	Manimuthar	Tamil Nadu	1958	940				CBIP 1987b
111.	Masan					20,000		CWC 1996
112.	Massanjore	Bihar	1955	6,950				CBIP 1987b
113.	Matatila	Uttar Pradesh	1958	14,243		7,500		CBIP 1987b, IIPA nd01
114.	Meja	Uttar Pradesh	1989	3,173	2,688			EAC 1990
115.	Mettur (Stanley)	Tamil Nadu	1934	15,346				CBIP 1987b
116.	Middle Vaitarna Dam	Maharashtra		673	528	71,972		Badrinath et. al. 1991
117.	Mukurthi	Tamil Nadu	1938	337				CBIP 1987b
118.	Mula	Maharashtra	1974	5,358				CBIP 1987b
119.	Nagarjunasagar	Andhra Pradesh	1974	28,500	5,000	24,400	14545	CBIP 1987b, Jauhari nd, IIPA nd01

Annexure 3.VI (Contd...)

Annexure 3.VI (Contd...)

S.No.	Dam Name	State	Year Of Completion	Total Area Submerged (Hectares)	Forest Area Submerged (Hectares)	Total Population Displaced	Additional Forest Land * (Hectares)	Source
120.	Narayanpur	Karnataka	1982	13,200		48,125		CBIP 1987b, IIPA nd01
121.	Narihalla Reservoir	Karnataka		279				CBIP 1979
122.	Narmada Sagar	Madhya Pradesh	Ongoing	91,348	40,332	82,120		NVDA 1996, NCA 1992, KV 1988
123.	Natubari	Maharashtra	1984	20,810				CBIP 1998
124.	Neyyar	Kerala	1973	907				CBIP 1987b
125.	Nirguna	Maharashtra	1977	430				CBIP 1987b
126.	Nizam Sagar	Andhra Pradesh	1931	12,950	6,130	67,445		CBIP 1998, GOAP 1965
127.	Obra	Uttar Pradesh	1972	1,859				CBIP 1987b
128.	Osman Sagar	Andhra Pradesh	1920	2,480				CBIP 1998
129.	Ozarkhed	Maharashtra		740		1,354		CBIP 1979, IIPA nd01
130.	Paithan	Maharashtra	1976	39,761		490		CBIP 1987b, IIPA nd01
131.	Palar Porandalar	Tamil Nadu	1978	518				CBIP 1987b
132.	Palkhed	Maharashtra		561		1,716		GOM 1971
133.	Panchet Hill	Bihar	1959	15,300		41,461		CBIP 1987b, IIPA nd01
134.	Pandoh	Himachal Pradesh	1977	123	70	150		CBIP 1987b, IIPA nd01
135.	Papavinasanam	Andhra Pradesh	1985	760				CBIP 1998
136	Parambikulam	Tamil Nadu	1967	2,072				CBIP 1987b
137.	Parappalar	Tamil Nadu	1974	115				CBIP 1987b
138.	Parappar	Kerala		2,000				CBIP 1979
139.	Parsons Valley	Tamil Nadu	1966	167				CBIP 1987b
140.	Pawna	Maharashtra	1976	2,300				CBIP 1987b
141.	Peechi	Kerala	1959	1,295				CBIP 1987b
142.	Peechiparai	Tamil Nadu	1906	1,515				CBIP 1987b
143.	Pegumbahalla	Tamil Nadu	1965	6				CBIP 1987b
144.	Periyar	Tamil Nadu	1897	2,900				CBIP 1987b
145.	Perunchani	Tamil Nadu	1952	962				CBIP 1987b
146.	Pillur	Tamil Nadu	1967	260				CBIP 1998
147.	Pimpar	Maharashtra	1985	1,678				CBIP 1998
148.	Pocharam	Andhra Pradesh	1922	1,684				CBIP 1998
149.	Polavaram	Andhra Pradesh		63,691	3,540	154,484		Pol nd, Rao et. al. nd
150.	Pong	Himachal Pradesh	1974	26,000		20,722		CBIP 1987b, IIPA nd01
151.	Porthimund	Tamil Nadu	1966	284				CBIP 1987b

Annexure 3.VI (Contd...)

Annexure 3.VI (Contd...)

S.No.	Dam Name	State	Year Of Completion	Total Area Submerged (Hectares)	Forest Area Submerged (Hectares)	Total Population Displaced	Additional Forest Land * (Hectares)	Source
152.	Pus	Maharashtra	1972	800	240			CBIP 1987b, IIPA nd01
153.	Puyamkutty	Kerala		5,000	5,000	300,000		Zacharia nd, Swaminathan nd
154.	Pykara	Tamil Nadu	1935	4,540				CBIP 1998
155.	Radhanagri	Maharashtra	1954	1,800				CBIP 1987b
156.	Rajghat	Uttar Pradesh And Madhya Pradesh		23,390	990			Shah nd
157.	Ramanadhi	Tamil Nadu	1974	39				CBIP 1987b
158.	Ramganga	Uttar Pradesh	1978	7,831	6,720	0	2365	CBIP 1987b, Anonymous 1990, Goel 1993
159.	Rana Pratap Sagar	Rajasthan	1967	19,800		12,500		CBIP 1987a, CBIP 1987b
160.	Raval	Gujarat	1978	246				CBIP 1987b
161.	Rengali	Orissa		2,256	67	4,015	2092	CWC 1997
162.	Gohira Dam (Rengali)	Orissa		35,300				CBIP 1979
163.	Rihand	Uttar Pradesh	1962.	46,600		55,000		CBIP 1987b, IIPA nd01
164.	Salal	Jammu & Kashmir	1987	785				CBIP 1998
165.	Sandy Nallah	Tamil Nadu	1963	254				CBIP 1987b
166.	Sardar Sarovar	Gujarat	Ongoing	39,134	13,744	150,720		NCA 1992, KV 1988
167.	Sathanur	Tamil Nadu	1958	2,010				CBIP 1987b
168.	Savehaklu	Karnataka		950				CBIP 1979
169.	Serlui	Mizoram		2,554	2,554	300	646	EAC Aug1990
170.	Servalar	Tamil Nadu	1986	1,681				CBIP 1998
171.	Sharavathi (Linganamakki)	Karnataka	1965	31,900				CBIP 1987b
172.	Sharavathi (Tail Race Scheme)	Karnataka	Ongoing	596	489			CBIP 1995
173.	Sharavathi (Talakalale)	Karnataka	1964	800				CBIP 1987b
174.	Shetrunji	Gujarat	1964	6,700		8,200		CBIP 1987b, IIPA nd01
175.	Sholayar	Tamil Nadu	1971	526				CBIP 1987b
176.	Sidheshwar	Maharashtra	1968	3,400				CBIP 1987b
177.	Sipu	Gujarat		2,863	317	5,494		CWC 1996
178.	Sirpur	Maharashtra	1975	3,300				CBIP 1987b
179.	Sohira			41,970	31,970	42,000		IIPA nd01

Annexure 3.VI (Contd...)

Annexure 3.VI (Contd...)

S.No.	Dam Name	State	Year Of Completion	Total Area Submerged (Hectares)	Forest Area Submerged (Hectares)	Total Population Displaced	Additional Forest Land * (Hectares)	Source
180.	Sondur	Madhya Pradesh	1989	2,439	2,025	1,510	184	CWC 1996
181.	Srinagar	Uttar Pradesh	Ongoing	350	0	343	66	Goodland 1987
182.	Sriramsagar And Lower Manair	Andhra Pradesh	1985	55,970	84	75,090	14571	CBIP 1987b, Reddy & Reddy nd, GOAP 1994, IIPA nd01
183.	Srisailam	Andhra Pradesh	1984	61,700		2,342		CBIP 1987b, Reddy & Reddy nd
184.	Sukta	Madhya Pradesh	1985	1,206				CBIP 1998
185.	Supa	Karnataka		12,900				CBIP 1979
186.	Tanaji Sagar	Maharashtra	1971	1,500				CBIP 1987b
187.	Taraka Reservoir	Karnataka		1,100				CBIP 1979
188.	Tawa	Madhya Pradesh	1975	20,200	15,770	3,070		CBIP 1987b, Caprihan 1974, IIPA nd01
189.	Teesta	Sikkim	Ongoing	68	49	1,020		GOS nd01, Tees nd
190.	Tehri	Uttar Pradesh	Ongoing	4,200	2,583	70,990		Tehri 1997
191.	Tenughat	Bihar	1981	6,362				CBIP 1987b
192.	Thambraparani	Tamil Nadu	1943	580				CBIP 1987b
193.	Thandava	Andhra Pradesh	1974	1,866				CBIP 1998
194.	Thein	Punjab		8,300				CBIP 1979
195.	Thirumurthi	Tamil Nadu	1967	389				CBIP 1987b
196.	Tilaiya	Bihar	1953	7,500		13,455		CBIP 1987b, IIPA nd01
197.	Tillari	Maharashtra And Goa	1998			4,274		CWC 1998
198.	Tipaimukh	Mizoram		50,100	19,000		1000	GOI 1995
199.	Totladoh	Maharashtra		7,750				CBIP 1979
200.	Tuttuli					13,600		CWC 1997
201.	Tungabhadra Dam	Karnataka	1953	37,800		54,452		CBIP 1987b, IIPA nd01
202.	Ujjani	Maharashtra	1980	33,650		35,069		CBIP 1998, IIPA nd01
203.	Ukai Dam	Gujarat	1972	60,100	31,000	80,000		CBIP 1987b, Purohit nd01, IIPA nd01
204.	Upper Bhawani	Tamil Nadu	1965	455				CBIP 1987b
205.	Upper Indravati	Orissa		11,000	1,655		26630	CWC 1998
206.	Upper Kolab	Orissa	1986	11,432	76	8,475	2800	CBIP 1987b
207.	Upper Mullamari Reservoir	Karnataka		2,800		750		CBIP 1979, IIPA nd01
208.	Upper Penganga	Maharashtra		9,845	189	16,940		GOM 1994

Annexure 3.VI (Contd...)

Annexure 3.VI (Contd...)

S.No.	Dam Name	State	Year Of Completion	Total Area Submerged (Hectares)	Forest Area Submerged (Hectares)	Total Population Displaced	Additional Forest Land * (Hectares)	Source
209.	Upper Wain Ganga	Madhya Pradesh	1990	5,603	228	6,435		CWC 1996
210.	Upper Wardha	Maharashtra		11,362	1,181	11,817	124	IIPA nd01
211.	Uri	Jammu & Kashmir		266		1,000	54	UHPP 1989
212.	Vaigai	Tamil Nadu	1959	2,419				CBIP 1987b
213.	Vani Vilasa Sagar Dam	Karnataka	1908	8,800		160		CBIP 1987b, IIPA nd01
214.	Vir	Maharashtra	1965	420		6,000		CBIP 1987b, IIPA nd01
215.	Waghadi	Maharashtra	1978	658		489		CBIP 1987b, GOM 1971
216.	Waghur	Maharashtra		3,140	297	1,220	319	EAC Aug1990
217.	Warna	Maharashtra		2,900	753	7,906	14	CBIP 1979, IIPA nd01
218.	West Varahapallam	Tamil Nadu	1967	3				CBIP 1987b
219.	Western Catchment No. 2	Tamil Nadu	1966	6				CBIP 1987b
220.	Wilson	Maharashtra	1926	1,600				CBIP 1987b
221.	Yeldari	Maharashtra	1968	10,200		120		CBIP 1987b, IIPA nd01

Note: A Blank Cell Indicates That Data Was Not Available.

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Chapter

2

FINANCIAL, ECONOMIC AND DISTRIBUTIONAL ANALYSIS OF DAMS IN INDIA

Pranab Banerji

INTRODUCTION

This study, sponsored by the World Commission on Dams (WCD), is a part of the WCD's larger study of India's experience with large dams. As per the contract, we have limited our study to Financial, Economic and Distributional Analysis. The terms of reference for this study were:

- Analyse evolution of various approaches, methods and tools for financial, economic and distributional analysis;
- Analyse how financial, economic and distributional analysis served as key tool in assessment of options and decision making;
- What are the key lessons emerging out of India's experience with financial, economic and distributional analysis of costs, benefits, impacts and risks of options;
- Explication of good practices till date in India for more rigorous and comprehensive distributional analysis of costs, benefits, impacts and risks.

The study has focussed on the evolution of appraisal procedures and criteria and on the economic, financial and distributional impact of large irrigation and multipurpose projects. Related issues of planning, decision-making and administration have also been examined to the extent they have impinged upon selection and performance of projects.

The scope of the study had to be limited due to the constraint of time. We have been able to analyse only, what economists call, internal costs and benefits. Externalities, which are extremely important in the case of dams, had to be left out for several reasons. Data on external costs and benefits are not easily available. Picking up whatever is available would run the risk of methodological bias because either some substantial benefits (like recharge of groundwater as claimed by Dhawan) or some large costs (environmental and health) may have got left out. Further, after listing, come the problems of quantification and valuation of externalities. My expertise does not give me the confidence that I could quantify external (environmental and social) costs and benefits. Further, valuation of even some of these items is a major study by itself. Moreover, an accompanying WCD study has examined some, but not all, of the externalities. To the extent that a few externalities have been iternalised over time, they have been included here.

The original methodology proposed was to obtain pre-project and post-project data for a comparative study. A large number of questionnaires seeking this type of information was mailed out. The response was nil. Moreover field data from six case studies also did not become available. Hence we fell back on *(a)* the study of official committee reports and documents; *(b)* survey of existing literature on the subject and *(c)* whatever evaluative or related studies that could be obtained in the short time. Fortunately, the picture that emerged was reasonably consistent and focused.

I. EVOLUTION OF APPRAISAL CRITERIA

At the time of independence, the criteria that was being followed for the appraisal of irrigation projects in India was the profitability criteria which had been designed as far back as 1879 by the Select Committee of the House of Commons. The profit of a given year was the difference between the receipts (direct and indirect) from irrigation projects and the annual costs of the project, comprising of working expenses for the year and a simple interest on the capital cost of the project. If this profit, as a percentage of capital costs plus interest arrears was above a specified rate, only then the project could be cleared for investment. This cut-off profitability rate, at the time of independence, was 6 percent which was reduced in 1949 to 3.75 but raised again in 1954 to 4.5 percent.

The profitability criteria for investment, it was occasionally felt, ignored the many economic benefits that accrue to the economy but do not get reflected in the profitability of the project authorities. As far back as 1901, the Royal Commission on Irrigation deliberated on the issue but finally decided to retain the profitability criteria as the basis for appraisal decision.

The adoption of the financial criteria for irrigation outlay got reflected in the comfortable financial position of the sector. "The net direct revenue earned by canals in undivided India, after deducting the cost of maintenance and operation, represented about 8 per cent of the outlay" (NCAER, 1959). The number of projects were also few with only 9.7 million hectares of potential created by major and medium projects.

After independence, though the criteria remained unchanged till 1964, actual practice reflected increasing flexibility and dilution:

> "Since 1947, the financial productivity test has not been applied very strictly and projects have been sanctioned on the basis of other considerations. But, in such cases, the Government of India has not adopted any uniform principle. Investment decisions are taken on an *ad hoc* basis." (*Ibid.* p. 107).

The relaxation was perhaps necessitated by ambitious development programmes of major and medium projects which led to the doubling of potential created through these projects by mid-1960s. There is also evidence of a number of states pressing for change/relaxation in the appraisal criteria.

The formal shift from the financial to quasi-economic criteria began in the early 1960s with the setting up of a Committee of Direction by the Planning Commission in 1961. The Committee, headed by Prof. D.R. Gadgil, concluded, on the basis of field studies of a number of projects, that there are substantial economic benefits from major and medium irrigation projects in terms of multiple cropping, diversification and better quality crops, higher yields, larger incomes and greater employment, in addition to indirect benefits in industry, trade and transport. Since these benefits accrue to the economy, but not to the project authorities, their neglect under-estimates the benefits from irrigation projects. The committee recommended the inclusion of agricultural benefits in project appraisal but left out, on consideration of simplicity of procedure, non-agricultural benefits. More specifically, benefit was to comprise the difference in the value of gross annual production less the cost of cultivation, before and after the introduction of irrigation. Annual cost comprised of annual interest on capital, depreciation and expenditure on operation and maintenance.

The recommendations of the (Gadgil) Committee received official approval in 1964 after the "Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects" recommended its adoption. The recommendation was that the annual benefit to annual cost ratio should be adopted as the criterion for appraising projects and only those projects where the ratio was at least 1.5 were to be cleared. The definitions of costs and benefits were on the lines suggested by the Gadgil committee and all valuations were made at market prices. The detailed format was as follows:

Format for Calculating Benefit-Cost Ratio

A. Before Introduction of Irrigation	B. After Irrigation
a. Gross Receipts	**a. Gross Receipts**
Gross value of farm produce	Gross value of farm produce
Dung receipts at 30% of the Fodder receipts.	Dung receipts at 30% of the Fodder receipts.
Total Gross Receipts	Total Gross Receipts
b. Expenses	**b. Expenses**
Expenditure on seeds	Expenditure on seeds
Expenditure on manure and fertilizers	Expenditure on manure and fertilizers
Expenditure on hired labour (human and bullock)	Expenditure on hired labour (human and bullock)
Fodder expenses*	Fodder expenses*
Depreciation on implements*	Depreciation on implements*
Share and cash rent*	Share and cash rent*
Land Revenue	Land Revenue
Total Expenses	Total Expenses
c. Net Value of Produce	**c. Net Value of Produce**
Total gross receipts minus total expenses	Total gross receipts minus total expenses

Net Annual Benefit = Difference in the net value of produce before and after irrigation, i.e. (B - A). Annual Costs : 1. Interest on Capital @ 10%; 2. Depreciation; 3. Administrative Expenses.
Benefit-Cost Ratio = Net Annual Benefit / Annual Cost.
* As a percentage of the gross value of produce.
SOURCE: Irrigation Commission (1972), p. 256.

The shift from financial to quasi-economic criteria was not without problems. The Irrigation Commission (1972) noted that this "had certain undesirable effects. It minimises the importance of securing an adequate return from investment on irrigation projects." The Commission recommended that the financial return should also be examined and if the returns do not cover costs, the impact on the irrigation revenues should be examined to decide if an increase in water rates is necessary.

However, the Irrigation Commission did not go far enough as to suggest an additional (financial) criterion for project selection. It, in fact, endorsed the continuation of the annual benefits to annual costs ratio as the basis of appraisal. Some leniency was introduced:

"....this rule (of B-C ratio greater than 1.5) should not be rigidly applied in the case of irrigation projects in drought affected areas ......A lower limit of one for the benefit-cost ratio may be accepted for such projects even if they later prove to be somewhat uneconomical" (p. 253).

While this recommendation would have allowed many new projects to qualify, another recommendation, that of including the costs of command area development, land shaping and construction of field channels, would have worked against easy selection of many projects. While the first recommendation was easily accepted, it took a number of years for the latter to be finally accepted. There was thus further leniency introduced in the selection and appraisal of projects in the 1970s.

Four years later, the National Commission on Agriculture (1976) endorsed the Irrigation Commission's recommendations of widening the definition of costs to include land development, etc. But while the Irrigation Commission had advised against the adoption of the internal rate of return criteria for project selection, the National Commission on Agriculture recommended its use as it would facilitate *inter se* ranking of projects.

Even simple recommendations, like the calculation of IRRs, do not get easily accepted by the bureaucratic system which is extremely resistant to change. Four more years passed, the Ministry of Irrigation's Working Group Report on "Guidelines for Preparation of Detailed Project Reports of Irrigation and Multipurpose Projects" (1980) was still not sure of the meaning and implications of use of IRRs:

> "The Working Group have considered a suggestion that the Benefit Cost Ratio should be calculated with the discounted cash flow techniques or by the Internal Rate of Return method. The Working Group felt that if these are to be followed there would be difficulties in working out economic prices of materials and crops" (p.10).

Clearly, the Working Group confused the issues of internal rate of return calculation (and discounting) with that of economic appraisal. Realising its own limitations regarding the subject, it recommended "the constitution of a committee consisting of representatives of all concerned disciplines to make a review of the existing method of calculating the benefit cost ratio and to indicate whether any changes in the present method are necessary......" Pending such a review, existing procedures were to continue. New projects and expenditures on major and medium projects accelerated in the latter half of 1970s and the issue of reforms in the appraisal procedures and criteria was therefore once again postponed.

However, the Planning Commission did set up a review team as suggested by the Working Group which submitted a very comprehensive set of recommendations in 1983. The "Report of the Committee to Review the Existing Criteria for Working Out the Benefit Cost Ratio for Irrigation Projects" (Desai Committee) ought to have been considered a landmark in appraisal procedures and criteria. To put it briefly, it recommended the replacement of the existing quasi-economic methods by comprehensive economic appraisal techniques and the use of the economic rate of return as the appraisal criteria with a cut-off rate of 9 percent (7 percent for drought prone areas). It also made detailed recommendations regarding the items to be included in costs and in benefits and on the steps to derive economic prices for them. Detailed recommendations were made regarding the manner and the sources from which data are to be collected and on the consequent organisational changes necessary.

The Desai Committee's recommendations were perhaps too revolutionary for a hidebound system. The silence with which they were met was deafening. On the other hand, there was increasing pressure on the Central Government for further relaxation in appraisal procedures. A National Conference on Irrigation and Water Resources Ministers was held in July 1986 which was followed by a meeting of State Secretaries of Irrigation in September, the same year. These meetings led to the setting up of a Group under the Chairman, Central Water Commission to examine the scope for abridgement of existing scrutiny procedures for project clearance.

The Centre resisted further relaxations as it faced pressures from both inside, due to the emerging fiscal crisis, and from outside as environmental groups and project affected people became increasingly vociferous. As the fiscal crisis deepened, the number of projects fell drastically from 435 new projects started in the late seventies (Fifth Plan and Annual Plans) to only 45 new projects started in the Seventh Plan (late eighties). Expenditures, in real terms (1980-81 prices), were however greater in the Seventh Plan, compared to the Fifth Plan, indicating a shift in priorities to see that projects under construction get completed before new projects are sanctioned. (Details in Statement I.1).

There was another reason for rising expenditures in the late 1980s. Faced with an increasingly articulate anti-dam lobby, the government finally began to accept not only some of the recommendations of earlier committees but went beyond to show its sensitiveness to environmentalist's arguments. The net effect was a widening of the definition of project cost. In 1986, the Ministry of Water Resources 'advised' the state governments that "soil conservation, catchment treatment, afforestation and other measures of siltation and maintenance of ecological balance should be viewed together and integrated project report should be formulated" (Annual Report 1986-87, p. 6). Further, project reports "besides containing benefit cost ratio on a single year basis as at present, should also give the Internal Rate of Return" (*Ibid.* p. 24). Additional support for change came from the National Water Policy (1987) which felt that "there should be an integrated and multi-disciplinary approach to planning, formulation, clearance and implementation of projects, including catchment treatment and management, environmental and ecological aspects, the rehabilitation of affected people and command area development" (p.7). In 1988, the Advisory Committee (in the Ministry of Water Resources) to scrutinise projects was expanded to include representatives from the Ministry of Environment and Forests and Ministry of Welfare. Thus, by end of the 1980s and early nineties, some of the social and environmental costs began to be internalised as project costs.

Yet the essential structure of project appraisal has hardly changed since 1964. The quasi-economic criteria of annual benefits to annual costs ratio, both evaluated at market prices and comprising of many rule-of-the-thumb items, continues even though the IRR is also reported and costs now have a broader definition. Since the widening of costs concept would make clearance of projects more difficult, it is possible that there would be pressures to expand the definition of benefits as well. The Central Water Commission is currently working on the preparation of new set of guidelines.

In 1991, following an acute balance of payments crisis, the Government of India had to go in for adjustment loans from the IMF which required, among other things, a reduction in its fiscal deficit. The implication for the irrigation sector were *(a)* subsidies, hidden or open, had to be cut, and *(b)* resources available for capital expenditures would shrink. Finance, once again, became a central issue. To examine issues relating to subsidies, the "Committee on Pricing of Irrigation Water" (Vaidyanathan Committee) was set up which submitted its report in September, 1992. The Committee recommended the re-introduction of a minimum financial return as an essential criterion for sanctioning all investment proposals along with social benefit-cost criteria. The wheel had turned a full circle since 1964.

The Vaidyanathan Committee recommendations were a culmination of the concerns expressed by various committees during 1980s, as the fiscal crisis had grown during the decade. In 1983, the Public Accounts Committee was of the view that irrigation works should yield adequate revenues so as to cover their operation and maintenance costs, depreciation costs and also yield some interest on capital. The 1986 Irrigation Ministers' Conference wanted water rates to be increased gradually to cover rising capital and operation costs. In 1987, the National Water Policy also re-iterated that water rates should not only cover operation and maintenance costs but also a part of the capital costs. Successive Finance Commissions also stressed the need for cost recovery, yet losses continued to mount. The recovery rate (percentage recovery of working expenses through gross irrigation receipts) fell from 93 percent in 1976-77 to 46 percent in 1980-81 and further to a meager 9 percent by the end of eighties. The irrigation sector had become a huge fiscal liability with annual operational losses crossing Rs. 3000 crores in 1993-94. (Details in Statement I.2)

It was inevitable that the possibility of private investment in irrigation would be explored. In 1995, a High Level Committee to study the feasibility of private sector participation in irrigation and multi-purpose projects concluded that such participation is feasible even in surface irrigation and multi-purpose projects and should be introduced on a pilot basis in non-sensitive areas. The Ninth Plan document informs that some states have initiated action for privatisation of irrigation projects: "These projects are envisaged for privatisation on Build-Own-Operate (BOO), or Build-Own-Operate-Transfer (BOOT) or Build-Own-Lease (BOL) basis. In the case of Projects on BOO basis, the irrigation Department may buy water in bulk from the agency at mutually agreed price for distribution to farmers" (p. 487). In addition there are cases of corporatisation of Irrigation Project Authorities to enable them to raise resources from financial and capital markets. The Achilles heel of the irrigation power structure - gross financial mismanagement - is beginning to spell the end of government role in capital investment in irrigation projects. The public investment boom of 1970s are gone forever. The economic criteria for appraisal of public investment projects is losing out to the financial criteria as market principles have begun to dominate.

Evolution of Criteria for Irrigation Investment: Chronology

1853 Separate Accounts instituted for irrigation works, necessitates the evolution of investment criteria.

1879 Select Committee of the House of Commons recommends "the financial results of works of irrigation" as "the best test for their utility". Capital Costs were actual cost of construction and annual costs were to be given by simple interest on the capital costs at the commencement of the year and working expenses of the year. Annual receipts included :

- *(a)* direct receipts(from the sale of water to towns, rents, fines under canal act and other miscellaneous receipts), and
- *(b)* indirect receipts (like the share of enhanced land revenue, interest on sale of proceeds of Crown Waste Land, rents on cultivation of Crown Waste lands, etc.) Criteria suggested was that the rate of return; Calculated as

$$\frac{(\text{Annual Receipts - Annual Costs}) \;\; \text{X} \;\; 100,}{\text{Capital Cost + Arrears of Interest}}$$

should be greater than the stipulated rate from the tenth year after its opening.

1901 Royal Commission on Irrigation examined the question of indirect benefits but concluded that indirect benefits from irrigation were either not substantial or these were proportional to the direct benefits as measured in terms of financial receipts to the State. Endorses continuation of financial criteria.

1961 Planning Commission initiated studies under the Committee of Directon headed by Prof. D.R. Gadgil showed that there are substantial benefits from major and medium irrigation projects in terms of multiple cropping, diversification and better quality crops, higher yields, larger incomes and greater employment in addition to indirect benefits in industry, trade and transport. Recommends use of benefit-cost ratio. Hence there is a formal shift from financial to quasi-economic criteria. Benefits to comprise the difference in the value of total annual agricultural production less the cost of cultivation, before and after the introduction of irrigation. Annual cost to include annual interest on capital, depreciation and expenditure on operation and maintenance. The Committee, on consideration of simplicity of procedure, left out non-agricultural benefits.

1964 The recommendations of the Gadgil Committee received official approval after the 'Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects' recommended its adoption. The Committee recommended the adoption of the Annual Benefit-Cost Criteria with a cut-off ratio of 1.5. Government accepts recommendations.

1972 Irrigation Commission suggests modifications in cost calculation and a lower cut-off ratio of one for irrigation projects in drought affected areas. It recommended that financial return should also be examined, since the quasi-economic criteria minimises the importance of securing an adequate return from investment on irrigation projects.

1976 National Commission on Agriculture recommends the use of internal rate of return instead of the annual benefit - cost ratio for appraisal of projects and for inter se ranking. For cost calculations, it endorses the Irrigation Commission's recommendation that the costs of land shaping and construction of field channels should be included.

1980 The 'Working Group Report on Guidelines for Preparation of Detailed Project Reports of Irrigation and Multipurpose Projects' suggested the constitution of a multi-disciplinary committee to review existing method of calculating benefit-cost ratio vis-à-vis DCF techniques and IRR. Pending such a review, existing procedures were to continue. Cost calculations should be broadened to include command area development.

1983 'Committee to Review the Existing criteria for Working Out the Benefit Cost Ratio for Irrigation projects' (Desai Committee) presents a comprehensive set of recommendations on most aspects of appraisal procedure. It recommends the use of discounted cash flow approach instead of the annual benefit cost ratio. Prefers the use of the internal rate of return with a cut-off rate of 9 percent in general areas and 7 percent in drought prone, chronically flood prone and hilly areas or in river basins where 75 percent of the dependable flow has already been utilised. According to Vaidyanathan Committee Report (1992) the recommendations of this Committee "have not yet been fully implemented" (p.23). Costs should include, inter alia, command area development and catchment area treatment.

1983 The 141st Report of the Public Accounts Committee (7th Lok Sabha) suggested the evolution of a suitable economic rate of return. The Project Appraisal Division of

Planning Commission advised to carry out post facto evaluation of projects at least at five yearly intervals. Recommends broadening of cost concepts to include all inputs that go to increase yield – especially. CAD, which should be surveyed.

1986 National Conference on Irrigation and Water Resources Ministers (July) followed by meeting of State Secretaries of Irrigation (September) leads to setting up of a group under the Chairman, CWC to examine the scope for abridgement of existing scrutiny procedures for project clearance. The State Governments 'advised' by the Ministry of Water Resources 'that soil conservation, catchment treatment, afforestation and other measures of siltation and maintenance of ecological balance should be viewed together and integrated project report should be formulated' (AR 1986-87, p. 6) Project reports 'besides containing benefit cost ratio on a single year basis as at present, should also give the Internal Rate of Return'. (*Ibid.*, p. 24)

1987 National Water Policy : "There should be an integrated and multi-disciplinary approach to the planning, formulation, clearance and implementation of projects, including catchment treatment and management, environmental and ecological aspects, the rehabilitation of affected people and command area development"

1988 Advisory Committee in the Ministry of Water Resources (constituted in Nov., 87) to scrutinise projects, expanded to include representatives from MOEF and M of Welfare.

1992 The report of the 'Committee on Pricing of Irrigation Water' (Vaidyanathan Committee) recommended the reintroduction of a minimum financial return as criteria for sanctioning all investment proposal along with social benefit-cost criteria.

1995 A High Level Committee was set up to study the feasibility of private sector participation in irrigation and multi-purpose projects, concluded that such participation is feasible in respect of all irrigation (including surface) and multi-purpose projects but should be introduced on a pilot basis in non-sensitive areas.

1999 Work on Revised Guidelines in Progress.

STATEMENT - I.1

Magnitude and Compostion of Investment Through Plan periods in Irrigation and Flood Control Sectors (Figures in Rs. Crore)

Plans	*Major and Medium Irrigation Projects*		*Numbers*	
	Current Price	*Price at 1996-97 level*	*Major*	*Medium*
First (1951-56)	376.24	7803.42	44	169
Second (1956-61)	380	6013.98	33	102
Third (1961-66)	576	6676.84	32	44
Annual (1966-69)	429.81	3943.9	11	30
Fourth (1969-74)	1242.3	7976.41	32	73
Fifth (1974-78)	2516.18	12519.48	70	300
Annual (1978-80)	2078.58	7949.67	13	52
Sixth (1980-85)	7368.83	19625.5	30	91
Seventh (1985-90)	11107.29	21207.15	12	33
Annual (1990-92)	5459.15	8125.6	1	-
Eighth (1992-97)	21071.87	31057.63	14	50
TOTAL	**52606.25**	**132389.93**	**292**	**944**

SOURCE: Ninth Five Year Plan 1997-2002. Vol. II , Planning Commission.

STATEMENT - I.2

Financial Results of Irrigation and Multipurpose River Valley Projects (All India)
(Rs. Crore)

Year	*Gross Receipts (GR)*	*Working Expenses (WE)**	*Interest on Capital Outlay at end of the Year (I)*	*Profit*	*Percentage Recovery of WE through GR*
1976-77	104.7	112.8	174.9	-182.9	93
1977-78	96.9	127.2	215.5	-245.7	76
1978-79	108.1	155.2	255.5	-302.7	70
1979-80	100.7	140.5	292.3	-332.2	72
1980-81	103.4	225.7	301.5	-423.9	46
1981-82	120.2	265.3	415.6	-560.7	45
1982-83	117.1	237.7	872.7	-993.3	49
1983-84	165.1	273.9	562.8	-671.6	60
1984-85	129.7	334.0	635.7	-840.0	39
1985-86	223.8	486.9	681.7	-944.8	46
1986-87	166.7	489.6	867.3	-1190.2	34
1987-88	138.7	1400.3	-	-1261.6	10
1988-89	166.4	2128.0	-	-1962.0	8
1989-90	207.6	2223.8	-	-2016.2	9
1990-91	228.9	2476.3	-	-2247.4	9
1991-92	232.2	2755.1	-	-2542.9	8
1992-93	316.1	3113.2	-	-2797.1	10
1993-94	459.2	3582.7	-	-3123.6	13

SOURCE: Water and Related Statistics, 1998, Central Water Commission.
* WE includes interest from 1987-88.

II. ANALYSIS OF PERFORMANCE

COSTS : MEASUREMENT AND TRENDS

Under the present methodology of project appraisal, 'annual cost' which enters as the denominator in the benefit-cost ratio consists of *(a)* interest cost at the rate of 10 percent on the estimated cost of the project including land development, *(b)* operation and maintenance costs on per hectare basis of gross irrigated area or culturable command area, whichever is more, *(c)* depreciation of the project based on the assumed life of the project; e.g. 1 percent of the total cost (excluding land development) for 100 years life of project and *(d)* maintenance of headworks at 1 percent of its cost. For lift canals, there are additional costs on power consumption and depreciation of rising mains and pumping systems.

CAPITAL COST

Since items (a) and (c) are percentages of the capital cost of the project, it is necessary to examine the magnitude and trends in capital costs. The usual approaches in the analysis of capital costs have been *(a)* to compare actual costs with the estimated costs of projects and *(b)* to use planning commission estimates of capital expenditure and potential created in the plans to arrive at capital cost of per hectare of potential created.

(a) Project Based Studies

The sharp differences between actual and original estimates of large projects are now fairly well documented both by official and non-official investigations. Taking official estimates first, we have the following illustrative evidence:

1973	Report of the Expert Committee on Rise in Costs of Irrigation and Multipurpose Projects	Revised estimates on 64 major projects were, on average, 108 percent higher than approved estimates. 32 projects had escalation exceeding 100 percent
1978	Estimates Committee (12th Report, 6th Lok Sabha) Ministry of Agriculture and Irrigation (Deptt. of Irrigation)	Expenditure exceeded outlay, upto 4th Plan, by 19.4 percent while physical targets in area irrigated showed a shortfall of 51.4 percent.
1979	Indian National Committee on Large Dams in India (as adapted in Singh 1997)	Average cost escalation of 41 dams was 254 percent with only 6 dams showing escalation of less than 100 per cent.
1983	Public Accounts Committee (141st Report, 7th Lok Sabha)	Cost overruns of 159 projects average 232 percent. 32 projects show overruns of 500 percent or more.
1983	Desai Committee Report Refer Statement II.1	During Fifth Plan, revised estimates of all schemes Irrigation projects were 3.2 times the original cost. In the Sixth Plan this ratio was 2.7. For new schemes costs increased by about 13 percent annually.

As regards non-official estimates of escalation of projects costs, the following excerpt from Singh (1997) is illustrative:

> "Further, according to another calculation by Chaturvedi, which is based on thirty irrigation projects, the estimated cost of Rs.913.49 crore rose to Rs.1,966.93 crore on completion - an escalation of 115.32 percent .....(computations) by Pant, once again based on government sources for the period 1971-81, gives an average cost escalation for major projects at 108 percent ......A study for the Kerala state puts the cost escalation for major and medium projects at about 675 percent." (p 118)

Clearly, there is a tendency to systematically underestimate capital costs and a minimum escalation of 100 percent is commonplace. The implication for this on the existing B-C ratio calculations is quite straightforward. A 100 percent escalation in capital costs translates into a little less than doubling of the denominator. An underestimation is therefore necessary to obtain favourable B-C ratios for marginal projects.

It can be argued that since part of the cost escalation is due to inflation, it should be ignored as benefit cost ratios relate to prices of a base year. The problem with the current practice, however, is that it is not time-specific. It compares 'annual costs' to 'annual benefits' without any consideration of the years to which they belong. Since benefits from large projects flow-in after considerable lag, these should be discounted more than capital costs which are incurred earlier. Or, alternatively, capital costs should be compounded upto the year benefits start accruing to make the two figures comparable. If cost escalation is viewed only at constant prices then the B-C ratios will not be as adversely affected because a substantial part of the escalation is due to price rise. However, if compounding of costs are introduced to take into account the gestation periods then project costs will increase.

Gulati *et. al.* (1995 a) computed the increase in costs at constant (1988-89) prices but also included an annual compounding factor of 5 percent (for the gestation periods) on actual outlays of 347 projects in 10 states. The period covered was 1963-64 to 1994-95. The average costs of irrigation potential created worked out to be Rs.29,000 per hectare for the entire period. Further, the time profile of cost "shows that the highest average cost has been during the decade of the 1980s, and that this cost of cumulative potential creation has been rising throughout the 1980s" (p. 59). According to the authors, the cost figures are likely to be underestimates. (The study does not present the costs of the late eighties for the project specific part but does so for the aggregate analysis (see below). If we use the ratio between the late eighties average cost and the average cost of the entire period, derived from the aggregative study, and use it to estimate the average project costs of late eighties (1985-90) then we come to the conclusion that in the late eighties the capital cost of irrigation potential created was at least Rs.45,000 per hectare at 1988-89 prices. The annual costs on this basis would be almost Rs.5000 per hectare on interest and depreciation.)

(b) Aggregative Studies

The starting point of most aggregative studies is the planning commission data on cost of creation of irrigation potential where the average annual expenditure on major and medium projects during a plan period is divided by the potential created during the plan to obtain the per hectare capital costs. Earlier this data was available only in current prices but now the costs at constant prices also are reported as given in the Table below:

Cost of Creation of Irrigation Potential: (Major and Medium: Rs./ha.)

Plan	*Period*	*Current Prices*	*1980-81 Prices*
1st Plan	(1951-56)	1200	8620
2nd Plan	(1956-61)	1810	9289
3rd Plan	(1961-66)	2526	10,289
Annual	(1966-69)	2893	8313
4th Plan	(1969-74)	4758	11,060
5th Plan	(1974-78)	6075	9074
Annual	(1978-80)	10,940	14,111
6th Plan	(1980-85)	21,610	18,771
7th.Plan	(1985-90)	50,000	31,475
Annual	(1990-92)	66,570	29,587

SOURCE: Report of the Working Group on Major and Medium Irrigation Programme for the Ninth Plan as quoted in Ninth Plan Document Vol. II p. 498.

It can be seen from the data that there has been a steep escalation in capital costs per hectare from 1978 to 1990 even when the effect of inflation is neutralised. The problem of gestation lags, however, remains as the expenditures incurred in a year creates potential with considerable lags and therefore if capital expenditures are increasing then costs per hectare is likely to be overestimated.

To obviate this problem, Gulati et.al (1995 a) assume an average gestation lag of 12 years between expenditure incurred and potential created and compound the expenditure at 5 percent annual compound rate to arrive at per hectare capital cost at constant (1988-89) prices. "The results reveal a J-shaped pattern of per hectare capital costs over the period 1963-64 to 1994-95, with minimum costs reached in the late 1970s and the maximum in late 1980s. The average costs of cumulative irrigation potential created through major and medium schemes over this three-decade period is estimated to be about Rs.35, 000 per hectare at 1988-89 prices....The exercise also revealed that, for the 1980s at least, the Central Water Commission estimates understate the capital cost of irrigation development by at least 50 percent" (p 70-71). The calculations show that in the late eighties (1985-90) the average capital cost of irrigation potential created had risen to Rs.55,181 per hectare (if interest is capitalised at 5 percent rate for the gestation period).

Another estimate, Dhawan (1997 a) using very different data and methodology, also indicates a sharp escalation in cost (not capital cost but total supply cost) in the 1980s. According to the estimates, the average 'supply cost' of irrigation, at 1980-81 prices, rose from Rs.488 to Rs.613 per hectare - i.e. by 26 percent between 1980-81 to 1992-93. Further, marginal costs - i.e. the incremental cost of additional hectare irrigated had risen even more sharply from Rs.635 to Rs.1709 per hectare at constant prices-a rise of 8 percent per annum. The increase disturbs Dhawan: "Unless the irrigation planners can convincingly demonstrate that the rise in marginal cost of developing new canal irrigation is wholly due to genuine causes, notions of high corruption in canal irrigation would continue to persist in public mind" (p. A-75). Dhawan's costs do not capitalise interest as in the Gulati et.al. study.

Dhawan also works out the marginal capital cost of bringing one new hectare under irrigation through major and medium projects. He uses the National Accounts Statistics data on "consumption of fixed assets" which in 1992-93 is reported as Rs.701 per hectare. This is the annual depreciation cost derived on the assumption of 100 years life of the project. The capital cost therefore is 100 times the depreciation charge. "In other words, the capital cost of bringing irrigation to one crop hectare area averaged Rs.70,100. Since depreciation is computed on replacement cost basis by the CSO, Rs.70, 100 per hectare can be validly interpreted as the marginal capital cost of large-scale irrigation in 1992-93. This capital cost is exclusive of the capitalised value of interest charges payable during construction phase" (p.A-73). The capital cost therefore is at current price of 1992-93 and may involve some under-estimation as interest is not capitalised during the construction period.

The steep increase in capital cost in the eighties is acknowledged by the Planning Commission which gives the following explanation:

> ".....a substantial increase in cost has taken place from the Sixth Plan onwards which is mainly due to introduction of the extension and distribution system upto 5-8 ha block, the cost of rehabilitation and resettlement, environmental and forest aspects, inclusion of the cost of the catchment area treatment and drainage system in the command of the irrigation projects and increase in the establishment costs, etc. However, studies indicate that by clubbing some of the above activities together, the costs overrun, primarily due to change in the scope of the project (35 to 43% of total increase in cost due to this factor alone in some selected projects), rise in the lump-sum provisions, which include, besides others, the R&R activities (40 to 47% of the total increase in the revised estimate of some selected projects); increase due to price rise/inflation which varied from 8% to 63% of the total increase in a period of 2 to 20 years in the sample of 11 projects and increase due to change in design (about 38% of the increase in a selected project was due to this factor),etc," (Ninth Plan, Vol. II, p. 498-499)

It appears from this excerpt that the definition of 'capital cost' may have been undergoing a change in the aggregative data. It is, however, not clear as to what extent this change was due to new calculations of benefit-cost ratio at the project level at the time of appraisal. Indeed, the entire concept of capital cost and its calculation is extremely problematic as has been highlighted by the Vaidyanathan Committee (and other researchers) which recommended the development and introduction of standardised management accounting system for projects. Accounting practices differ between states and between projects, the rates of interest charged (for agreegative supply cost data) also differ and there is no uniformity in the practice of closure of accounts. Further, interest charges during construction are not capitalised which, according to the Committee, ought to be done. The system of financial accounts therefore do not provide a good basis for costing.

The excerpt from the Ninth Plan document reinforces the findings of other studies that inflation is not the major factor in cost escalation. The fact that changes in scope, design and 'lump-sum provisions' have led to steep escalation in costs points to the, now well documented, fact of considerable differences between *ex ante* and *ex post* capital costs arising out of inadequate or improper investigation and surveys. This fact was pointed out and quantified by the Committee of Experts in 1973 and by various official committees and investigations. Yet the problem remains. This has led some to conclude that "improper investigations were perhaps deliberate to ensure the clearing of projects reports. The fear that a thorough investigation would render the project cost higher than the stipulated percentage, acted against a comprehensive and rigorous project plan." (Singh, 1997 p. 128)

In my interactions with officers of irrigation departments, I have come across cases of such 'fears' being expressed. But to put the entire blame on the "lobby of civil engineers" who benefit from the process is, in my opinion, too simplistic. One reason why proper analysis of costs and benefits is not made is that often the decisions to invest are announced by political leaders without any prior study. The project report is then an attempt to justify the already committed investment. The viel of secrecy helps.

Another reason is that the irrigation sector is showing the classic case of increasing marginal costs as development has proceeded from easier sites to more difficult ones. Further, newer cost elements, earlier external, are now increasingly internalised by project authorities. Finally, the benefit-cost ratio criteria itself is flawed and works to the disadvantage of project authorities, at least for some items. Since the costs are in financial terms, and do not reflect their economic values, they may be overestimated by about 25 percent if we go by the standard conversion factors used by international agencies for irrigation project costs in India. Annexure I gives the conversion factors from Subanarekha project as illustration. Specifically, unskilled labour gets overvalued by a considerable margin. Further, a ten percent interest is shown as "annual cost". The reason is not clear. Why should ten percent be the assumed interest cost for the *entire life* of the project? Presumably, the idea is to compare the benefits of a "representative year" with annual costs of a "representative year". In a representative year costs are incurred on operation and maintenance. If the life of the project is 100 years, it is again reasonable to assume that 1 percent of the capital is used up every year and hence one percent depreciation cost also makes sense. But a 10 percent interest on entire capital cost implicitly assumes, because the representative year is one of the hundred years, that 10 percent interest will be paid for all the 100 years on the entire project cost. Clearly this is an exorbitant cost of capital. More logically, since one percent of the capital depreciates every year, for a 100 years, the average amount of capital locked-up during the period is only 50 percent of the capital cost. Hence interest should be charged not on the entire capital cost but on half of it. Or, alternatively, interest could be computed on declining balance if the present method of annual benefit-cost ratio is to be continued.

It would however, be better to follow the standard procedure of discounting, at the social discount rate, both costs and benefits as they actually occur. The social discount rate, as Gulati et.al argue, should be somewhere around five percent in real terms, i.e. when the exercise is done at constant (base year) prices. The Desai committee implicitly recommended a discount rate of 7 to 9 percent for irrigation projects. All these arguments point to the fact that the present procedures of appraisal may be unwittingly inflating the cost calculations so that even genuinely beneficial projects may have found it difficult to qualify had the capital costs been estimated correctly. Underestimation of capital costs became the way out for the system.

O&M Costs

Another item entering the concept of - "annual cost" is the anticipated expenditure on operation and maintenance. The expenditure on O&M is generally based on a 'norm' of required expenditure on a per hectare basis. As mentioned earlier, the costs on this head are relatively small though they too have shown an increasing trend (the norms have increased but not necessarily actual expenditures). The guidelines had originally laid down a norm of Rs. 50 per hectare of gross irrigated area or culturable command area, whichever is more. The Eighth Finance Commission (1984) recommended that O&M costs should be Rs.100 per hectare of gross irrigated area for all states, except for hill areas where they should be 30 percent higher. A committee set up by the Ministry of Water Resources suggested a norm of Rs.180 per hectare of gross irrigated area at 1988 prices. The Ninth Finance Commission retained the norm while adjusting it for inflation. The present position, as recommended by the Tenth Finance Commission (1994), is a norm of Rs.300 per hectare for the utilised potential and Rs.100 per hectare for the unutilised potential, with 30 percent higher norms for hill states.

The figures show that, compared to capital costs, the expenses on O&M are small. Even if substantially higher norms are adopted the viability of the projects will not be affected. What is disturbing is that actual expenditures on O&M have been much lower than the norms and even declined during the 1970s. Further, establishment costs as a proportion of O&M expenses rose in the 1980s while that of maintenance and repairs fell sharply. "This has led to the paradoxical situation where, while huge amounts is spent on development of irrigation facilities - to the tune of Rs.35,000 per hectare, at 1988-89 prices - available irrigation potential remains unexploited for lack of a small sum of about Rs.300 per hectare annually for O&M" (Gulati, Svendsen and Roy Choudhary 1995 p.95). There is therefore a clear case for a liberal approach towards O&M expenses.

There is also a case for developing regional/state specific norms for O&M expenditures as there are considerable variations in actual expenditures between states. The Vaidyanathan Committee recommended that states set up special expert groups to work out appropriate norms for O&M costs and a procedure for periodic monitoring and updating for different agro-climatic regions and broad categories of projects. The Committee also recommended that O&M costs can be reduced to some extent if irrigation departments transfer the responsibility for the maintenance of canal network below a certain level (say, a 100 ha outlet) to users' groups. Some attempts have been made in this direction. A more realistic and decentralised development of O&M norms is needed.

BENEFITS: MEASUREMENT ISSUES

The direct benefits can be divided into irrigation and hydro-power benefits.

(a) Irrigation Benefits

The present practice is to compute annual benefits from irrigation and compare them with annual costs of irrigation supply. Annual benefits from irrigation are obtained as the difference in the value added of farm produce with and without irrigation. To obtain value-added estimates, the first step is to estimate the gross value of agricultural output. Gross value of agricultural output after irrigation depends on the following estimates:

- Gross Irrigated Area
- Cropping pattern
- Yields of crops, and
- Prices of the produce

(i) Yields

Various official committees have commented on the discrepancies between actual yield and yield assumptions of project reports. The Nitin Desai Committee made the following observation:

> "With regard to yields the project reports generally rely on estimates certified as reliable by the State Agriculture Department. In order to examine the reliability of these estimates some project reports were studied and the yield estimates given in them were compared with the actual realisation on irrigated plots in the States as reported in published statistics. (The results of this comparison are presented in Annexure II in our report and statement II.2). It will be seen that in almost every case the actual yield on irrigated plots is substantially below what has been assumed in the project report. In fact in many cases it is less than half. In the case of rice, project

> reports assume yields in the range of 27.5 to 30 quintals/ha whereas the actual for the states range from 9 to 19 quintals/ha. The situation is similar in the case of wheat if Haryana is excluded: the project report assumptions range from 20 to 30 quintals/ha. whereas the actuals range from 10 to 20 quintals/ha. The position is similar in the case of other crops. It is possible that the state level average yield, even on irrigated plots, may underestimate the yields which can be realised under controlled irrigation. Nevertheless the difference is so large that it is difficult to accept the project report yield assumptions as being reasonable even as guesses." (p. 20-21)

Earlier, the Sixth plan document had observed that yield increases due to irrigation have been disappointing:

> "In spite of the large investment made in the irrigation sector and the phenomenal growth of irrigation during the past 30 years, the returns from the investment both in terms of yield as well as finance are very disappointing. Irrigated land should yield at least 4 to 5 tonnes of grains per hectare per year. However, at present it is hardly 1.7 tonnes on an average."

The Public Accounts Committee too highlighted the enormous differences between actual irrigated yields and potential yields as demonstrated under controlled circumstances. Also, PAC was "surprised to learn that net increase in yield in the command of an irrigation project is not assessed. In the absence of such assessment the committee wonder how actual benefit derived could be ascertained and compared with the project anticipation". (p.124)

The observations of the PAC indicate that, at least in the first three decades of planned development, yield figures used in projects had little relation to actual yields. The Desai committee cautioned: "any attempt to simplify the matters by using national or even state-wise (yield) norms would be misleading" (p.60).

Yield figures, even for irrigated areas, show great variation and so does the difference in yields between irrigated and unirrigated plots in a given region. In a study on the productivity of water in ten canal commands, Dhawan (1989) reports that the percentage increase in land productivity (Kgs of rice equivalent per net area in hectares) due to irrigation ranged from 68 percent (Mahandi Delta) to 383 percent (Jayakwadi) and the percentage rise in output (after adjusting for capacity utilisation) ranged from 110 percent to 245 percent. Dhawan concludes that the "mean value of output impact of canal irrigation is of the order of 16 quintals of rice equivalents for each crop hectare brought under irrigation, almost twice the magnitude of output level without irrigation. Even when due account is taken of the fact that barely 70 percent of the created irrigation potential of the ten projects was actually utilized.....The output enhancing role of canal irrigation appears impressive, namely, about 10 quintals of rice equivalents for each hectare of irrigation potential brought into existence." (p.188-189).

Keeping in view the great variations in actual yields, the Desai Committee made extensive recommendations for improving the procedure and data base for estimating incremental yields on a project specific basis keeping in view factors like soil type, spread of new farming practices, quality of water management and availability of water from alternative sources.

(ii) Cropping Pattern

Cropping patterns projected in project documents similarly have been normative and rarely realistic:

> "The cropping pattern assumed is generally based on certain normative principles governed by soil type, water availability, etc. A systematic analysis of likely cropping pattern is seldom attempted. Often the proposed cropping pattern includes more or less arbitrary provisions for high value crops like fruits and vegetables, sugar-cane etc. which inflate the estimated benefit". (Desai Committee Report, p. 59).

The Committee recommended that assumed cropping pattern should be based on actual experience in a comparable area. The assumptions should be justified in terms of factors like market prospects, consumer preferences and availability of processing facilities, etc. Due to limitations of time it was not possible to investigate the extent to which the Desai Committee's recommendations regarding yield and cropping pattern estimation is being followed by project authorities in different states.

The combined effect of yield overestimation and over-optimistic cropping pattern projections mean that annual benefits in market value terms will be over-estimated. It is therefore important to estimate the quantity of actual irrigation benefits so as to obtain reference estimates for benefits from irrigation projects. Annexure III computes the ratio of irrigated yields to non-irrigated yields for a large number of crops and across various states based on the data given out by the Ministry of Agriculture. It can be seen that physical yields, as a result of provision of irrigation, generally increase in the range of 1.5 to 2.5 times compared to unirrigated yields as per the data of the early 1990s.

In addition to yield increases, cropping patterns also change with the introduction of irrigation. According to Dhawan (1997 b), in the eighties "Bulk of the real growth in crop sector came from forces enhancing crop productivity (combined effect of pure yield increase and improvement in crop mix in favour of more valued crops) because gross crop area increased by mere 7 percent in the above period." Dhawan reports that the value of output per hectare in irrigated area is about 2.3 times that in unirrigated area. This ratio includes the effects of both yield and crop-mix changes. The upper limit for irrigation benefits per hectare is therefore likely to be about 2.5 times the value of output per hectare in unirrigated area (on an average).

(iii) Irrigated Area

There are also discrepancies between the projected irrigated area and actual irrigated area as pointed out by a number of studies some of which are summarised below:

Yr.	*Report/Study*	*Projects*	*Actual Irrigated Area as percentage of Projected Irrigated Area*
1976	Supplementary Report of the Comptroller and Auditor General of India 1975-76.	11 Projects	64.4 percent (average)
1983	Desai Committee Report	Kosi Hirakud	76 percent 57 percent
1989	Dhawan	10 Canal Commands	70 percent (average)
1995	Gulati, Svendsen and Roy Chaudhary	347 projects over 10 states	70 percent (average)

The PAC and the Estimates Committee have also expressed anxiety over the shortfall in irrigated area. According to Himanshu Thakkar, "the Planning Commission estimates show that between 1953 and 1993, one eighth of the additional potential has not been used. The gap is much larger when we compare Land Use Statistics (LUS) estimates of GIA (Gross Irrigated Area) with the Planning Commission estimates of potential." The table below does that exercise:

GIA as per LUS as % of total Irrigation Potential Created

Pre Plan	99.82
1st Plan (1951-56)	97.64
2nd Plan (1956-61)	96.22
3rd Plan (1961-66)	92.05
Annual Plan (1966-69)	95.63
4th Plan (1969-74)	91.13
5th Plan (1974-78)	88.58
Annual (1978-80)	86.93
6th Plan (1980-85)	83.61
7th Plan (1985-90)	80.82
Annual (1990-92)	81.0
8th Plan (1992-97)	78.87

As can be seen from the table the gap between gross area irrigated and potential created is hovering around 20 percent in the last ten years or so. However the gross irrigated area includes area irrigated by minor schemes where there is hardly any difference between potential created and utilised as per planning commission data. If we make a rough adjustment for this by subtracting the reported utilisation figures for minor irrigation (planning commission data) from the gross irrigated area (from LUS) we get a figure for irrigated area under major and medium (M&M) projects. Comparing this figure with potential created by M&M projects gives us a rough idea of the shortfalls in the case of M&M projects. The results show that only 63 percent of the potential created by M&M projects was utilised during the Seventh Plan. This percentage had fallen to an estimated low of 56 percent during the Eighth Plan. However, there are problems with the Planning Commission data on minor irrigation, and therefore it is more likely that irrigated areas as a proportion of potential from M&M projects is around 70 per cent.

All these estimates show that it will not be an underestimate if we put the utilisation figure as 70 percent of potential for major and medium projects in the early 1990s. One effect of the under-utilisation of potential is that the capital cost of actual irrigated area increases sharply. Dhawan (1997 b) points out that while his estimate of marginal capital cost (Rs.70,100 per hectare) is substantially higher than the Planning Commission's implied marginal capital cost (Rs.53,000 per hectare), the difference is illusory. The Planning Commission uses its data on potential created while Dhawan has used the actual irrigated area from the LUS. The effect of under-utilisation of potential is that even the Planning Commission's lower estimates actually approximate Dhawan's estimates when adjustment is made for unutilised potential.

As regards the reasons for the shortfall in utilisation, the neglect of O&M is perhaps a major cause. In addition, conveyance losses, lack of proper distribution networks and cropping patterns adopted appear to be particularly significant explanatory factors. The Ninth Plan gives the following explanation (in addition to reporting deficiencies and gestation lags).

> "...area which can be irrigated in a system depends on several variables including availability of distribution networks, the volume and seasonal pattern of water availability, conveyance losses, distribution and application on fields, the extent to which conjunctive use is developed and the actual crop pattern on ground. In so far as the assumptions in respect of these parameters underlined in the project design are not actually realised in full, there is bound to be divergence between actual area irrigated and the potential created". (p.481)

Various estimates have shown that the last sentence of the above quotation is a highly misleading under-statement. The "assumptions" in the project designs have been far removed from actuals. The PAC (1983) observed that while conveyance losses in most canals were projected at 8 cusecs per million square feet, the actual losses ranged from 2.7 to 39.7 cusecs per m.sq. ft., with average of actual exceeding the average of projected by over 108 percent for a sample of 13 canal systems (For details , refer to Statement II.3).

Water availability is also reduced due to siltation of reservoirs. Singh , Kothari and Amin (1992) show that the observed siltation rates of nine reservoirs exceeded the assumed siltation rates by 23 percent to 79 percent as per data given by the PAC. They also report findings of the Irrigation Commission where the observed rates exceed assumed rates by large percentages. Singh (1997) reports data on twenty reservoirs where the observed rates are considerably higher than assumed rates for nineteen reservoirs (Table 5.2 of Singh).

The problem of under-utilisation of potential created has received official attention since early 1970s. It was discussed at the Conference of State Ministers of Irrigation and Power in 1972, following which a Committee of Ministers was set up to identify the causes. The Committee identified various reasons which included delay in construction of field channels, inadequate drainage facilities, inadequate preparation of land, lack of consolidation of holdings, etc. On its recommendations, the programmes of Command Area Development were started in 1974 as a part of the overall project. In 1976-77, the Estimates Committee studied a number of projects to identify the causes of under-utilisation of capacity. Its findings were that the principal causes were:

(a) Unrealistic Crop Pattern envisaged in the original project,
(b) Heavy Siltation,
(c) Inadequate extension facilities in command area,
(d) Water-logging in the project command,
(e) Seepages from canals,
(f) Lack of field channels and drainage facilities, and
(g) Inadequate land development.

Clearly, there is more to irrigation than the construction of dams and canals - a point which has been repeatedly highlighted by various committees and analysts but still does not find reflection in actual planning, design and implementation as the gap between utilisation and potential widens.

(iv) Prices

In a proper cost-benefit analysis, valuation of output is an extremely important and complex issue. The annual benefit-cost ratio calculated for irrigation projects bypasses the main issues in valuation and adopts market prices as the basis of valuation for most of agricultural produce. Often, at the least for cereals and some other crops, there are two prices - one the minimum support price (procurement prices) and the market price. Often a fixed percentage (usually 10 percent) is valued at the support prices and the remaining is valued at the wholesale market prices prevailing in the major market of the state. In the case of vegetables, fruits etc. there is considerable scope for over-valuation as the prices of these products are not readily available. But even in the case of cereals inflated prices are not unknown:

> "...(in) the Panchkhero Project Report wheat prices have been taken at Rs.150 (minimum support/procurement price) per quintal for 10% of the produce and the

> Rs.270 per quintal for the remaining 90% of the produce. It is extremely unlikely that the procurement prices would be almost half of the prevalent market price." (Saha 1993, p. 40)

According to the Desai Committee, market prices do not reflect opportunity cost of output adequately. Output should be valued at opportunity cost to the economy which will be reflected in *(a)* increased imports, *(b)* reduction in exports, or *(c)* increase or shortfall in production or availability and consumption.

The Committee Report therefore suggested valuation of wheat at the cost of imports (adjusted for a foreign exchange premium). Other cereals should be valued at the opportunity cost of wheat plus any premium or discount implicit in the prices which domestic consumers are prepared to pay for the cereal relative to what they are prepared to pay for wheat. Varieties of cereals, for example Basmati Rice, which are exported to a significant extent, should be valued at the relevant export price. A similar approach was recommended for non-cereal outputs like oilseeds, cotton and jute. The committee also recommended that the price should be the average of five year prices and suitable corrections should be made for freight / transportation, etc.

Desai committee's recommendations of using opportunity costs to value outputs (and inputs) have not been followed. It is possible that in recent years with the considerable depreciation of the Indian rupee and restricted trade in agricultural commodities, international (border) prices would be higher for a large class of agricultural products and hence the shadow pricing of the produce would lead to higher valuation of benefits. This possibility (guess) requires further investigation.

In addition to gross value of crops, benefits include, as per the prevalent procedure, the value of fodder and dung on the basis of a standardised norm. The Desai committee suggested changes in the procedure as crop residues vary not only between crops but according to variety and dung receipts depend on the extent of mechanisation. It therefore suggested that byproducts should be assessed from actual data obtainable from cost of cultivation studies.

Cost of Cultivation

Cost of cultivation studies can also provide valuable data which can be used to obtain the net value of agricultural produce - i.e. gross value <u>minus</u> cost of cultivation. "The present method for assessing the costs of cultivation", the committee observed, "seems to rest on a very unreliable data base. Many of the calculations seem to be based on thumb rules rather than direct estimates. With growing importance of material inputs in agriculture it is necessary that the cost of cultivation be analysed more thoroughly" (p. 77).

It is important to mention that the Desai committee consistently recommended the use of 'opportunity cost' as the appropriate price for valuation whether of the output or of the inputs. Since a large part of agricultural inputs are subsidised, the use of shadow prices will undoubtedly increase the cost of cultivation and therefore reduce the net value of agricultural produce. As stated earlier, gross values may increase but since cost of cultivation will also be adjusted upwards, the effect on net value of produce is difficult to forecast without a proper study.

The discussion on benefits shows that there is enough evidence to show that *(a)* the actual area irrigated by major and medium projects falls well short of the projected area and the discrepancy may be increasing, *(b)* actual yield figures are often well below anticipated yields, *(c)* there is divergence between assumed cropping patterns and actuals and *(d)* there is some evidence of over optimistic price assumptions. The effect of these is that actual benefits from irrigation, as measured in market prices and not in "opportunity cost", are considerably lower than the anticipated/projected direct benefits from irrigation.

Comparing Benefits with Costs

The impact of these factors on actual benefit-cost ratios and internal rates of return are obvious and have been corraborated by studies - the actuals have not only been lower than the projected ratios/values but they have sometimes also reached levels which show that direct agricultural benefits fall short of costs. Unfortunately, the number of such studies are few.

In one of the earlier studies initiated by the Planning Commission, a detailed attempt was made to evaluate the benefits and costs from the Canvery-Mettur Project (Sonachalam, 1963). The study reported a number of benefit-cost ratios using various methodologies and covering the years 1925 to 1942 for capital costs and the years 1943 to 1954 for calculation of average annual benefits. Among the various results, the one closest to the CWC method yielded a B-C ratio of 2.63 (p 183). The assumed interest rate was only 4 percent (against the practice of 10) and the method of depreciation followed was different. If adjustments are made to make the ratio confirm to the CWC ratio then the B-C ratio comes to only 1.64.

In 1965, the Programme Evaluation Organisation (PEO) of the Planning Commission published evaluation (case) studies of eight major irrigation projects. Again the method for calculating the B-C ratio was somewhat different from the CWC's annual benefits to annual cost ratio. The PEO calculated the present values of costs and benefits at different rates of discount. The present values were divided by the number of years (different for costs and benefits) to obtain annual benefit and annual cost figures. The definitions of costs and benefits approximated the CWC definitions, though the interest rate assumed was 5 percent. The results are presented below:

Project	*Estimated B-C Ratio(at 5% Discount Rate)*
Kakrapar	1.50
Tungabhadra	2.93
Hirakud	1.83
Gangapur	6.60
Malampuzha	2.58
Lower Bhawani	4.07
Matatila	1.82
Mayurakshi	3.62

(Source: Planning commission , 1965 , P17)

These early studies by the Planning Commission were essentially aimed at comparing the financial criterion with a quasi-economic criterion. They showed that though many of the projects were unable to satisfy the prevailing financial criterion, they yielded annual benefits in excess of annual costs. In the early years the costs (excluding external costs which were not counted) were low.

The situation seems to have changed later. In a painstaking attempt, Saha (1993) reworked on the data given in eight project reports in the light of actuals and, using the discounted cash flow approach, found that the net present value of six of the eight projects was negative. The summary of some of his results are placed below.

Benefit-Cost Ratio (at 10% discount rates)

Project (State)	*As in Report*	*Saha's findings*
Kesho Reservoir (Bihar)	1.60	0.58
Panchkhero Reservoir (Bihar)	1.54	0.51
Bhaiwara Reservoir (Bihar)	1.25	0.57
Pathrai Dam (U.P.)	1.43	0.32
Gyanpur Pump Canal (U.P.)	2.15	0.26
Narainpur Pump Canal (U.P.)	1.54	0.50
Barna Dam (M.P.)	10.75	2.54
Halali Dam (M.P.)	4.26	4.11

Saha's results show that out of the eight projects studied, the actual benefit cost ratios were not only lower than the projected ratios in all cases, the costs exceeded benefits in as many as six projects. A similar negative NPV and a B-C ratio below unity is reported by Singh (1994) for the Western Gandak Canal Project. Even World Bank assisted irrigation projects have shown that the post-project economic rates of return are often well below the rates estimated at the appraisal stage (see Thakkar, 1999, p.18). The ERRs after project completion of eight projects given in Thakkar (1999) also shows that the ERRs of as many as six projects were below 9 percent - the cut-off rate recommended by the Desai Committee for the selection of irrigation projects.

It can be seen that the few evaluation studies that were available (few other studies exist) have followed different methods. It may be desirable to re-work the B-C ratio before and after the project using the same (CWC) method. However such studies, to the best of my knowledge, have not been made. Since it requires fresh estimation of costs and benefits as actually occurring , it is a task beyond the means of individual researchers in a short time. We have however tried to obtain indicative results from (interim) evaluation studies done for 12 projects. Using the data given in these studies we have worked out the annual benefit to annual cost ratio as per the prevalent practice. In addition, the discounted B-C ratios and NPV have also been reported. The results relate to with and without estimated command area development benefits and costs. (Details are presented in the Statement II.4).

It can be seen that according to the original project proposals (without CAD) the annual benefits to cost ratios (based on data of evaluation studies) are less than the cut-off rate of 1.5 in eight of the ten projects (relevant data for 2 projects were not available). If CAD is included, then also six of the eleven projects fail to reach the qualifying ratio of 1.5. Our earlier analysis of higher actual costs and lower post project benefits appear to get confirmed in a majority of cases.

The studies so far reported, look at individual projects. It is also necessary to attempt an answer to the question whether or not benefits from large scale canal irrigation clearly outweighs direct costs of providing the irrigation at the aggregate (national) level. Dhawan (1997 b) has tried to answer this question by making a number of adjustments to data given in the National Accounts Statistics. His findings show that, on a per hectare basis, benefits exceeded costs by substantial amounts even when both were computed at constant prices. The picture, however, is different if we shift to a marginal analysis which Dhawan does not attempt. In the early 1990s, according to his estimates, the capital cost of M&M projects per hectare is Rs.70,100. Following the existing procedure of annual costs calculation we obtain costs approximating about Rs.8000 per hectare in 1992-93, at current prices. The benefits from irrigation at current prices in the same year is reported as Rs.7132 per hectare. Therefore according to the existing criteria, M&M projects on an average are not viable for irrigation benefits alone. If we make adjustments for the fact that interest should be charged on the average capital held then of course, the projects are viable. However, the correct procedure is to use the DCF technique to find the net present value of projects. A back of the envelope calculation of Rs. 70,100 capital cost per hectare in year 1 and net benefits of Rs.6,800 every year (adjusting Rs.300 for O&M charges), accruing after a lag of 11 years and continuing for 100 years, all discounted at 10 percent rate, gave us an NPV figure which is negative but the IRR was slightly over 9 percent. These calculations are very rough and ready and on a per hectare basis using data given by Dhawan, with all their limitations. Yet the conclusion seems to be uncomfortably true: by the early 1990s, major and medium projects may have become unviable if irrigation benefits alone are considered. On the margin, the benefits from bringing one hectare of land under irrigation through M&M projects falls short of the direct costs involved.

The real impact of big dams, as far as irrigation benefits are concerned, is therefore almost entirely distributional. The benefits are reaped by farmers and others in the command areas and the costs are borne by society at large, the taxpayers and the project affected people. There is possibly no net gain to the economy from major and medium irrigation projects.

(b) Hydro-power

Among the non-irrigation benefits, the largest benefits come from hydro-power. In the economic appraisal for hydro-power for the Sardar Sarovar project the following (economic) costs and benefits are reported in the SPIESR study (Alagh et.al , 1995), which also quotes the World Bank estimates:

Hydropower Cost and Benefits (Rs. million)

	SPIESR	WB
Cost	15,408	14,266
Benefits	2,60,203	1,49,974

The enormous benefits, compared to cost, are the result of a high price of power which in the SPIESR study is put at Rs.1.83 per KWH and Rs.3.07 per KWH for non-peaking and peaking power. In fact so high are the reported benefits from hydro-power that these alone cover the reported cost of the entire project (including canal costs) in both the WB and SPIESR estimates. It must also be pointed out that the WB and SPIESR studies follow different approaches in obtaining the shadow (economic) prices for hydro-power. Further , it may be noticed that costs are very low. The project is to have an installed capacity of 1450 MW, therefore the cost per MW of capacity creation is extremely low. Part of this is due to the under-reporting of capital cost and part is the result of apportioning of costs where the major costs are apportioned to irrigation. Further, external costs are excluded.

Since hydro-power appears to be a major benefit in multipurpose river valley projects, it needs a closer examination. At the time of independence, the installed capacity for hydro-power generation was 508 MW or 37 percent of the total capacity in the power sector. The first two decades saw a rapid expansion with the installed capacity increasing nearly ten-fold and the share of hydro-power in total capacity rose to nearly 46 percent. The growth of capacity thereafter was slow, increasing from about 7000 MW in 1973-74 to nearly 21,000 MW in 1994-95, with the share in total falling from 42 percent to 26 percent. Similar are the figures for generation with hydro-power generation increasing from 2194.5 GWH (1947) to 28,971.8 GWH (1973-74) and then to 82,712 GWH (1994-95). During this period, the share of hydro-power to total generation fell from 54 percent to 24 percent. (Details in Statement II.5).

The valuation of hydro-power, which is necessary to arrive at benefit figures, is a tricky business as the cost of power generation differs considerably from hydro-power to gas based power and because of inter-state and inter-use differences in tariffs and subsidies. However, it is possible to have some rough and ready estimates, one of which is attempted here based on cost data reported in DVC (Damodar Valley Corporation) Annual Report. The 1997-98 Annual Report estimates the cost per KWH of hydel and thermal (next expensive alternative) as 70.97 paise and 120.38 paise respectively for 1995-96.

The net economic benefit from one additional unit of hydel is therefore (roughly) the difference in costs - i.e. 49.41 paise or Rs.0.49 per KWH. Multiplying this with actual hydel generation in 1994-95 gives Rs.4052.89 crores of annual benefit. This figure, though only indicative, is not a very small amount. In fact, it works out that hydro-power (annual) benefit could be in the range of one-third to one-fourth of irrigation benefits if Dhawan's figures of per hectare benefits are multiplied by the gross irrigated area from major and medium projects to obtain gross benefits from irrigation.

It is also desirable to look at the benefits in terms of rate of return on capital. However, such an exercise is not possible in the absence of data on the total capital invested for hydro-power development. Moreover, even if some data were available, the method of apportioning of costs would, in all likelihood, significantly lower the capital costs of hydro-power generation. To take an example, the capital cost of installing one MW capacity in the Tehri Project (StageI) (Projected estimates) comes to about Rs.3 crores (1993 prices) which is comparable to capital costs of other power projects despite the well-known fact that the capital cost of dams and related capital costs are enormous. Similarly for the Nathpa Jhakri Hydro-Electric Power Project the capacity of 1500 MW was expected to cost (at 1993 prices) Rs.4338 crores only. The implication of this apportionment is discussed in the financial section. Here, it can be mentioned in passing that (a) recent years have seen considerable increase in capital costs and (b) the projected costs are invariably far below the actuals/revised estimates. The projected cost of the 3X115 MW Salal Hydro-Electric Project was only Rs.55.15 crores (1970 prices) or only Rs.0.16 crore per MW. But by 1978, the year the project got transferred to NHPC and separate finances were no longer reported, the cost had escalated to Rs.229.33 crore. Similarly, for the Kopili Hydro-Electric Project the completion time was 23 years with the cost escalating from Rs.57 crore (1975) to Rs.243.82 crore (1998). Sharp cost escalation has already been reported for Nathpa Jhakri Hydro-Electric Power Project and the Tehri Dam and Hydro Power Project (Stage I). There is therefore some evidence to believe that capital costs in hydro-power projects, as in irrigation projects, suffer from the same malady of under-reporting at the project stage and, after clearance, are gradually stepped up. It is also not clear whether the interest cost arising out of the delay in execution are capitalised or not. Although the 1992 Planning Commission Guidelines does recommend this, it is unlikely that the practice was followed earlier. There is therefore reason to believe that the cost estimates, as per project reports, are likely to be considerably lower than actual costs even if external costs are not included.

But power has emerged as a central area of concern for policy makers in India. At the commencement of the Eighth Plan, the country faced a peaking shortage of 19 percent (9000MW) and energy shortage of 8 percent (22.5 billion Kwh). The Electric Power Survey and the Rakesh Mohan Committee have forecasted an increase in shortages unless urgent steps are taken to rectify the situation. A likely fall-out of this is that effort to increase installed capacity for hydro-power is extremely probable. The hydro-electric potential has already been increased to 600 billion Kwh as against the earlier assessment of 472 billion Kwh.

Efforts are being made to increase hydro-power capacity. But due to scarcity of large investible funds with the central and state governments which are required for large river-valley projects, it is unlikely that much headway will be made in this direction unless external funding is tapped. Eight Plan experience tells the story:

Hydro-Power Targets and Achievement (MW) : (Eighth Plan 1992-97)

Sectors	*Target*	*Achievement*	*% shortfall*
Central	3286	1465	55
State	5860	794.7	86
Private	162	168	-
TOTAL	9282	2427.7	74

The involvement of private sector being small, the onus for development of hydro-power capacity lies really with the government, as the table indicates. Although electricity is in the concurrent list, the large investment required for hydro-power development are not easily available with state governments. The central government's role has therefore increased in this sector beginning with the launching of centrally sponsored power projects in early 1970s and the subsequent incorporation of the National Hydro Power Corporation (NHPC) in mid-seventies. The organisational structure followed for hydro-power development has relied on the setting up of corporate structures, with share capital contributed by the centre and concerned states, with the responsibility of developing and managing large hydro-power projects. Besides the Damodar Valley Corporation and the Bhakra Beas Management Board, which came into being before 1970, recent years have witnessed the incorporation of NHPC, North Eastern Electric Power Corporation (NEEPCO), Tehri Hydro Development Corporation and the Nathpa Jhakri Power Corporation. These bodies do not have the financial muscle for the development of hydro-power capacity. Given the high capital cost, long gestation period and the environmental and social costs, hydro-power development is not the preferred option for power generation compared to other sources.

PROJECT PREPARATION

The analysis so far shows that there are considerable differences between estimations at the time of appraisal and actuals. Costs are systematically underestimated and benefits exaggerated so that the requisite B-C ratio is shown to have been arrived at. Further, during actual implementation, there are enormous escalation in costs, considerable delays and changes in design and scope of projects. Benefits, on the other hand, fall well below anticipated figures as actual irrigated area and achieved yields fall below projected levels. In this background, it is important to enquire into the planning and implementation processes in order to seek reasons for this sorry state of affairs.

The first steps in the preparation of project reports are identification and investigation. The identification of projects should follow from an assessment of water resources by the State and the plan for phased development of such resources. Regarding the existence of such assessments and plans, the PAC (1983) had the following to report:

"One of the strategies/priorities of the Sixth Five Year Plan in the irrigation sector is preparation of State-wise Master Plans and completion of all investigations by 1989-90. Not a single State has, however, been able to prepare such a plan pending completion of investigations needed therefor. The Committee trust that the State Governments would realise the desirability and the urgency of preparing such plans in the interest of orderly and phased development of the precious water resources." (p. 53)

In the absence of a plan and even of requisite detailed information regarding water resources in the state till as late as the Sixth Plan, it is a mystery how project identification was done. Clearly, some ad-hocism must have ruled in the absence of a technical approach. In my discussions with officers of irrigation departments, I have been informed that sometimes the decisions are taken and announced at the political level without even a preliminary survey.

Another factor which seems to have influenced the identification of projects is inter-state competition for developing irrigation projects. Although rivers are inter-state , irrigation has been a state subject. Rivalries therefore have not been unusual. As far back as 1964, the "Committee to Suggest Ways and Means of Improving Financial Returns from irrigation Projects" put the following question to state governments: "Will it be possible to concentrate on the continuing schemes and to start only a minimum of new schemes to complete them on a priority basis?" The answer of one state (Mysore) was absolutely frank: "Not agreed. Most of the rivers in the State are inter-state. Some major projects on them are already under construction in neighbouring states. So, possible projects on them in Mysore, if not started early, will be objected to on the ground of "perspective rights". Again most part of the State is arid requiring irrigation facilities urgently." (p. 53)

A perusal of committee reports shows that state governments have guarded their rights zealously. The Irrigation Commission (1972) had recommended the setting up of an 'Indian Service of Engineers', but the PAC (1983) was informed: "The matter has been under consideration since August 1961. It will take some more time for a final decision to be taken ..... (and) to obtain the view of some of the State Governments whose reactions are still awaited" (p 58). Clearly, the states wanted the centre to remain at an arms-length: "....so far as the association of the Central Water Commission is concerned, the State Governments have been quite averse to associating the Central Water Commission .....Perhaps, they have got the fear that there may be certain inter-state aspects which will become known to the Central Government and their projects might be delayed" (p. 59).

Given the inherent tendencies towards competitive construction of projects, phases of easy availability of finance saw spurts in launching of new projects. The Gadgil formula, which operated during the fourth and fifth plans, alloted 10 percent of plan funds to states on the basis of major continuing irrigation and power projects. In addition, non-plan assistance, assistance under advance action and additional central assistance for command area development (a centrally sponsored scheme from 1975-76) were also provided to states during the period. In addition, World Bank finance also began to flow-in. New Project reports were the key to getting all these finances. As is well known, success in the bureaucracy is generally measured by the officer's (department's) abilities to get finances. It is no wonder then that the fourth and fifth plans saw a major spurt in the initiation of new projects.

This is how new projects have been identified in addition to the common-sense approach of providing irrigation to dry and drought-prone areas. Large projects required detailed project reports for their inclusion as new plan projects. The machinery for investigation was wanting in many respects. In the early years of planning, i.e. upto mid-sixties, large projects were taken up with little investigations:

> "Although, investigations were carried out for fixing dam sites, and for dam or barrage foundations, detailed investigations on the canal system were carried out later and in most cases, the estimates framed were based on preliminary investigations and cost studies of one or two small branches or distributaries. A per acre cost was adopted for working out the total cost of the canal system. Also provision for drainage etc. were made on *ad-hoc* basis. It was only in the course of construction of main dam and barrages that further detailed investigations were carried out for the canal systems, railway crossings, cross drainage structures etc." (PAC, 1983 p. 31)

In 1973, the Naegamwala Committee identified inadequate investigations as a principal cause for cost and time over-runs. It recommended that projects costing over Rs. 30 crore should be given a more strict treatment regarding detailed investigations and preparation of project reports and that the outlay on these could be upto 5 percent of the anticipated project cost. In 1983, the PAC was again recommending that "this suggestion be pursued vigorously with State Government."

The Estimates Committee found that the State governments were not adhering to CWC guidelines which caused delays in sanctions. Project reports were incomplete in many crucial ways (as listed out in PAC, 1983 p. 54). Further, the survey staff were not competent enough. Proper training was lacking, though improvements in this were reported in later years. Further, there were no incentives to conduct surveys in distant and difficult locations with virtually no amenities. The quality of project reports therefore was generally extremely unsatisfactory.

But project reports were the key to finance. The requisite B-C ratio was necessary to jump over a number of initial hurdles – the CWC, Central Electricity Authority (for hydro-power projects) and the Technical Advisory Committee – so that the projects could be blessed by the relevant working group and then included by the Planning Commission. If allotment for the irrigation sector was large, more new projects will come in. Alternatives were rarely, if at all, examined. The requisite B-C ratio was therefore a necessary condition for inclusion subject to the availability of finances for the irrigation sector.

No examination of alternatives, from an economic appraisal viewpoint, is done for projects. The benefit-cost ratio, as the Desai Committee found, is restricted to the final version of the project which is posed for approval. Technical and economic analyses are separate – the latter is generally an add-on to the final technical version. Optimisation of technical parameters within a techno-economic framework was suggested by the Desai Committee. Also, the use of sensitivity analysis to estimate the effects of changes in assumptions was recommended by the committee.

The disturbing picture that emerges is that the appraisal procedure and criterion seem to have been reduced to so many bureaucratic requirements which needed to be shown to have been fulfilled to get finance and the go-ahead for execution. And the requirements were somehow fulfilled on paper.

STATEMENT - II.1

Increase in Cost Estimates of Irrigation Projects (all figures in Rs. Crore)

	Fifth Plan				Sixth Plan	
State	*All Schemes*		*New Schemes*		*All Schemes*	
	Original	*Latest*	*Original*	*Latest*	*Original*	*Latest*
Andhra Pradesh	206.17	1129.98	17.2	59.86	415.96	1336.7
Assam	15.85	22.49	15.83	22.49	31.15	39.31
Bihar	153.52	991.88	41.4	86.3	172.26	1021.6
Gujarat	237.22	666.22	60.31	122.09	281.23	742.29
Haryana	156.68	290.22	117.11	192.11	251.11	385.17
J & K	35.01	59.82	29.84	52.7	35.01	59.02
Karnataka	223.13	924.18	90.54	125	201.93	851
Kerala	34.61	305.21	-	-	34.61	385.21
Madhya Pradesh	76.06	291.51	-	-	420.24	990.21
Maharashtra	522.24	1849.21	300.19	606.39	640.26	2064
Manipur	8.37	25.98	3.75	9.12	55	78.68
Orissa	309.26	536.07	267.74	441.42	430.94	752
Punjab	221.65	206.73	166.15	191	401.79	765.54
Rajasthan	265.34	754.04	98.12	206	279.5	773.63
Tamil Nadu	40.72	130.25	14.55	44.5	40.72	130.25
Uttar Pradesh	445.19	1339.66	271.05	380.2	732.61	1846
West Bengal	125.07	338.16	69.72	213.7	125.07	330.16
TOTAL	3074.07	10022.4	1563.3	2913.46	4646.01	12568

SOURCE: Desai Committee Report, 1983. Central Water Commission.

STATEMENT - II.2

National Average Yield on Irrigated Areas 1978-79 (qtl./ha.)

	National Demonstration	*Average of State Yields*
Wheat	35.97	18.69
Rice	34.82	17.82
Maize	36.54	15.46
Jowar	35.24	12.39

SOURCE: Desai Committee Report, 1983; Central Water Commission.

STATEMENT - II.3

Table for Canal Losses (Cusecs/million sq.ft)

Projects	*Losses*	
	Projected	*Observed*
1. Chambal Right Main Canal	8	15
2. Tawa	8	22.8
3. Mahanadi Canal System (M.P.)	8	39.7
4. Nagarjunasagar Left Bank Canal	8	21.2
5. Nagarjunasagar Right Bank Canal	8	16.7
6. Periyar Main Canal (Lined)	2	3.5
7. Periyar Franch Canals (Lined)	2	3.25
8. Periyar Branch Canals (Lined)	2	3.26
9. Periyar Vaigai Distribute and watercourses (unlined)	8	2.7
10. Girna/Jamda LBG	8	11
11. Mula Right Bank Canal	8	24-25
12. Nira Rilght Bank Canal	8	6
13. Purna (Bamath Branch)	8	15
14. Mula Sonai Distributary	8	9-19

SOURCE: 141st Report of Public Accounts Committee.

STATEMENT - II.4

Financial Analysis of Some Projects

Project	*Evaluated by*	*Annual Benefits/Annual Costs figures in Rs. Crores*	*B.C. Ratio @ 12%*	*Net Present Value @ 12% figures in Rs. Crores*
JLN Haryana	Water and Power Consultancy Services (INDIA) Pvt. Ltd. (Jan.1996)	9.55/26.71 = 0.36 (10.04/30.96 = 0.32)	0.37 (0.36)	- 56.7 (- 56.7)
Jamuna Assam	Water and Power Consultancy Services (INDIA) Pvt. Ltd. (July.1996)	3.26/4.16 = 0.78 (7.55/6.86 = 1.10)	0.66 (0.76)	- 8.15 (- 6.04)
Mayurakshi West Bengal	Water and Power Consultancy Services (INDIA) Pvt. Ltd. (July.1996)	103.22/38.23 ≈ 2.70 (214.48/36.73 = 5.80)	1.63 (1.65)	120.17 (124.85)
Chambal Rajasthan	Water and Power Consultancy Services (INDIA) Pvt. Ltd. (June 1996)	174.83/27.76 ≈ 6.30 (261.72/63.81 = 4.10)	3.19 (3.26)	181.29 (200.73)
Giri Himachal	Consulting Engineering Services (India) Pvt. Ltd. (Oct. 1996)	1.495/1.06 = 1.41 (1.916/1.295 ≈ 1.48)	- (1.06)	- (8.90)
Malaprabha	C.C.Patel and Associates Pvt. Ltd. (Sep. 1995)	Master Plan : 37.64/70.44 = 0.53 Yaragatti Plan: 94.03/70.44 = 1.33	Master Plan : 0.47 Yaragatti Plan :5.23	Master Plan : (-)1833.46 Yaragatti Plan : 14757.18

Figures in parenthesis pertain to benefits / costs associated with CAD project as well.
Blanks represent non-availability of data.

STATEMENT - II.4 (CONTD.)

Financial Analysis of Some Projects

Project	*Evaluated by*	*Annual Benefits/ Annual Costs figures in Rs. Crores*	*B.C. Ratio @ 12%*	*Net Present Value @ 12% figures in Rs. Crores*
Bhadar Rajkot	C.C.Patel and Associates Pvt. Ltd. (March 1996)	- -	0.93 (1)	- 3.5
Dharoi Gujarat	Kirloskar Consultants Ltd. (March 1996)	- (2.22)	- (1.59)	- -
Kukadi Maharashtra	Kirloskar Consultants Ltd. (Oct. 1996)	86.69/70.53 = 1.23 (113.84/90.89 = 1.25)	- (4694.04/4428.34 = 1.06)	- (8.90)
Sharada canal Project U.P.	Operations Research Group (Feb. 1996)	420.27/324.98 = 1.28 (1129.15/466.59 = 2.42)	- (534.9/299.78 = 1.78)	- (235.12)
Hasdeo Bango M.P.	Redecon (India) Pvt.Ltd. (June 1996)	6.61/69.93 = 0.09 (31.79/74.17 = 0.43)	- -	- -
Barna M.P.	Redecon (India) Pvt. Ltd. (July 1996)	(4.09/3.42 = 1.20) (7.89/4.3 = 1.83)	- -	- -

Figures in parenthesis pertain to benefits / costs associated with CAD project as well.
Blanks represents non-availability of data.

STATEMENT - II.5

Hydro Electric Power Installed Capacity And Generation All India : (1947 To 1994-95)

	Installed Capacity		*Generation*	
Year	*Hydro (MW)*	*Hydro As % of Total*	*Hydro (GWH)*	*Hydro As % of Total*
1	2	3	4	5
1950	559.3	32.7	2519.8	49.3
1955	939.5	34.9	3742.2	43.6
1960-61	1916.7	41.2	7836.6	46.3
1965-66	4123.7	45.7	15225.0	46.2
1968-69	5906.9	45.6	20722.7	43.7
1973-74	6965.3	41.8	29071.8	43.5
1978-79	10833.1	40.6	47158.9	46.0
1979-80	11384.0	40.0	45477.6	43.5
1984-85	14460.0	33.9	53948.3	34.4
1985-86	15471.6	33.1	51020.8	30.0
1986-87	16195.6	32.9	53840.9	28.7
1987-88	17265.3	31.9	47444.4	23.5
1988-89	17798.1	30.2	57867.9	26.1
1989-90	18307.6	28.8	62116.1	25.3
1990-91	18753.4	28.4	71641.3	27.1
1991-92	19194.3	27.8	72757.1	25.4
1992-93	19575.9	27.1	69869.3	23.2
1993-94	20378.0	26.6	70462.6	21.7
1994-95	20832.3	25.7	82712.0	23.6

SOURCE: Water and Related Satistics, 1998, CWC.

III. FINANCIAL PERFORMANCE

> "The Supplementary Report of C & AG for the year 1975-76 had pointed out that just before Independence i.e. 1945-46, the net gain to the Exchequer from Irrigation schemes after meeting working expenses, interest charges and deducting loss on unproductive works was Rs.7.92 crores i.e. a return of 5.3 per cent on the investment of Rs. 149 crores. Just after Independence, irrigation works in the country as a whole yielded a net annual profit of over Rs. 1 crore after meeting the cost of maintenance and interest charges. In the subsequent periods, the irrigation and multi-purpose projects incurred losses." (PAC, p. 130)

Irrigation systems before independence were divided into "productive" and "unproductive works" for the purposes of finance and accounting. Prior to the great famine of 1877-78 all works were 'productive' in the sense that they yielded profits after meeting the interest charges and O&M costs. After the famine, the category of "protective" or "unproductive" works were introduced mainly as a protection to vulnerable agriculture in drought-prone areas. Profit was not the intended criterion.

After the Montague-Chelmsford reforms, irrigation became a provincial subject (1921). Thereafter, all unproductive works were financed from the provincial revenues or central grants. Central loans, in addition to state revenues, were used only for productive works. In 1947, the losses from unproductive irrigation works were Rs.0.84 crores and the area under these works was only 1.6 million hectares. Compared to this, the area and profits from productive works were 5.6 million hectares and Rs.1.9 crores. The profits more than compensated for the losses.

Post-independence India embarked on ambitious development of the irrigation sector. Although the financial criterion for project sanction remained on paper till 1964, considerable dilution was allowed in practice. Irrigation development became a part of plan resources in the states sector with finances coming from *(a)* state revenue surpluses, *(b)* state loans from the public and *(c)* central loans and grants. In the first three Plans some weightage in the allocation of central funds was given to states with large irrigation schemes. In the fourth plan 10 percent of the plan funds were earmarked for meeting the financial needs of major projects in states. As the capital outlays increased, the financial losses from public irrigation works mounted. The losses in 1955-56 were Rs. 4.84 crore. The figure increased to Rs.14.48 crore in 1960-61 and then to Rs.56.91 crore at the end of the third plan. (For details, kindly refer back to Statement I.2).

Concerned with the rapidly deteriorating state of irrigation finances, the Government of India set up a "Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects" in 1964. In 1972, the Irrigation Commission expressed concern over the financial situation and also made recommendations so that irrigation projects, as a whole, "give an annual income at least equal to their annual cost of operation." In 1976, the

National Commission on Agriculture noted that losses had risen to Rs.141 crore in 1971-72. It too, like the Irrigation Commission, recommended that "at the time of considering a new project for sanction, its financial return should also be carefully examined." Its recommendations also related to revision of water rates. By the end of the seventies the deteriorating financial position of the sector was beginning to have its impact on capital outlays. Simultaneously, the earlier urgency of increasing food production had eased. The irrigation sector began to feel the constraint of finances for capital expenditures in a big way. The Estimates Committee of 1977-78 was principally concerned with the inadequacy of resources for even completing on-going projects. It recommended an enhancement of irrigation outlay as a percentage of total plan outlay and special treatment/ provision for states with large incomplete projects. But these were not enough. The real help, which the Estimates Committee had just begun to understand, had begun to flow in from the World Bank.

The Estimates Committee noted that "upto the end of the Fourth Plan, the assistance from the World Bank as rendered or committed for major and medium irrigation projects amounted to 112.9 million dollars for six projects"....(p.72) The trend is assistance was clearly on the rise. "In all 23 projects are stated to have been identified for credit assistance from the Bank. Of these, the Bank has evinced interest to consider providing assistance to twelve projects" (p.73). We have compiled a list of externally funded projects in late seventies and eighties based on information in the Ministry's annual reports and on data provided by Singh (1997). The list is not exhaustive (as annual reports of few years could not be readily obtained due to paucity of time). Nevertheless, the available list shows that the World Bank funded about 46 irrigation projects with the total assistance amounting to nearly $5000 million. In addition, hydro-power projects were also financed taking the total assistance to nearly $7,800 million. (For details, refer to Annexure IV) There is little doubt that the spurt in the number of new major and medium projects taken up in the Fifth Plan was the result of World Bank funding. External funding appears to have tapered off in the late eighties.

The easy availability of external finance put into the background the issue of financial reforms in the irrigation sector. Paradoxically, as losses in the sector mounted, the allocations and the number of new projects increased. In 1975-76, the losses were Rs.146 crore which rose to Rs.403 crore in 1980-81 (PAC, p130). The PAC (1983) also enquired into the question of losses. The evidence placed before the PAC makes a sad reading:

> "The trend in irrigation losses has been a matter of serious concern... successive Five Year Plans have stressed the need for adopting suitable measures for reducing progressively the losses on irrigation works and ultimately eliminating these altogether......The successive Finance Commissions have also gone into the question of irrigation losses and have made several suggestions from time to time for implementation by States. The Irrigation Commission (1972) also examined this matter in detail and suggested a number of steps to improve financial return on

> investment for irrigation projects. The Committee on Taxation of Agricultural Wealth and Income (Raj Committee) also recommended that water supplied by public irrigation projects should be priced like any other input so as to cover the cost......Planning Commission and Ministry of Irrigation have been taking up this question with the State Governments in many forums like the National Development Council meetings, annual plan discussion, State Ministers Conference, Regional Conferences etc.....The National Development Council....also recognised that the financial results of ... irrigation works needed urgent improvement for orderly implementation of the Sixth Plan."

To this long list of futile attempts we need to add the "Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects" (1964), the "National Commission on Agriculture" (1976), the "Public Accounts Committee" (1983) National Water Policy (1987) and the "Committee on Pricing of Irrigation Water" (1992). According to CWC data, losses from Irrigation and Multipurpose River Valley Projects rose from Rs.424 crore in 1980-81 to Rs.945 crore (1985-86) and then to Rs.3124 crore in 1993-94.

As the Vaidyanathan Committee (1992) pointed out, the CWC figures underestimate the actual losses on account of four factors. First, the interest (and depreciation) shown are with regard to commercial projects (a vestige of the earlier productive irrigation category). It does not include interest on capital expenditures on the non-commercial (protective) projects and on command area development. Second, the rate of interest shown is a book adjustment based on rates indicated by the state government and not actuals. To correct for this the Vaidyanathan Committee used the "average interest rate paid on the outstanding public debt of each state." Third, interest during construction is not capitalised. Finally, "gross receipts" or incomes from irrigation projects include a number of items which are not irrigation income and can account for upto a fifth of "gross receipts." Quick but incomplete estimates made by the Committee for the year 1986-87 showed that losses were in the region of Rs.1526 crore compared to CWC estimate of Rs.1379 crore, nearly 11 percent more in a single year.

The immediate causes for the mounting losses, as emerges from various reports, are *(a)* rising costs *(b)* stagnant water rates and *(c)* shortfalls in area irrigated and delays in completion. Of these, the issue of water rates has emerged as the most important in recent years.

Water Rates

Despite repeated exhortations by numerous official committees, water rates have remained remarkably sticky:

> "Revision of water rates has been infrequent, hesitant and very much less than the increase in costs. For instance, water rates in Tamil Nadu were last revised 30 years back. In Punjab, Kerala, Haryana, Jammu and Kashmir and Himachal Pradesh,

> there has been no change in rates since the mid-seventies. Several (states) announced revisions during 1981-86, but in some cases the implementation of the revised rates was held up by the Governments.....The rate increases were themselves rather modest and no state has accepted, much less implemented, the Irrigation Commission's recommendation for reviewing and adjusting rates every 5 years......During this period, the prices of agricultural produce have roughly doubled and overall yields of irrigated crops were also rising." (Vaidyanathan Committee 1992, p.37-38).

Not only were the rates not revised even to account for inflation, they were fixed at ridiculously low levels. "In no state", the Vaidyanathan Committee noted, "does the gross receipt by way of water charges per hectare account for more than 3 percent of the gross productivity per hectare of irrigated area." Further, even this meagre amount was not collected and the arrears in collection had been allowed to accumulate. There was also no rational basis for the fixation of rates; the water-intensive crops actually paid less per unit of water and the correlation between gross receipts and productivity across states was absent. Cost coverage, of course, was not a consideration at all.

Cost Escalation

The two other proximate factors cited as causes for the losses, are escalation in costs and shortfalls in area irrigated and delays in completion of projects. Both these are primarily the result of faulty planning – from the project to the national levels-and tardy implementation. The "Expert Committee on Rise in Costs of Irrigation and Multi-Purpose Projects" (Naegamwala Committee, 1973) and the Planning Commission's Working Group for Sixth Plan (1980) identified ten factors causing cost escalation and time over-runs. Of these eight are clearly attributable to faulty planning:

(i) proliferation of projects resulting in thin spreading of resources,
(ii) lack of thorough investigations before starting work,
(iii) delays in taking decision,
(iv) non-availability of essential inputs,
(v) change in scope of projects during implementation,
(vi) lack of construction planning and monitoring organizations in states,
(vii) lack of detailed plans and estimates for the distribution systems and structures thereon; and
(viii) failure to update estimates and inform governments of the rise in cost of projects.

The PAC (1983) noted that the problem of proliferation has escalated since 1969:

> ".......until 1969 major projects were added at a steady rate, averaging 4-5 projects per year. However, since then there has been a spurt in the number of new projects. As many as 119 major projects and 479 medium projects have been taken up since

> the commencement of the Fourth Plan till the end of 1979-80.....The Committee have been given to understand that 'with the severe droughts in the late sixties and early seventies there were immense and persistent demands for undertaking new projects. It also became a national policy to exploit our water resources and provide the basic infrastructure of irrigation as early as possible.' The Committee need hardly point out that long gestation projects need very thoreugh and detailed investigations. In any case, drought conditions call for quick result yielding schemes which is possible only through the development of minor irrigation facilities. The Committee, therefore, consider it to be a negation of planning for the Planning Commission to sanction a large number of major schemes without making sure the availability of funds, the technical personnel and essential inputs like cement, steel, coal etc. to enable completion of the projects within the time schedule laid down and within the approved estimates". (p.51).

According to the PAC, therefore, the escalation in costs is attributable almost entirely to faulty planning. The combined effect of the politics of water rates and the administration of project planning and implementation is that the irrigation sector has made staggering losses since independence. According to Gulati et.al (1995) during the period 1951-90 "more than Rs.600 billion (at 1988-89 prices) have been spent towards creating a huge canal network through major and medium irrigation schemes. The direct financial recovery from the irrigation schemes is less than Rs.3 billion at 1988-89 prices."

The enormous losses in the irrigation sector have serious implications for the financial viability of hydro-power. As already noted, the cost per unit of hydro-power is low because only a small part of the capital cost of multi-purpose projects are apportioned to hydro-power. Hydro-power therefore generally shows a profit if power rates are at reasonable levels. But this is only notional. The bulk of the costs are apportioned to irrigation from where benefits are only notional; actual financial returns are negligible. Therefore, if the combined financial viability of the project is studied, the gains from power are unlikely to compensate for losses from irrigation unless hydro-power generation is extremely large. We did a case study of the Damodar Valley Corporation to examine this argument. It was seen from the case study that the combined impact of hydro-power, irrigation and flood-control is financially non-viable. The profits of DVC are essentially the result of thermal power generation and sales.

IV. DISTRIBUTIONAL ASPECTS

Distributional Weights

The philosophy underlying usual benefit-cost analysis is that those who get benefited from the project should be able (hypothetically) to compensate the losses of those adversely affected and still have some net benefits left (Hicks-Kaldor compensation test). In short, benefits from the project must exceed costs. However, this presumes that all benefits and losses, irrespective of whom they accrue to, are given equal weightage. The rich and the poor are treated alike. To correct for this, distributional weights are sometimes assigned so that the benefits to the poorer are given more weightage.

In India, economic appraisal of projects has not followed this practice. In the case of irrigation projects, neither the earlier financial criterion nor the subsequent quasi-economic criterion raises the question of distribution. None of the official committees, except the Desai Committee (1983), has made any recommendation regarding the incorporation of distributional issues in project appraisal procedures. The Desai Committee recommended the inclusion of distributional effects for project appraisal. It, however, was not in favour of the use of distributional weights. According to it, "the analysis of distribution of surplus income should be used to estimate *(a)* the number of small and marginal farmers who would benefit and *(b)* the proportion of benefits which will accrue to them. As a part of benefit-cost analysis this factor can be taken into account by taking credit for the savings in subsidy......" (p.11). Similarly, employment benefits should also be taken into account with due care. The committee also stressed that the issue of rehabilitation requires special attention:

> "It is essential that the loss of income and property as also aminity suffered by displaced persons should be quantified as thoroughly as the gain in income of beneficiary households. The data base for such calculations has to be obtained from land holdings data and, if necessary, a socio-economic survey. The estimates of loss must also include an adequate solatium for the psychic consequence of displacement. The provision for compensation included in the project can be set off against this estimated loss". (p. 96).

The recommendations of the Desai Committee, as mentioned earlier, have been ignored. Surprisingly, distributional analysis of irrigation projects in India have been rare even by individual researchers. To the best of my knowledge, only two cost-benefit studies have incorporated distributional analysis using income weights. The first is an unpublished Ph D. thesis by M.N. Murty on the Nagarjuna Sagar Project (which could not be obtained due to paucity of time). The other is a study of Western Gandak Canal Project by Singh (1994). Singh does an evaluative study of the financial, economic and social (using distributional weights) net benefits from the project (barrage and canals). The financial analysis yields a <u>negative</u> NPV of Rs.4.52 crores. Economic analysis (using economic prices) also yields a <u>negative</u> NPV of Rs.0.72 crores. However, when regional income distributional weights are used, the NPV becomes significantly positive. Since the project under study is a barrage it is not really a representative one for this study, but it indicates that there is no a priori reason to expect that the inclusion of distributional analysis will invariably lower the net benefits.

Subsidies

Another way of looking at the question of "who gains and who loses" is to examine the financial performance of projects (which has been attempted in the earlier section). The operational losses from public irrigation projects are, in fact, implicit subsidies which the state governments provide to the beneficiary farmers. These subsidies are large and have continuously increased. A study by Srivastava and Sen (1997) for the year 1993-94 have estimated that, among the state government subsidies, irrigation subsidies were the largest (Rs.12,421 crore) and accounted for 24 percent of all subsidies. Education subsidies came second, accounting for 20 percent of total subsidies, followed by power subsidies (11.4 percent). On a per capita basis, irrigation subsides for the same year ranged from Rs.33 in West Bengal to Rs.300 in Goa with Maharashtra, Haryana, Gujrat and Karnataka (all well-off states) showing per capita irrigation subsidies exceeding Rs.225. Since the beneficiaries of public irrigation are only a section of the farmers, not the entire state population, per beneficiary subsidies will be fairly high.

The inequity involved in such large scale subsidisation of beneficiaries have often drawn sharp reactions from various committees. The Irrigation Commission (1972) was perhaps the most explicit:

> "There is a view that irrigation projects should be undertaken not as much for the purpose of earning revenue but as a measure of social welfare and that the irrigation rates should be kept low. This approach would be valid if the benefits from irrigation projects were more or less evenly distributed over the entire farming community. But this is not the case as the main beneficiaries are only a section of the cultivators in the command area. It would be highly inequitable to call upon dry-farmers and the general tax-payers to pay for benefits enjoyed by irrigators." (p. 264-5)

In a similar vein, the PAC (1983) saw "no reason why the big landowners who are the principal beneficiaries of the irrigation facilities, should continue to be subsidised any longer though it may be justified in the case of small and marginal farmers and share croppers" (p. 136). It must be mentioned that the subsidies relate only to operational losses, the capital expenditures are not covered. Since capital expenditure involves long term borrowing, and since irrigation projects yield almost no income, inter-generational distributional issues also become an important consideration as the tax burdens over future generations are likely to be heavier and/or future development expenditures are likely to be curtailed.

Regional Distribution

An analysis of the regional distribution of benefits shows that the benefits from large irrigation and multipurpose projects have been confined mainly to the Northern and Southern regions with the Western region coming third. The Eastern and North Eastern regions have reaped very little benefit. (Details presented in Annexure V).

It can be seen from the annexure that the Southern region (comprising 4 states) alone accounts for 45 percent of the hydro-power installed capacity in the country (excluding the central sector) and 25 percent of gross irrigated area. The northern states, on the other hand, account for about half of the irrigated area and nearly 29 percent of the installed hydel capacity. In contrast, the combined share of eastern and north-eastern states in hydro-power capacity is only 10 percent and that in irrigated area only 6.5 percent. Statewise, the maximum share in hydro-power benefits have been received by Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Punjab, Kerala and Uttar Pradesh (in that order). The maximum shares in irrigation benefits have accrued to Uttar Pradesh, Punjab, Andhra Pradesh, Rajasthan and Madhya Pradesh. In short, the states in the northern and southern regions account for 75 percent of both hydro-power and irrigation benefits. Clearly, the regional distribution of benefits from large irrigation and multi-purpose projects have been highly inequitable.

Intra-Project Distribution

The issues relating to intra-project distribution of costs and benefits have been widely commented upon and also forms a major part of an accompanying WCD study (Singh, 2000). Hence the issues are mentioned here only in passing.

Dams, by their very nature, lead to submergence and displacement in the catchment area, which is hilly, and the irrigation benefits flow to the command area. The burden of costs and benefits therefore fall on different sets of people (geographically separated). One expects, and this is confirmed by Singh's (2000) study, that the costs fall disproportionately on tribals. The benefits accrue to farmers, usually the bigger or more dominant ones, who are able to influence, in many cases, the actual distribution of water. Land ownership data sometimes show that larger landowners benefit. This could also be the result of the fact that land holdings in unirrigated areas are usually larger. Once irrigation is provided the benefits accrue to these larger farms. Further, since Punjab, West U.P. and Rajasthan are some of the states benefiting more, and since the average size of holdings in these regions are larger than in eastern India, the positive correlation between size and irrigation may appear.

Another intra-project issue is the unequal distribution of benefits between the upper, middle and tail reaches of canals. A quick study, done by us, based on evaluation studies of five projects (result presented below) only reconfirms the already known results. As can be seen from the table, both (net) area irrigated and cropping intensities are much lower in the tail reaches.

Intra-Project Distribution of Irrigation Benefits

Project	*Evaluating Organization/ Reference Year*	*Avg. Size of Holding*	*Cropping intensity*	*Irrigated area*
Mayurakshi-West Bengal	WAPCOS 1992-93	Upper 1.11 ha. Middle 1.14 ha. Tail 1.16 ha.	U.152.68% M.148.50% T.143.73%	U.123.71 ha. M.207.14 ha. T.154.03 ha.
Jamuna- Assam	"	U.2.45 ha. M.2.51 ha. T.2.31 ha.	U.167.02% M.180.98% T.179.52%	U.1033 ha. M.1165 ha. T.981 ha.
J.L.N. Haryana	"	U.2.88 ha. M.3.83 ha. T.2.80 ha.	U.175.17% M.176.40% T.161.47%	U.385.11 ha. M.451.88 ha. T.465.66 ha.
Chambal Rajasthan	"	U.4.55 ha. M.3.73 ha. T.4.25 ha.	U.122.89% M.118.63% T.116.38%	U.817.28 ha. M.421.58 ha. T.565.35 ha.
Giri-H.P.	Consulting Engineering Services Iindia) Pvt. Ltd.	U.2.39 ha. M.1.90 ha. T.2.46 ha.	RBC.183.1% LBC.169.1%	U.22 ha. M.66 ha. T.75 ha.

RBC = Right Bank Canal; LBC = Left Bank Canal.

Finally, the problem of project affected people have become a central one. Unfortunately, wide differences exist regarding the number of persons displaced by large irrigation and multi-purpose projects. The estimates range from 2 million to 40 million. What is, however, less contentious is that the compensation paid hardly covered a small part of the costs borne by the displaced in an overwhelming majority of projects as brought out, among others, by Thukral (1992) and Singh (2000). A large number of people have undoubtedly been impoverished as costly projects with doubtful net benefits have been undertaken.

V. LESSONS AND CONCLUSIONS

In this brief study, we have attempted to trace the evolution of appraisal procedures and criteria employed by government authorities to analyse and decide upon large projects. We have also traced the behaviour of actual costs and benefits and compared them with anticipated costs and benefits using both project-level and aggregative studies. Only direct costs and benefits have been studied.

The study brings out the enormous lethargy and resistance to change in the irrigation sector. It took seventeen years after independence for a shift from financial appraisal to quasi-economic appraisal procedures. The procedures established in 1964 continued almost without change till about 1990, by which time the cost definition was widened and IRR calculation was added. But even now, despite Desai committee recommendations in 1983, the shift to full economic appraisal has not materialised.

This amazing resistance to change is not because the existing procedures were helpful for project-clearance. Undoubtedly, it is easy for computation. But, as pointed out, the accounting fallacy of 10 percent interest on *entire* project cost actually makes it difficult for projects to qualify. Yet there was no change because appraisal exercises were not taken seriously. The problem was tackled through data misrepresentation - costs were grossly underestimated and benefits overestimated. The actuals showed that the projected data were, by and large, fictitious. The entire appraisal process developed into a huge systematic exercise in self-deception.

One reason for this is that the benefit cost analysis has never been used as a tool for assessing alternatives and therefore never been central to the planning process. As the National Commission on Agriculture noted:

> "Irrigation projects do not individually compete with projects under other heads of development. For instance an irrigation project cannot be dropped in favour of a fertiliser project merely because the latter has a higher benefit-cost ratio or rate of return. If due to financial constraint the outlay for irrigation is squeezed that does not affect the acceptance or rejection of any individual irrigation scheme. It merely defers the taking up of a new scheme or slows down the pace of construction" (p. 62-63).

Thus the only use of the benefit-cost ratio is for accepting or rejecting a project. Since the development of water recourses has been a state subject and outlay on irrigation is provided in the state sector, the real onus of proper appraisal lies with the states. Each state investigates, constructs and operates its irrigation projects. The benefit-cost ratio enters only as a central government imposed criterion which must be *shown* to have been fulfilled to obtain central clearance and plan finance. It is not surprising therefore that sometimes projects are announced and even started without an appraisal and thereafter the project report undertakes the tortuous exercise of benefit-cost justification. Capital costs are under-estimated by at least half the actuals and projected benefits are nearly double that of actuals.

While this has been the dominant story since 1964, the last twelve years may have witnessed a change towards more realistic benefit assessments and the inclusion of many cost elements which were previously ignored. The reason for this is that, due to financial difficulties faced by the centre and the states, the number of new projects have declined making better appraisal easier. Pressures from enlightened public opinion has also reinforced the need for greater realism in project preparation. Transparency and debates are therefore good for all concerned parties.

Harder budget constraints have also meant that the overwhelming domination of political and bureaucratic concerns over economic and financial considerations is no longer possible. The recovery ratio, which fell from over 90 percent to less than 10 percent, has shown the utter lack of financial management in this large sector. Water rates have been ridiculously low and have borne no relation to either benefits or operational costs. Pricing of water has been a victim of populist politics. Thus not only huge capital expenditures with doubtful benefits but even operational expenditures in this sector have depended on subsidies and taxpayers' money. Unwittingly, it has been a huge but costly distributional exercise. Many in the sector and also the beneficiaries have made hay while the budgetary position was easy. Now the adjustments are proving difficult as old habits die heard. The position is now so pathetic that even maintenance expenditures have been shown as capital expenditures, for which plan funds are available, for renovation and modernisation of systems.

In short, the absence of accountability and transparency has harmed the long-run interests of irrigation development in India. It is necessary to discuss the entire appraisal procedures and criteria as well as financial accountability systems in public so as to enable the development of a more enlightened and professional decision-making and management system which examines alternatives so that scarce public resources are put to the most beneficial uses. This WCD exercise is a small attempt in this direction and must be followed up by detailed and comprehensive economic and social benefit-cost evaluation of a few selected projects.

ANNEXURE - I

Conversion Factors from Financial to Economic Costs for Capital Investment and O&M Items

S.No.	*Items of Investment*	*Conversion Factor*	
		Capital Cost	*O&M Cost*
1.	Headworks	0.75	0.75
2.	Primary and Secondary Canals		
	2.1 Earthwork		
	(a) Cutting		
	i. Manual	0.65	-
	ii. Mechanised	0.80	-
	(b) Filling		
	i. Manual	0.65	-
	ii. Mechanised	0.80	-
	(c) Compaction		
	i. Manual	0.65	-
	ii. Mechanised	0.95	-
3.	Tertiary Canals		
	(a) Earthwork		
	i. Manual	0.65	0.75
	ii. Mechanised	0.80	0.75
4.	Structures	0.75	0.75
5.	Field Channels	0.60	0.75
6.	Lining of		
	i. Primary and Secondary Canals	0.75	0.75
	ii. Tertiary Canals	0.75	0.75
	iii. Field Channels	0.75	0.75
7.	Drainage System	0.75	0.75
8.	Construction of Roads	0.80	0.75
9.	Consultancy	1.00	-
10.	Physical Contingencies	0.75	0.75

SOURCE: "Subarnarekha Irrigation Project. Feasibility Report, Volume-I." Chapter-IX, Table 9.07 (a).

ANNEXURE - II

Comparison of Projected Yields with Actuals

Note: Projected yields are given in project reports. Actuals are averages for the available observation on irrigated yield in the State for the period 1968-69 to 1979-80

P = Projected **A = Actuals (in quintals/hec.)**

State and Project	Rice		Wheat		Jowar		Bajra		Maize		Gram		Groundnut		Cotton	
	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A
A.P: Pocham-ped	40	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bihar : Auranga-bad	27.5	9	27.5	11	-	-	-	-	-	-	-	-	-	-	-	-
Gujarat: Mahi	30	16	28	19.5	20	12	12	12	25	16	-	-	13	10	18	8
Haryana: Jui Lift Irrgn.	30	-	15	20	-	-	30	8	-	-	25	8	-	-	-	-
M.P.: Tawa	40	11	35	13	29.5	na.	-	-	-	-	15	8	20	na.	15	na
Orissa: Lower Indra	30	11	25	na.	-	-	-	-	35	na	-	-	26	na.	-	-
Rajasthan: Canal Phase-II	-	-	30	14	-	-	25	na.	-	-	20	9	-	-	18	6
T.N. : Cauvery Delta	30	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U.P: Sarda Sahayak	27.5	13	30	14	-	-	-	-	-	-	10	8	-	-	-	-

n.a. Data not available or no. of years for which it is available less than 5.
SOURCE: "Desai Committee Report, 1983".

ANNEXURE - III

Ratio of Irrigated to Unirrigated Yields of principal Crops in India
(Period: 1991-92 to 1994-95)

States	*Ratio*
ANDHRA PRADESH	**Rice**
KHARIF	1.969
RABI	-
ASSAM	
AUTUMN	2.00
WINTER	1.07
SUMMER	1.71
BIHAR	
AUTUMN (92-93)	1.59
WINTER (92-93)	1.80
SUMMER (92-93)	-
GUJARAT	1.82
HARYANA	-
HIMACHAL PRADESH	1.38
KARNATAKA	
KHARIF	1.57
RABI	-
SUMMER	-
KERALA	
AUTUMN	1.10
WINTER	1.08
SUMMER	0.87
MADHYA PRADESH	
AUTUMN	1.678
MAHARASHTRA	
AUTUMN	0.94
SUMMER	-
ORISSA	
AUTUMN	1.379
WINTER	1.259
SUMMER	-
PUNJAB	
AUTUMN	2.12
RAJASTHAN	
KHARRIF	2.95
TAMILNADU	
(i) I&II Corp.	-
(ii) K/K/S	2.18
(iii) S/T/P	2.65
(iv) T/N/P	-
UTTAR PRADESH	-

States	*Ratio*
WEST BENGAL	
AUS	1.42
AMAN (WINTER)	1.30
SUMMER	1.15
	Jowar
ANDHRA PRADESH	
KHARIF	3.219
RABI	2.72
GUJARAT	
KHARIF	0.90
RABI	1.22
HARYANA	
KHARIF	1.64
KARNATAKA	
KHARIF	2.09
RABI	1.94
MADHYA PRADESH	-
MAHARASHTRA	
KHARIF	-
RABI	2.00
TAMIL NADU	2.12
	Bajra
ANDHRA PRADESH	2.23
GUJARAT	
KHARIF	1.787
SUMMER	-
HARYANA	1.41
KARNATAKA	2.13
MADHYA PRADESH	1.39
MAHARASHTRA	1.63
PUNJAB	1.41
RAJASTHAN	
KHARIF	2.18
TAMIL NADU	2.20
ORISSA	1.35
	Maize
ANDHRA PRADESH	
KHARIF	1.49
RABI	1.48
BIHAR	
AUTUMN	-

States	*Ratio*
RABI (92-93)	-
GARMA (92-93)	-
GUJARAT	1.42
HARYANA	1.268
HIMACHAL PRADESH	1.07
KARNATAKA	
KHARIF	1.05
RABI	-
SUMMER	-
MADHYA PRADESH	1.50
MAHARASHTRA	
KHARIF	-
RABI	-
PUNJAB	1.479
RAJASTHAN	1.50
WEST BENGAL	-
	Ragi
ANDHRA PRADESH	
KHARIF	2.00
RABI	1.90
GUJARAT	0.92
KARNATAKA	-
MAHARASHTRA	-
TAMIL NADU	1.82
	Wheat
ASSAM	1.558
BIHAR	1.48
GUJARAT	4.39
HARYANA	2.00
HIMACHAL PRADESH	1.22
JAMMU & KASHMIR	1.12
KARNATAKA	3.14
MADHYA PRADESH	2.39
MAHARASHTRA	2.32
PUNJAB	1.79
RAJASTHAN	2.42
UTTAR PRADESH	-
WEST BENGAL	1.38
	Barley
BIHAR	-
HARYANA	1.466
HIMACHAL PRADESH	0.97
MADHYA PRADESH	1.80
PUNJAB	2.327
RAJASTHAN	1.64
UTTAR PRADESH	-
WEST BENGAL	-

States	*Ratio*
	Gram
BIHAR	-
GUJARAT	1.37
HARYANA	1.537
KARNATAKA	1.309
MADHYA PRADESH	1.158
MAHARASHTRA	1.306
PUNJAB	1.526
RAJASTHAN	1.58
UTTAR PRADESH	-
WEST BENGAL	1.04
	Ground-nut
ANDHRA PRADESH	
KHARIF	1.609
RABI	1.38
GUJARAT	
KHARIF	2.83
SUMMER	-
KARNATAKA	
KHARIF	1.18
RABI	0.90
MADHYA PRADESH	-
MAHARASHTRA	-
KHARIF	-
RABI	-
ORISSA	
KHARIF	1.28
RABI	0.90
PUNJAB	1.357
RAJASTHAN	1.59
TAMIL NADU	1.73
	Sugar Cane
ANDHRA PRADESH	1.63
ASSAM	-
BIHAR	0.71
HARYANA	-
KARNATAKA	-
MAHARASHTRA	-
PUNJAB	1.22
RAJASTHAN	1.27
TAMIL NADU	-
WEST BENGAL	-
	Tobacco
ANDHRA PRADESH –	
VIRGINIA	1.25
NATU VARIETY	1.99

States	*Ratio*
GUJARAT	1.959
KARNATAKA	1.379
MAHARASHTRA	-
	Rapseed & Mustard
ASSAM	1.628
BIHAR	-
GUJARAT	2.38
HARYANA	1.36
MADHYA PRADESH	2.418
ORISSA	1.648
PUNJAB	1.49
RAJASTHAN	1.22
WEST BENGAL	1.50
	Cotton
ANDHRA PRADESH	1.53
GUJARAT	2.92
HARYANA	-
KARNATAKA	1.87
MAHARASHTRA	1.80
PUNJAB	2.18
RAJASTHAN	2.02
TAMIL NADU	2.13
MADHYA PRADESH	1.71
	Jute
ASSAM	0.818
WEST BENGAL	1.297
BIHAR	-
ORISSA	1.577

Computations Based on Data from "Area and production of principal crops in India : 1993-94 to 1994-95."Directorate of Economics and Statistics, Ministry of AgricIture.

ANNEXURE - IV

External Finance for Irrigation and Hydropower Projects: A Select List

A. Power		
Projects	**Source**	**Amount**
1. Upper Indravati Project	World Bank	US $326.40 million
2. Bodhghat	,,	$267.20 million
3. Kerala Power	,,	$175.00 million
4. Karnataka Power	,,	$330.00 million
5. Second Karnataka Power	,,	$260.00 million
6. Uttar Pradesh Power	,,	$289.90 million
7. Maharashtra Project	,,	$400.00 million
8. Nathpa Jhakri Power Project	,,	$485.00 million
9. DVC Project	,,	$43.50 million
10. Koyna Projeact	,,	$46.10 million
11. Indira Sagar	,,	$300.40 million
Total—A	,,	**$2923.50 million**
B. Irrigation		
1. Godavari Barrage Project (Andhra Pradesh)	World Bank	US $45 million
2. Nagarjunasagar Composite Project (Andhra Pradesh)	,,	$145 million
3. Periyar Vaigai Project (Tamil Nadu)	,,	$23 million
4. Maharashtra Irrigation Project	,,	$70 million
5. Orissa Medium Irrigation Project	,,	$58 million
6. Upper Krishna Irrigation Project (Karnataka)	,,	$126 million
7. Gujarat Medium Irrigation Project	,,	$85 million
8. Haryana Modernisation and CAD Project	,,	$111 million
9. Sone Irrigation (Bihar)	,,	$18.09 million
10. Shetrunji Irrigation (Gujarat)	,,	$5.19 million
11. Purna Irrigation (Maharashtra)	,,	$15.67 million
12. Salandi Irrigation (Orissa)	,,	$9.54 million
13. Pochampad Irrigation (Andhra Pradesh)	,,	$40.60 million
14. Kadana Irrigation (Gujarat)	,,	$35 million
15. Rajasthan Chambal CAD	,,	$52 million
16. Rajasthan Canal and CAD Project	,,	$83 million
17. Chambal (M.P.) Irrigation	,,	$24 million
18. A.P. Irrigation and CAD Project	,,	$145 million
19. Periyar Vaigai Irrigation-II Project	,,	$35 million
20. Maharashtra Irrigation Project-II	,,	$210 million
21. Mahanadi Barrage Project (Orissa)	,,	$83 million
22. Subarnarekha Irrigation Project (Orissa and Bihar)	,,	$127 million
23. Orissa Irrigation Phase-II Project	,,	$105 million
24. Karnataka Irrigation Project	,,	$117 million
25. Karnataka Tank Irrigation Project	,,	$54 million
26. Gujarat Medium Irrigation-II Project	,,	$172 million
27. Gujarat (Composite) Irrigation-II Project	,,	$175 million
28. Haryana Irrigation-II Project	,,	$150 million
29. Punjab Irrigation Project	,,	$129 million

Annexure IV (Contd...)

Annexure IV (Contd...)

30. Upper Ganga Modernisation Project	,,	$125 million
31. Madhya Pradesh Medium Irrigation Project	,,	$140 million
32. Madhya pradesh Major Irrigation Project	,,	$220 million
33. Chambal (M.P.) Irrigation Project-II	,,	$31 million
34. Kallada Irrigation and Treecrop Development Project (Kerala)	,,	$80.30 million
35. Narmada River Development (Gujarat) Sardar Sarovar Dam and Power Project	,,	$300 million
36. Narmada River Development (Gujarat) Water Delivery and Drainageb Project	,,	$150 million
37. Maharashtra Composite Irritation-III	,,	$169.083 million
38. Andhra Pradesh Irrigation-II Project	,,	$271 million
39. National Water Management Project	,,	$114 million
40. Upper Krishna Irrigation-II Project (Karnataka)	,,	$327 million
41. Punjab Irrigation and Drainage Project	,,	$171.429 million
42. Andhra Pradesh Irrigation-III Project	,,	$325 million
43. Punjab Drainage	,,	$12.05 million
44. Madana Irrigation Project	,,	$36.55 million
45. Tamil Nadu Irrigation	,,	$23 million
46. Bhima CAD Project (Maharashtra)	IFAD	$50 million
47. M.P. Medium Irrigation	IFAD	$25.06 million
48. Rajasthan Canal and CAD Project	,,	$55 million
49. Rajasthan Medium Irrigation Project	U.S.	$36.25 million
50. Tawa CAD Irrigation Project (M.P.)	KFW, FRG	(i) Grant DM 30 million (ii) Loan DM 45 million
51. Sidhmukh and Nohar Project (Rajasthan)	EEC	ECU 45 million
52. Upper Indravati Irrigation Project	Japan	Yen 3744 million
53. Upper Kolab Irrigation Project	,,	Yen 3769 million
54. Indira gandhi Nahar Project (Rajasthan)	,,	Yen 84 million
55. Modernisation of Kurnool-Cuddapah Canal (Andhra Pradesh)	,,	Yen 16049 million
56. Rajghat Canal Major Irrigation Project (Madhya Pradesh)	,,	Yen 13222 million
57. Rengali Irrigation Project (Orissa)	,,	Yen 7760 million
58. Community Irrigation Project (Kerala)	Netherlands	DFL 11.02 million
59. Tungabhadra Irrigation Pilot Project (Phase-II) (Karnataka)	,,	DFL 5 million
Total (50 projects)		**US $5102.812 million**
Total (6 projects)		**Yen 44628 million**
Total (1 project)		**DM 75 million**
Total (1 project)		**ECU 45 million**
Total (2 projects)		**DFL 16.02 million**
Total (World Bank Assistance A+B)		**US $7867.002 million**

SOURCE: Annual Report, Ministry of Irrigation and Power: 1973-74, 1984-85.
Annual Report, Ministry of Agriculture and Irrigation: 1976-77, 1977-78, 1978-79.
Annual Report, Ministry of Water Resources: 1985-86, 1986-87, 1987-88, 1988-89, 1990-91, 1995-96, 1997-98, 1998-99.
Singh, 1997.

ANNEXURE - V

Inter-State Distribution of Benefits from Irrigation and Hydro Power Projects

State	*Installed Hydel Capacity* (in MW)	*% of Total Installed Capacity*	*Number Of Projects* Major	Medium	*Gross Irrigated Area* (in Ha.)	*% of Total Gross Irrigated Area*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
NORTHERN REGION						
Haryana	883.90	4.52	11	0	-	-
Himachal Pradesh	299.37	1.53	1	4	-	-
Jammu and Kashmir	184.06	0.94	2	24	214000	1.16
Punjab	1798.94	9.20	7	3	2428000	13.14
Rajasthan	971.08	4.97	9	99	1990000	10.77
Uttar Pradesh	1507.75	7.71	67	41	4587000	24.83
Chandigarh	0.00	0.00	-	-	-	
Delhi	0.00	0.00	-	-	3000	0.02
TOTAL	5645.10	**28.89**	97	171	9222000	**49.92**
% of all INDIA Totals	**28.89**		**29.66**	**17.01**	**49.92**	
EASTERN REGION						
Orissa	1271.92	6.51	16	50	-	-
West Bengal	141.51	0.72	7	30	-	-
D.V.C.	144.00	0.74	-	-	-	-
Sikkim	32.89	0.17	0	0	-	-
TOTAL	1590.32	**8.14**	19	75	1157000	**6.26**
% of all INDIA Totals	**8.14**		**5.81**	**7.46**	**6.26**	
NORTH - EASTERN REGION						
Assam	2.00	0.01	7	13	-	-
Arunachal Pradesh	29.55	0.15	0	0	-	-
Manipur	2.60	0.01	3	5	-	-
Mizoram	5.31	0.03	0	0	-	-
Meghalaya	186.71	0.96	0	1	-	-
Nagaland	3.500	0.02	0	0	0	0
Tripura	16.01	0.08	0	3	38000	0.21
TOTAL	245.68	**1.26**	10	22	**38000**	**0.21**
% of all INDIA Totals	**1.26**		**3.06**	**2.19**	**0.21**	
WESTERN REGION						
Goa	0.05	0.00	1	2	12000	0.06
Gujarat	547.00	2.80	21	118	668000	3.62

Annexure V (Contd...)

Annexure V (Contd...)

State	*Installed Hydel Capacity* (in MW)	*% of Total Installed Capacity*	*Number Of Projects* Major	Medium	*Gross Irrigated Area* (in Ha.)	*% of Total Gross Irrigated Area*
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Madhya Pradesh	846.11	4.33	32	136	1738000	9.41
Maharashtra	1801.22	9.22	62	239	1127000	6.10
Dadra and Nagar Haveli	0.00	0.00	-	-	2000	0.01
Daman and Diu	0.00	0.00	-	-	-	-
TOTAL	3194.38	**16.35**	116	495	3547000	**19.20**
% of all INDIA Totals	**16.35**		**35.47**	**49.25**	**19.20**	
SOUTHERN REGION						
Andhra Pradesh	2656.94	13.60	30	126	2203000	11.92
Karnataka	2555.55	13.08	19	54	1213000	6.57
Kerala	1699.50	8.70	14	13	-	-
Tamil Nadu	1955.70	10.01	22	49	1084000	5.87
Pondicherry	0.00	0.00	-	-	11000	0.06
TOTAL	8867.69	**45.37**	85	242	4511000	**24.42**
% of all INDIA Totals	**45.37**		**25.99**	**24.08**	**24.42**	
ALL INDIA TOTALS	*19543.17*	*100*	*327*	*1005*	*18475000*	*100*
Total Central Sector	2365.01					
GRAND TOTAL	**22083.08**					

Figures of Installed capacity (col. 2) relate to March 1999.
Figures of Number of Projects (Col.4 and 5) refer to completed and ongoing projects upto 8th plan.
Gross Irrigated Area figures relate to GIA from government canals as in 1992-93.
All percentages are with reference to All India Totals which for hydro-power exclude "Central Sector".
SOURCE: Water and Related Statistics , Central Water Commission , July 1998.

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Chapter 3

SOME AGREED CONCLUSIONS

R. Rangachari, Nirmal Sengupta, Ramaswamy R. Iyer, Pranab Banerji, and Shekhar Singh

3.1 AN OVERVIEW: LARGE DAMS IN INDIA

1. India has over four thousand 'large dams' as defined by The International Commission on Large Dams (ICOLD). Many of these (a little less than half) are lower than 15 m in height (the principal criterion) but are classified as large dams based on other ICOLD criteria.

2. At the start of the twentieth century India had 42 large dams. By 1950 a further two hundred and fifty had been added. The rest were undertaken in the second half of the last century. Half the large dams were undertaken in the period 1970 to 1989. An examination of the Statewise picture of the distribution of large dams shows that nearly half the large dams are in the two States of Maharashtra and Gujarat, and that almost three fourths lie within the three States of Gujarat, Maharashtra and Madhya Pradesh.

3. The basic thinking behind dam-building in India was *(a)* that rainfall in the sub-continent was highly seasonal, with most of the precipitation occurring within a few months of the year and within that period the intensity being concentrated within a few weeks; *(b)* that precipitation was also highly variable as between different parts of the country and from year to year; and *(c)* that it was therefore necessary to store river waters in reservoirs behind dams for the purpose of transferring supplies from surplus to deficit seasons/areas, and from years of good rainfall to deficient ones.

4. The average annual runoff carried by the rivers in India, estimated by the Central Water Commission as around 1869 billion cubic meters (BCM), has been revised by the National Commission for Integrated Water Resources Development to 1953 BCM. The extent of total live storage created under the various completed schemes (big and small) so far is of the order of 177 BCM. The addition that is anticipated through the schemes under construction is of the order of 75 BCM, taking the total to 250 BCM. Of this, 'large' storages, defined as having a capacity (gross) of more than 1 BCM, will account for 164

BCM live, taking both completed schemes and those under execution. The balance is accounted for by minor schemes and small storages.

Objectives

5. The principal concern in undertaking these projects was to provide irrigation for protecting agriculture from the vagaries of the monsoon. Even 'multi-purpose' projects had irrigation as a major aim. However, some projects were taken up mainly or wholly for hydro-power generation, and a few for industrial and domestic water supply. In some flood-moderation was among the principal aims.

Investments

6. As 'large dam projects' do not figure as a separate category in accounting, it is not possible to give figures of investment in such projects. Instead, the category of 'major and medium irrigation projects', could be used as a proxy. (The classification of projects into 'major/medium' and 'minor' is at present by the extent of culturable command area covered.) Not all major/medium projects may involve dams (large or other), but many of them do; and the number of dams built for hydro-electric power without any significant irrigation component and thus falling outside this classification is likely to be small. In fifty years of planned development, a sum of about Rs. 91943 crores (Rs. 919 billion) at current prices was invested for irrigation from all categories of schemes. This is equivalent to Rs. 231386 crores at constant (1996-97) prices. 'Major and medium' projects accounted for Rs. 52606 crores (132390 crores at 96-97 prices) and 'minor' schemes for Rs. 29162 crores (73387 crores at 96-97 prices)[1]. A further sum of Rs. 5419 crores (or Rs.13386 crores at 96-97 prices) was spent in 'command area development' schemes for promoting the use of the irrigation potential created by the projects. Flood management accounted for Rs. 4857 crores (12222 crores at 96-97 prices).

Contribution of Dams: Irrigation

7. What has been the contribution of large dams to the country? Taking irrigation first, India's 'irrigation potential' (i.e., the area which had the potential of being irrigated – a somewhat problematic concept) increased from 22.6 million hectares (ha) in 1951 to about 89.6 million ha by 1997, marking a fourfold growth over a period of 50 years. The production of foodgrains increased from 51 million tonnes in 1950-51 to almost 200 million tonnes by 1996-97. About two-thirds (66.7%) of this increase came from the irrigated area, which is around one-third of the cultivated area. The increase in the production of foodgrains was the result of a combination of several factors such as high-yielding varieties of seeds, chemical fertilizers and pesticides, credit, extension, support prices, and so on, but clearly irrigation played a crucial role, and some of that irrigation

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[1] All these figures are taken from the Ninth Plan, but there is a problem here. If the figure of Rs. 132390 crores is divided by 3500 dams (the number assumed to be built after the commencement of planning), the investment per dam comes to less than Rs. 40 crores, which seems too low even as an average.

came from large dams. Taking the 'major/medium' category (which accounts for 36.8% of irrigation) as a proxy for large dams, we can say that 36.8% of the increase in the production of foodgrains in the irrigated area (which in turn is two-thirds or 66.7% of the total increase), i.e., 24.5% (66.7% x 36.8%) of the total increase, came from areas irrigated by large dams. This still leaves open the question of how much of this increase can be attributed to the dams themselves. One view is that excluding the effects of the other inputs, 10% of the increase can be attributed to dams. However, others are of the view that this is an under-estimate, as irrigation is a precondition for the use of other inputs. The Central Water Commission puts the quantum of increase attributable to large dams at 30%, but the details behind that number are not available. Leaving the numbers aside, it can be stated that large dams have made a contribution to the development of irrigation and therefore to food production and food security.

Contribution of Dams: Hydro-Power

8. Hydro-electric power generally forms part of the purposes of dam projects, along with irrigation, flood control, water supply, and so on, but there are a few cases where the only or most important objective in view is hydro-electric power. There are also many 'run-of-the-river' schemes (i.e., without the building of storages on the river) for the generation of hydro-electric power. At the time of Independence (1947), the total installed generating capacity was 1362 MW, including 508 MW of hydro-power capacity. The installed capacity in March 1998 stood at 89000 MW inclusive of a hydro-power capacity of 21891 MW[2]. About two-thirds of the installed hydro-power capacity is attributed to storage-backed schemes (i.e., dams) and one-third comes from run-of-the-river schemes.

Contribution of Dams: Flood Moderation

9. Generally speaking, large dams have indeed moderated floods to some extent, particularly when a flood-reserve capacity is specifically allocated, proper reservoir regulation instructions are laid down, and adherence to them is independently monitored. Even in multipurpose reservoirs without a prescribed flood-reserve, the available storage space at the time of a peak flood flow can be used to impound the flood waters to the extent possible, but in the absence of an earmarked reserve space it may become necessary to release the impounded waters in the event of further inflows, and this could lead to increased flows lower down and create difficulties.

There has, however, been considerable settlement and economic activity in the flood plains lower down, because of which even the reduced peak flows below the large dams tend to cause serious flood damages. Hence, appropriate structural measures for flood moderation need to be coupled with the requisite nonstructural measures.

[2] 'Firm Power' may be much lower than the installed capacity, particularly in the case of hydro-power projects operated as peaking stations.

Contribution of Dams: Other

10. Public water supply is not often a stated objective of large dam projects, but in many cases reservoirs and canals are in fact made use of for this purpose. In some cases, this objective has been explicitly added at a later date. Whatever be the reason, this is welcome and is in accordance with the prioritization of uses in the National Water Policy (1987). Certain cities and towns depend on nearby reservoirs for their drinking and municipal water needs. Some also get a part of their water through long-distance transfers.

There are a few projects which meet industrial demands for water. No compiled data are readily available for dam-based storage meeting the industrial need of water, but this is an important function, sometimes the primary function, of some dams.

As regards navigation, this has not so far played a significant role in the planning of dam projects, except in the case of the Damodar Valley Corporation; even there it did not develop as originally envisaged.

Large dam projects also lead to certain incidental benefits not included among the declared objectives. For instance, degraded catchment areas may improve as a result of being treated in the interest of reducing the siltation of the reservoir; the new forest created as `compensatory afforestation' may grow into a new ecological system; the large waterbody created may become a wildlife habitat and contribute to bio-diversity; fisheries may develop in the reservoirs, offsetting to some extent the impact of the project on the existing fish population; the reservoir may become a centre of tourism and recreational activities; and so on.

Some Problems

11. Most large dam projects, particularly those undertaken in recent decades, have been characterized by certain problems, such as substantial environmental and social costs, the thin and sub-optimal spreading of resources on a large number of projects, inordinate delays in completion, large increases over the sanctioned project costs (both because of delays and because of initial under-estimation), projects spilling over from Plan to Plan and needing large provisions, a persistent gap between the created irrigation potential and its utilization, failures to achieve the projected benefits in full, inequities and injustices in the incidence of costs and benefits and in the distribution of the benefits, and so on. There have also been complaints about corruption and of collusion between project planners/ managers/politicians on the one hand and consultants/ contractors on the other. These are doubtless generally prevalent problems in the country, but dam projects (like other large projects) seem especially prone to the incidence of these managerial, social and political ills because of their size and complexity and the magnitude of the financial resources involved. A further problem is the failure of most of these projects to generate adequate revenues for the state exchequer, largely as a result of low water rates and poor collections.

Controversy

12. In recent years there has been a fierce controversy regarding large dams. Being moved by massive displacements and poor rehabilitation performance, some activists fighting for dam-affected people, as also some experts and professionals assessing the planning and performance of projects, have raised doubts about the desirability of large dams. Awareness of the many adverse environmental and social impacts of dams first led to doubts about specific dams and then developed into a questioning of large dams as a viable technology for equitable and sustainable development. The supporters of large-dam projects argue that they confer many benefits; that without them growing needs of food, water and energy cannot be met; that any harm that they may cause can be anticipated and remedied or mitigated; and that some of the adverse consequences attributed to dams really arise from certain 'political economy' factors prevalent in the country. Those who question the acceptability of some or all large dams contend that the benefits of many large dams are overstated and the costs understated; that they do far more harm than good; that their impacts and consequences are rarely assessed in advance and cannot be fully foreseen, much less remedied; that many adverse impacts are irremediable; and that in so far as certain 'political economy' factors are in fact operative in the country, these have to be taken into account while undertaking large projects. They argue further that future needs can be met without recourse to large dams, through smaller structures and through other methods including demand-side management. The rejoinder to this by the supporters of large dams would be that small dams, local watershed development, water harvesting, etc., are all complementary measures that can meet only a small part of overall requirements, and are not substitutes for large projects. This is not accepted by those who advocate alternatives. Unfortunately, the controversy has become emotionally charged. Extreme positions held strongly at either end of the spectrum tend to dominate the debate, drowning the voices of the reasonable.

In this context, apart from considering the overall balance of the good and bad aspects of dams, it will be necessary to ask whether all or most large dams are viable and optimal; whether the other approaches/ techniques suggested hold promise of meeting the future needs of food, water and energy; whether they actually have less adverse social and environmental impacts; and whether they are really *alternatives* that obviate the need for large dams, or at least some or many of them. It has also to be determined under what conditions large dams can be considered viable and optimal and what processes are required to establish this.

13. The issues referred to in the foregoing paragraphs, as well as others such as the environmental and social aspects of dam projects, have been discussed by different members of this Team in the various chapters of this Report. The responsibility for each chapter rests with its author or authors. This chapter seeks to present a set of conclusions acceptable to the Team as a whole, and not summaries of the earlier chapters.

3.2 THE LEGAL AND INSTITUTIONAL FRAMEWORK

1. There is an implicit assumption that rivers are resources of the state to be dealt with by the governments *for* the people. This fails to recognize that the people could have concerns and interests of their own, and that there could be conflicts between these and the aims and purposes of the government.

2. The 'eminent domain' claimed by the state over land and water tends to prevail over the rights of the people.

3. The actual operation of the Land Acquisition Act, dating back to the 19th century, under which private land is acquired by the state for a public purpose, and which is the principal instrument of displacement in the implementation of large-dam projects, has been beset with problems in many cases. The affected people can question the quantum of compensation, but it is very difficult for them to challenge the 'public purpose' claimed by the state, or to argue that alternative ways of achieving that public purpose should be considered. Major changes are necessary in the Land Acquisition Act and the related procedures.

4. Until recently, there was no statutory requirement of a public hearing in relation to the environmental clearance of such projects. It has now been introduced but has not yet become a well-established procedure.

5. Some State Governments have tried to provide project-affected persons (PAPs) with benefits in the command area through legislation, but while these Acts are on the statute book and contain some enlightened provisions, it cannot be said that they have been fully put into practice.

6. The Official Secrets Act creates a veil of secrecy around governmental actions, keeps the people at a distance, denies not merely information but even physical access to areas, and in general renders all talk of 'participatory' or 'people-centred' planning meaningless.

7. A new dimension has been added to the legal and policy framework by the persistent efforts of the Judiciary to expand the human rights jurisdiction of the courts and extend the scope of judicial review of executive action. As a part of this 'activism', the Judiciary has been encouraging what is known as 'Public Interest Litigation' (PIL). Many individuals and NGOs have played an important role in these developments.

8. It seems likely that in future the third tier in the constitutional structure, created by the 73rd and 74th Amendments, namely, the village *panchayats* and the city *nagarpalikas* (municipalities/corporations), will come to play an important role in relation to water-resource development. However, the processes of decentralization are still evolving, and the role of the third tier is as yet only incipient.

9. Twelve years after it was adopted, the National Water Policy 1987 still remains a set of general statements and has not been effectively translated into detailed sub-policies, programmes and action plans.

10. An effort to codify the set of principles and practices that have been evolving on the subject of the resettlement and rehabilitation of people displaced or otherwise affected by large projects in the form of a National Rehabilitation Policy has not reached finality so far.

11. 'The Policy on Hydro Power Development' (August 1998) makes a case for large hydro-power projects without any reference to options and alternatives that some have put forward.

12. Outlays on projects and other new developmental activities are classified as 'plan' and operation and maintenance as 'non-plan'. This, together with the mounting establishment costs, and the inherent tendency on the part of the bureaucracy, the technocracy and the politicians in India to be more interested in the construction of new projects than in the efficient running of completed projects, leads to the under-provisioning and neglect of maintenance.

13. If and when 'private sector participation' in large dam projects becomes a significant reality, a crucial question will be how the human and social aspects, which have presented great difficulties even in public sector projects, will be taken care of in private ones.

14. Planning has by and large tended to proceed on the basis of discrete, individual projects. A truly integrated, holistic planning for a basin or a sub-basin would involve an *inter-disciplinary* planning for the basin or sub-basin, marrying land-use and water-use, harmonizing diverse water uses on the demand side and integrating *all* 'development' from local rainwater-harvesting and micro watershed development to 'mega' projects (and surface water and groundwater) on the supply side, while at the same time fully internalizing environmental, ecological, human and social concerns, and fully associating the people concerned ('stakeholders') at all stages. That kind of basin planning has not really been seriously attempted in India.

15. The basic criterion for the approval of projects has been the Benefit-Cost Ratio (BCR). The BCR as actually operated is an unsatisfactory criterion, and is liable to distortion. Dissatisfaction with the manner in which irrigation and multi-purpose projects were being dealt with led to the establishment of the Nitin Desai Committee which submitted a report in 1983 making recommendations for a change-over to a better appraisal system involving a proper socio-economic cost-benefit analysis leading to the determination of an economic IRR. This remains unimplemented.

16. Partly as a consequence of the abandonment of the earlier financial return criterion, and partly because the pricing of irrigation water in many States is so low and the recovery so poor as to make it virtually free, most large dam projects are loss-making propositions in so far as the state exchequer is concerned. This aggravates the resource shortage of the States.

17. The primary, controlling discipline in project preparation at the State level, and examination at the Central level, is engineering. Other disciplines, concerns and points of view are to some extent brought in through consultations and comments, but there is no *inter-disciplinary* planning in the proper sense of the term.

18. There is and can be no integrated, 'holistic' planning under these circumstances, despite instructions and exhortations to that effect.

19. One major feature of project planning has been the dominance of irrigation. Even multi-purpose projects' often have only two components, namely irrigation and hydro-electric power. The integration of other purposes has not been a standard feature of project planning. There could be conflicts between two different uses (e.g., between irrigation/ power generation and flood moderation, between irrigation and maintaining minimum flows), but these are not always explicitly recognized and built into project planning.

20. Project decisions do not represent carefully considered choices out of a number of possible answers to a given need or problem. Only one unique project is proposed for approval. *Within* the ambit of a project, there may be multiple possibilities at various stages, and some of these may be covered in the processes of project preparation, but *alternatives* to the project are not usually considered. Also, there is no conscious principle or policy of '*minimum environmental impact*' or '*least displacement*', and choices based on such considerations are unlikely to be presented.

21. One of the factors that militate against holistic, integrated planning is the fragmentation and compartmentalization of responsibilities at the administrative level. Even within the area of water resources proper there is a compartmentalization of different components or aspects such as major/medium projects; minor irrigation; command area development; groundwater; watershed development; rainwater-harvesting; water management; and so on. Different Divisions/ Departments/Agencies tend to deal with these matters with little coordination, much less integration.

22. The processes of appraisal and decision-making are not rigorous enough, as evidenced by the post-clearance history of scope changes and modifications in several projects, and the unsatisfactory investment criterion employed.

23. Civil society (in the sense of the people concerned, i.e., beneficiaries and those who are likely to be adversely affected, and the community in general) plays little or no role in the planning and implementation of such projects. The activity is essentially governmental. It is only in recent years that a consciousness of the importance of 'stakeholder participation' has begun to emerge.

24. In the absence of institutional arrangements for consultation and grievance-redressal, the processes of displacement, resettlement and rehabilitation often generate serious dissatisfactions leading in some cases to confrontationist situations.

25. The monitoring system is weak, and there is no effective mechanism to ensure that wherever sanctioned costs are likely to be, or have been, exceeded, the Revised Cost Estimate (RCE) is promptly brought the TAC/ Planning Commission for a fresh appraisal. There is also no established system of a post-completion evaluation. Very few projects, other than those that receive World Bank assistance, are subjected to such an *ex post facto* reappraisal.

26. Where the approval of a project is conditional, there is no effective mechanism for ensuring compliance with those conditions and taking appropriate measures in the event of non-compliance.

3.3 FINANCIAL, ECONOMIC AND DISTRIBUTIONAL ASPECTS

1. The "Report of the Committee to Review the Existing Criteria for Working Out the Benefit Cost Ratio for Irrigation Projects" (the Nitin Desai Committee) recommended the replacement of the existing quasi-economic methods by comprehensive economic appraisal techniques. However, the essential structure of project appraisal has hardly changed since 1964. The quasi-economic criterion of a ratio of annual benefits to annual costs , both evaluated at market prices and comprising of many rule-of-the-thumb items, continues even though the IRR is also reported and costs now have a broader definition.

2. The "Committee on the Pricing of Irrigation Water" (Vaidyanathan Committee) which submitted its report in September, 1992 recommended the re-introduction of a minimum financial return as an essential criterion for sanctioning all investment proposals along with social benefit-cost criteria.

3. The recovery rate (percentage recovery of working expenses through gross irrigation receipts) fell from 93 percent in 1976-77 to 46 percent in 1980-81 and further to a meagre 9 percent by the end of eighties. The irrigation sector had become a huge fiscal liability with annual operational losses crossing Rs.3000 crores in 1993-94.

4. The cost of creation of irrigation potential in Major and Medium irrigation projects shows a sharp increase in the capital cost per hectare between the First Plan period (1951-56) and the Annual Plans of 1990-92, from Rs. 1200 to Rs. 66570 in current prices, and from Rs. 8620 to Rs. 29587 in constant (1980-81) prices.

5. Actual expenditures on O&M have been much lower than the norms and even declined during the 1970s. Further, establishment costs as a proportion of O&M expenses rose in the 1980s while the proportion of maintenance and repairs fell sharply.

6. There is enough evidence to show that in aggregate terms (a) the actual area irrigated by major and medium projects falls well short of the projected area and the discrepancy may be increasing, (b) actual yield figures are often well below anticipated yields, (c) there is divergence between assumed cropping patterns and actuals and (d) there is some evidence of over optimistic price assumptions.

7. In the case of both irrigation and hydro-power projects, costs are often underestimated and benefits exaggerated so that the requisite B-C ratio is shown to have been arrived at.

8. Interim evaluation studies done for 12 command area development projects indicate that according to the original project proposals (without CAD) the B-C ratios (based on data of evaluation studies) are less than the cut-off rate of 1.5 in eight of the ten projects (relevant data for 2 projects were not available). If CAD is included, then also six of the eleven projects fail to reach the qualifying ratio of 1.5.

9. Turning to the general question whether or not the benefits from large scale canal irrigation clearly outweighs direct costs of providing the irrigation, the conclusion seems to be that by the early 1990s, major and medium projects may have become unviable if irrigation benefits alone are considered.

10. There is ad-hocism in the identification of projects and competition between States for developing projects with a view to establishing their respective rights over the waters of inter-State rivers.

11. According to CWC data, losses from Irrigation and Multipurpose River Valley Projects rose from Rs. 424 crore in 1980-81 to Rs. 945 crore (1985-86) and then to Rs. 3124 crore in 1993-94. The Vaidyanathan Committee (1992) pointed out that the CWC figures underestimate the actual losses. Quick but incomplete estimates made by the Committee for the year 1986-87 showed that losses were in the region of Rs. 1526 crore compared to the CWC estimate of Rs. 1379 crore. The immediate causes for the mounting losses, as seen from various reports, are (a) rising costs (b) stagnant water rates and (c) shortfalls in area irrigated and delays in completion.

12. Water rates have remained remarkably sticky. The rates are fixed at very low levels and are not revised even to account for inflation. Even this meagre amount is not collected and arrears in collection are allowed to accumulate. There has also been no rational basis for the determination of rates; in many cases, water-intensive crops actually pay less per unit of water. Correlation between gross receipts and productivity has been absent across States. Cost coverage, of course, has not been a consideration at all.

13. The "Expert Committee on Rise in Costs of Irrigation and Multi-Purpose Projects" (Naegamwala Committee, 1973) and the Planning Commission's Working Group for Sixth Plan (1980) identified ten factors causing cost escalation and time over-runs. Of these, eight are largely attributable to faulty planning:

(i) proliferation of projects resulting in thin spreading of resources,
(ii) lack of thorough investigations before starting work,
(iii) delays in taking decision,
(iv) non-availability of essential inputs,
(v) change in scope of projects during implementation,
(vi) lack of construction planning and monitoring organizations in states,
(vii) lack of detailed plans and estimates for the distribution systems and structures thereon; and
(viii) failure to update estimates and inform governments of the rise in cost of projects.

14. The cost per unit of hydro-power is low because only a small part of the capital cost of multi-purpose projects is apportioned to hydro-power. However, this is notional. If the combined financial viability of the project is studied, the gains from power are unlikely to compensate for losses from irrigation unless hydro-power generation is extremely large and its pricing has a significant margin over costs.

15. In the case of irrigation projects, neither the earlier financial criterion nor the subsequent quasi-economic criterion raises the question of distribution. The Desai Committee had recommended the inclusion of distributional effects for project appraisal, but this has been ignored.

16. The operational losses from public irrigation projects are, in fact, implicit subsidies which the State Governments provide to the beneficiary farmers. The inequity involved in such large-scale subsidization of beneficiaries has often drawn sharp reactions from various committees. The PAC (1983) saw "no reason why the big landowners who are the principal beneficiaries of the irrigation facilities, should continue to be subsidised any longer though it may be justified in the case of small and marginal farmers and share croppers" (p 136). Further, apart from operational losses, capital expenditures are not covered at all. As capital expenditure involves long-term borrowing, and as irrigation projects yield almost no income, inter-generational distributional issues also become important, as the tax burdens over future generations are likely to be heavier and/or future development expenditures are likely to be curtailed.

17. In so far as intra-project distribution is concerned, dams, by their very nature, lead to submergence and displacement in the catchment area, which is hilly, and the irrigation benefits flow to the command area. The burden of costs and benefits therefore fall on different sets of people (geographically separated). The benefits accrue to farmers, usually the bigger or more dominant ones, who are able to influence, in many cases, the actual distribution of water. Another intra-project issue is the unequal distribution of benefits among the upper, middle and tail reaches of canals. Finally, the problems of project-affected people have become a central issue. Wide differences exist regarding the number of persons displaced by large irrigation and multi-purpose projects. In an overwhelming majority of projects, the compensation paid covered only a small part of the costs borne by the displaced

18. Summing up

There has been enormous lethargy and resistance to change in the governmental system. Even now, despite the Desai committee recommendations of 1983, the shift to full economic appraisal has not taken place.

The appraisal exercises were often not taken seriously. The appraisal criterion adopted was faulty, and this tended to evoke the response of underestimating costs and overestimating benefits. The entire appraisal process degenerated into a formality.

One reason for this is that the benefit-cost analysis has never been used as a tool for assessing alternatives and has therefore never been central to the planning process. The ratio enters the picture only as a criterion imposed by the Planning Commission for the inclusion of a project in the Plan. However, there may have been a change in recent years towards more realistic benefit assessments and the inclusion of many cost elements which were previously ignored.

Water rates have been extremely low and have borne no relation to either benefits or operational costs. In general, they not only do not make a contribution towards the servicing of the large capital costs, but they do not cover even the O&M costs.

It is necessary to discuss the appraisal procedures and criteria and the financial accountability systems openly and purposefully with a view to developing more enlightened and professional decision-making and management systems which examine alternatives, so that scarce public resources are put to the most beneficial uses.

3.4 ENVIRONMENTAL, SOCIAL AND EQUITY ASPECTS

1. In India, large dams have had many costs and benefits. However, though the benefits (except for some incidental or unanticipated ones) have in general been identified and assessed, a large part of the costs, especially the environmental and social costs, have been ignored.

2. Till 1978, there was no formal requirement to assess the environmental or social impacts of large dams, either in order to assess their viability or to attempt to prevent or minimize adverse impacts.

3. Over 2500 large dams were initiated in India prior to 1978. Consequently, for these 2500 plus large dams, no assessment was required to be done of their social and environmental costs or viability nor was there any attempt to prevent or minimize most of the adverse impacts.

4. Apart from not acknowledging the social and environmental costs, most of these dams were also not required to internalize the costs of preventing, minimising or mitigating most of the adverse impacts.

Environmental Impacts

5. For some of these projects, there was an attempt to assess at least two of the environmental parameters: rate of sedimentation and possibility of water logging. These aspects were assessed primarily because of their impact on the life of the dam and on agricultural productivity in the command, respectively.

6. From 1978, the Government of India started insisting that all new dams be assessed for their environmental impacts and obtain environmental clearance prior to construction. However, despite such a stipulation, the 1800 large dams subsequently taken up for construction continued to adversely impact on the environment, though to a lesser extent. The reasons for this are summarised below.

7. The guidelines for conducting environmental impact assessments (EIA) of river valley projects were developed, in 1978, by the Department of Science and Technology and published, in 1985, by the Ministry of Environment and Forests (MoEF). These guidelines were very sketchy and did not prescribe a comprehensive assessment. Despite this, and the fact that knowledge and science has progressed much since then, these guidelines have still not been amended.

8. In many cases, even the minimal assessments required by the guidelines are not completed prior to project constructions. Often, State Governments start construction work even before the environmental clearance is received. In a few cases, they manage to obtain clearance before the completion of the required assessment, with the stipulation that the assessment would be completed by a stipulated future date and that safeguards would be implemented *pari passu* with construction work. In both instances, the basic purpose of an environmental assessment is defeated and the project is presented as a *fait accompli*, because the government does not have the political will to abandon a project on which considerable costs have already been incurred.

9. The process of environmental assessment is often hurried mainly because it is started when the project preparation is at an advanced state, rather than when the project was conceived. By the time the project comes to the MoEF for environmental assessment, considerable momentum has been generated for starting construction. Any delays in granting environmental clearance necessitated by the need to properly scrutinise the project is looked at askance and considerable pressure is brought upon the MoEF to quickly clear the project.

10. The situation is exacerbated by the fact that the consultants who prepare the environmental impact statements, on which the assessments are mostly based, are hired and supervised by the project authorities, Consequently, these statements are not always reliable.

11. Also, the MoEF prescribes no standards for most of the adverse environmental impacts, thereby making the final assessment of environmental viability excessively subjective and arbitrary.

12. To make matters worse, the conditions invariably prescribed at the time of clearance are often disregarded once the clearance is given. There is little ability within the MoEF to enforce these, short of revoking clearance, which is almost impossible to do within the prevailing political and administrative system.

13. There is no system of assessing the actual (as opposed to the anticipated) environmental impacts of completed projects. Therefore, the actual environmental impact of large dams remains a matter of speculation. There is, consequently, little opportunity of evaluating the efficacy of the methods of assessment, prevention and mitigation of such impacts. There is also little ability to evaluate whether the financial and economic costs such impacts and their prevention or mitigation incurred, were as anticipated and, if not, how a more realistic assessment of such costs would affect the economic viability of projects.

14. Clearly there is a need to prescribe a comprehensive environmental assessment of all dams and to insist that standards are formulated such that there is an ability to assess the environmental viability of proposed large dams. The process of assessment must be objective and scientific and the costs of prevention, reduction and mitigation must be calculated in full. The residual adverse impacts that cannot be so prevented, reduced or

mitigated must also be taken into consideration before assessing the economic viability of proposed dams.

15. There must be a system by which the onus is on the project authority to periodically establish that they are respecting the conditions of clearance. Environmental clearances to projects must automatically lapse if they cannot establish this.

16. There must be a constant assessment of the efficacy of assessment, prevention, reduction and mitigation techniques and the adequacy of the financial costs allocated for the purpose.

17. This whole process should be transparent so that it can bear public scrutiny.

Social Impacts

18. Large dams also have many social impacts, both beneficial and adverse. Many of the beneficial social impacts, in terms of enhanced supply of water for irrigation, domestic, municipal and industrial uses and the generation of power for industrial, domestic, agricultural and other uses are assessed in financial and economic terms and form the basis of the justification of a dam.

19. In a few cases, flood control is also an explicit objective and forms a part of the dam's justification. However, some level of flood control occurs as a result of many dams even though it might not be an explicit objective and the resultant beneficial social impacts are, therefore, not assessed as part of the project's benefits.

20. However, large dams also have many adverse social impacts, the costs of many of which are either not reflected at all or inadequately reflected in the benefit cost ratio. The assessment of some aspects of rehabilitation, mainly the rehabilitation package offered, is required to be done as a part of the environmental assessment process, but only since 1978.

21. The most significant social costs of large dams are borne by those who are forcefully displaced from their homes because of the dam. Only the financial costs of relocating and resettling them or, more often, compensating them, form a part of the financial analysis of a dam.

22. For most of the earlier projects, there is little or no reliable information on what happened to the displaced people. This is mainly because most of them were not rehabilitated in any meaningful sense, but given mainly cash compensation and left to look after themselves. In retrospect, it is impossible to trace them down and find out what happened to the rest of their lives as, indeed, to the lives of their children and grand children.

23. In some of the recent projects, there has been a tendency to provide a more comprehensive rehabilitation package and, occasionally, to even provide land for land. In a few of the very recent projects, it is proposed to provide land to the land-less and, in at least two cases, even to adult, unmarried, sons and daughters.

24. However, even in the progressive rehabilitation packages, a large number of needs are not provided for, or inadequately and inappropriately provided for. However, the vast

majority of the packages cannot be considered progressive, at least from current perspectives.

25. Apart from the adequacy of the rehabilitation package, a greater problem is its implementation. Even the inadequate provisions of the package are not implemented in full. In many projects, there are complaints that many of the promised benefits did not materialise. Where land was given, it was reportedly often of poor quality. The promised infrastructure, people complain, is missing or of poor quality and even basic necessities like water, shelter and economic survival are not always provided for. It is difficult, from whatever perspective one looks, to find many success stories.

26. Part of the problem of implementation is due to the faulty processes of rehabilitation. The planning and implementation is top down, bureaucratic, with little or no involvement of the affected and other concerned people. There is no transparency in the system and corruption is reportedly rampant. The minimum empathy and sensitivity that project affected people deserve, given their plight, is reportedly hard to find. Rehabilitation of project affected persons is generally treated as a marginal issue that does not deserve focussed attention.

27. Unfortunately, even the economic benefits flowing from a dam seem to have certain adverse social impacts. There are no specific government guidelines regarding equity aspects of large dams and the costs and benefits of dams are generally not equitably shared, with some people paying a bulk of the costs while others corner the bulk of benefits. Unfortunately, a disproportionately large number of those who pay the costs are members of scheduled tribes and castes, or other disadvantaged sections of society.

28. Even the distribution of benefits is not equitable. Irrigation benefits are mostly cornered by farmers with large land holdings and, among them, by those who are at the head of the distribution system rather than at the tail reach. Electricity is also disproportionately accessed by the urban rich and the rich farmer, as opposed to the urban poor and the poor farmer. Though such a distortion is not inherent to a power project, in actual fact it occurs.

29. Consequently, dams have not only helped to maintain the current inequities in the Indian society but, in some ways, have exacerbated them. However, despite this, no class-benefit analysis is required to be carried out of proposed dams and no equity standards have been laid down to which proposed dams must conform before they are considered socially viable.

30. Though there is today much greater soul searching about the adverse social impacts of dams than there is about the adverse environmental impacts, such soul searching has not led to a revaluation of the cost of dams on society. It has not yet led to the laying down of government policy directions incorporating standards of social disruption beyond which a dam, whatever its economic benefits, would not be considered viable. It has not led to a system by which more than just the financial costs of "compensating" social trauma are considered while determining the viability and optimality of a proposed dam. It has not

even resulted in the acknowledgement of the fact that gross injustice has been done to those who have had to bear the costs of large dams in India. There is a need to do all this and to follow it up, even at this late stage, by a sincere attempt to rehabilitate the millions of "development refugees" created by large dams. And it is the time to consider stipulating that, until this is done, or at least well begun, no further displacement would be allowed.

CONCLUSIONS

31. The process of planning for and assessing large dams must include a realistic look at the various alternatives and supplementary methods that are available to deliver the benefits large dams are expected to deliver. Each of these alternatives must be assessed in terms of their social and environmental impacts and the alternative consequently chosen must not only be viable, but also optimal. The process must be participatory and transparent.

32. Where a large dam emerges as the best viable alternative, this must be after the costs of preventing, reducing and mitigating the adverse social and environmental impacts of dams have been realistically calculated and included in the benefit cost analysis. Any residual adverse impacts must also be considered while conducting the final assessment.

33. There must be a strong institutional structure to ensure the proper implementation of the social and environmental safeguards, with the support of adequate policy and legal backing.

34. The monitoring of compliance with prescribed safeguards and conditionalities should also involve independent agencies and be open to the scrutiny of affected and concerned people.

35. There must be a constant effort to learn from experience by assessing, periodically, completed projects and judging the impacts they have had and are having and how these compare with what was anticipated.

3.5 OPTIONS

Two kinds of options have been discussed in connection with the controversy about large dams. One is managerial, the other is technological. Both of these need attention.

Managerial Options

1. Significant additions to the irrigated area can be made without large new investments in big projects by

- (i) the fuller utilization of the irrigation potential already created by major/medium projects and by minor irrigation schemes;
- (ii) the reclamation of waterlogged and salinity/alkalinity-affected areas in the commands of major/medium projects; and
- (iii) increases in the efficiency of water-use in all sectors, and particularly in irrigated agriculture.

2. The productivity level of irrigated agriculture in India is in general just fair, and well behind what has been achieved in some countries of the world. Increases in the level of productivity of irrigated agriculture can add substantially to agricultural production even without large new projects. The productivity of rainfed agriculture can also be significantly stepped up.

3. Both water-use efficiency and agricultural productivity can be significantly increased through the transfer of the management of state-built and state-managed systems at a certain level to Water Users' associations (WUAs) under the Participatory Irrigation Management (PIM) programme, with clear contractual obligations between the Department and the WUA, backed by a requisite system of legal rights.

4. In conjunction with large projects, recourse to community-managed systems with small local storages under the control of farmers, similar to traditional irrigation systems, will also reduce the dependence of farmers on the governmental machinery and help to increase productivity.

5. In so far as the power sector is concerned, significant improvements in capacity utilization and reductions in distribution losses will be equivalent to the creation of substantial new generating capacity. The requirement of additional hydro-electric power will diminish accordingly.

6. Rationalizing the power tariff structure can reduce electricity demand, and the conservation of energy through energy-efficient equipment and technological innovations can augment supplies, thus minimizing the need for investments in new capacities.

7. The addition of pumped storage schemes in existing reservoirs and the full operation of pumped storage facilities already installed will be able to meet peak demands without major new investments for quite some time.

8. For flood management, appropriate non-structural measures need to be coupled with the structural measures. Though large dams are better structural options than embankments, remedies need to be developed for the subsequent problems arising from the dynamics of development. The incidence of floods in the 'protected' belts can be reduced by the improvement of dam operations.

Technological Options

9. Wide varieties of water appropriation techniques, including in-situ harvesting, surface and subsurface storage, diversion, regulations of spread, soil conservation methods that help in increased groundwater recharge, and treatments for the enhancement of surface run-off collection or for evaporation control, are water appropriation options. These can be used separately or in conjunction with other options including large dams.

10. Power generation options include small hydropower, wind power, biomass gasifier, power from municipal wastes, solar power, fuel cell technology, ocean energy etc. For a long-term perspective, technological breakthroughs in several other areas must also be taken into consideration.

11. Approaches such as rainwater-harvesting, watershed development, etc., need to be extensively adopted in the vast rainfed areas of the country. They also have an application in other areas in conjunction with canal or groundwater irrigation.

12. Such local systems, whether traditional or more recent, need improvement. With the help of modern engineering and by pursuing a 'bottom-up' approach, it is possible to extend these systems to extensive areas where canal irrigation cannot reach.

13. The principles learnt from traditional irrigation systems may be applied even to modern canal systems, leading to improved performance. It is also possible to design a new, modern project in conjunction and integration with existing traditional systems, and on a 'participatory' (i.e., people-centred) basis. This is also an 'option'. Such an approach may allow some of the current projects, now mired in controversy, to proceed smoothly.

14. For easing the projected water problems of the country, the 'available' water resources can be converted into 'usable' water resources not only by storing the 'run-off' in reservoirs behind dams, but also by traditional irrigation and modern water-harvesting techniques.

15. Nearly 90% of drinking water needs are met from groundwater. The rapid depletion of groundwater aquifers in a number of states is particularly alarming in this context. Small storage structures would be of great use for meeting drinking water needs through rainwater harvesting as well through the recharge of groundwater.

16. The potential of the technological options cited is neither illusory nor minor. Even after fifty years of development of not only thousands of dams but also a massive expansion of tubewell irrigation, the relative contributions of rainfed and irrigated areas to the production of foodgrains in the country has only changed from around 60:40 to 40:60; in other words, rainfed agriculture still remains a significant contributor. Similarly, starting from a capacity of no more than 25 MW, renewable (non-conventional) energy sources attained a capacity of 1365 MW within a period of five years. However, the performance needs to be improved. Programmes have not been designed carefully or implemented with determination.

17. Alternatives to large dams in flood control are embankments. This is not an option to be commended. However, dams are rarely built for flood-moderation alone, and as mentioned earlier, most dams do not contain a flood reserve provision, and even where they do, the cushion tends to be encroached upon by the demands of irrigation and power-generation. What needs to be done is to put in place a proper flood management and disaster-mitigation policy. However, that subject goes beyond the scope of this report.

3.6 A FINAL SUMMING UP

1. Large dams have made important contributions to the development of irrigated agriculture and improved productivity and the production of food. They have also contributed hydro-electric power and enhanced domestic and industrial water supply.

2. However, they have also had significant adverse impacts, including social and environmental impacts. Specifically, they have displaced a large number of people and submerged large areas of forest and other lands.

3. Some of the adverse impacts of large dams are of such a nature that they can be neither prevented nor mitigated.

4. Most of the adverse impacts and some of the incidental benefits of large dams have not been recognized and assessed in the past.

5. The computation of the financial and economic costs of preventing or mitigating the adverse impacts of large dams would undoubtedly have an impact on their financial and economic viability.

6. This is borne out by a retrospective assessment of the economic and financial aspects of some large dams. This showed that when the costs of preventing and mitigating even a few of these adverse impacts were included in the overall costs of the large dam projects of the 1990s, they seemed to become by and large economically non-viable.

7. Also, since the early 1980s the investment cost per hectare of irrigation from major and medium projects has escalated to such a degree that these projects have on an average become both financially and even economically non-viable.

8. This is despite the fact that appraisal processes use too many rule-of-thumb entries and rely on data that are often questionable. These have not been challenged because the process is not transparent.

9. Further, if the costs of the residual environmental and social impacts that cannot be prevented or mitigated are brought on board, there would be an additional impact on the financial and economic viability of large dams.

10. If we also look (as we must) at the costs and benefits of other, alternative, methods for achieving the objectives set out for large dams, then some of these alternatives might turn out to be better options than large dams.

11. Also, the distribution of most of the costs and benefits of large dams seems to accentuate socio-economic inequities. This seems primarily due to a lack of policy direction regarding the equity aspects of projects.

12. It is evident that past projects, in general, have not been comprehensively assessed in terms of their environmental, social and economic viability and optimality. The planning and assessment processes outlined in the earlier sections of this chapter are the minimum required to determine the viability and optimality of large dams and, consequently, their development effectiveness.

Chapter 4

RESPONSES

The draft India Country Study was circulated to various stakeholders, including the Ministry of Water Resources, Government of India and the Central Water Commission. It was also discussed at the two stakeholder meetings in Chennai and Delhi. Subsequently, the WCD forwarded, to the authors, comments received from the Central Water Commission, Government of India, on the portion of the report dealing with environmental impacts. No comments were received, prior to the finalisation of the country study, on the portions of the draft report dealing with social or economic impacts.

The authors studied the comments so received and a detailed response was sent back to the WCD, for onward transmission to the CWC. The comments and the author's response are reproduced below.

Subsequent to the submission of the revised report and the publication of the WCD report, the CWC and the Ministry of Water Resources have criticised the India Country Report, particularly the portions dealing with the environmental and social impacts, on at least two counts.

One, they have stated that "the Country paper on India was prepared by a team of Experts majority of whom were not well connected with dams / water resources Engineering". Leaving aside the qualifications of the "experts", two points need to be made here. First, a paper should be judged on its own merits and not on the credentials of its writer. Also, the paper does not deal with the engineering aspects of dams. It assesses the environmental and social aspects of large dams.

Secondly, the: have stated that "GoI's comments on the first draft were not utilised for an appropriate revision of the issues brought out where an amendment was warranted." However, it will be seen from the documents reproduced below that all the comments of the GOI were considered and responded to. Where additional data, like that for the rate of siltation of dams, were provided, these were incorporated into the final report. However, if it was expected that every comment that the CWC made would be accepted in totality, then their expectations were unreasonable, especially in light of the comments given below.

Apart from the CWC, many other institutions and agencies sent in their comments, which are also given here.

IV.1 Comments of the Central Water Commission, Government of India, on the draft report on environmental and social impacts of large dams, as forwarded to the authors by the WCD

Comments of the authors follow each point, *in bold Italics, indented to the right.*

Paper No.5-Environmental and Social Impacts of Large Dams: The Indian Experience (Summary Report) by Prof. Shekhar Singh et al of IIPA, New Delhi.

1. It is to be noted that the paper prepared by Shri. Shekhar Singh et al, of IIPA reflects only negative impacts leaving aside all positive impacts on large dams.

    As has been mentioned in the report, most of the positive impacts were taken into consideration in the economics section. The paper must be read together and not in parts. However, in the revised version, all the positive impacts have been put together right in the beginning.

2. Most of the relevant publications containing useful data and information on the topic published by MOWR, CWC, CEA, CBIP, IWRS, NIH, CWPRS and the Institution of Engineers (India) have been over-looked while preparing the draft paper. On the other hand, most of the publications referred to in the paper have either been written by non-professionals or anti-dam agencies which alone have been seemingly utilised..

    This is not correct. We had the bibliography analysed and found that of the 223 references, 121 (over 54%) were documents of the central or state governments, or of their agencies. Another 52 were from academic journals or other publications. 38 were NGO publications, 6 were from newspapers and 6 from international agencies like the World Bank.

3. Water Resources Day (WRD) functions are held throughout the country since 1987 for creating balanced public awareness and theme papers published for the water resources day are widely circulated. Most of the issues covered in the referred paper have been dealt within the WRD theme papers published by the Indian Water Resources Society and also in the proceedings of the Bi-annual National Water Conventions organised by National Water Development Agency, sponsored by Ministry of Water Resources. Such publications are available in various libraries.

    They have been consulted.

4. It is relevant to note that the theme for the IV National Water Convention held at Thiruvananthapuram in June, 1993 was, 'Water and Environment'. Similarly, in the V and VI National Water Conventions held at Faridabad and Bhopal, respectively, the performance overview of water resources projects and need for public awareness in water management were discussed and published in detail. Even such prominent publications have not been used in the study at IIPA, New Delhi.

Many case studies and related aspects of environmental and social impacts of water resources projects are available in some of the publications given as Annexure. This brings out a critical review of environmental impacts of Indian river valley projects. The authors may please refer all such relevant material while preparing the crucial paper on, "Environmental and Social Impacts of Large Dams", to make it more meaningful as World Commission on Dams is looking into the overall impacts and not the negative impacts exclusively, as has been reported.

5. It is a matter of concern that the Representatives of most important stake holders like, Industries, Municipalities farmers, etc., were not invited in any of the two stake holders meetings organised at Chennai and New Delhi on 1st and 3rd March, 2000. (*There was no representative from the Ministries of Agriculture, Industry, Urban Development, Rural Development, Power, Environment and Forests, Health, etc. while discussing the response of the stakeholders on the crucial subject of large dams. Most of the participants in the two meetings belonged to the fields of journalism, anti-dam activists, non-professional NGOs, authors of the papers besides the few participants from the Ministry of Water Resources and select Academic Institutions.*)

   As per our mandate, we invited representatives from the northern and central states as also from Gujarat. Representatives from the other states were invited to the Chennai meeting. From the states, most of the invitees (secretaries of water resources) sent their regrets. Only Gujarat sent a representative.

   We had also written to the Secretary, Ministry of Water Resources, Government of India (GOI), requesting him to persuade the state representatives to attend. Despite this, they could not come.

   We also invited secretaries or their representatives from all the concerned ministries of the Government of India, including Tourism, Environment and Forests, Urban Development, Rural Development, Agriculture, etc. Representatives from the Central Electricity Authority, Ministry of Agriculture, Ministry of Rural Development, Tehri Hydro Development Corporation, Ministry of Water Resources, Central Water Commission, and Planning Commission attended the meeting. The invitee from the Ministry of Environment and Forests rang up on the morning of the meeting and expressed his inability to attend because of ill health.

6. Only the summary report of the paper has been received wherein only the negative environmental and social impacts of large dams have been blown up while their tremendous positive environmental and social impacts are totally omitted. Even in the tabular representation of the stated possible environmental impacts (Annexure 1.I, page 81) and possible social impacts (Annexure 1.II, page 82 and 83); not a single out of the manifold beneficial environmental and social impacts of large dams has been mentioned.

   Already responded to above.

7. Even though on page 2, the authors have agreed that the dams have both positive and negative impacts, their statement,
"It is unlikely to find intended negative impacts, though positive impacts can be both intended and unintended" makes it obvious that the paper is meant only to bias the reader.

    We cannot understand how this statement can be seen as intending to bias the reader. Would the GOI have us say that dams have intended negative impacts – or that all positive impacts are unintended!!

8. On page 6 of the paper, while total reliance has been laid on the figures given by the NGOs especially regarding the displaced persons, submerged forests or the effective command; on the other hand, the government figures have been stated to be unreliable inferring that such departments interpret and present the data to promote their own interests best. It is quite clear that the anti-dam activists and NGOs, who have been reporting exaggerated figures of PAPs and submerged forests, have been supported in the paper while making no efforts for reconciling the figures due to varying definitions and time frames in the official documents.

    In fact, most figures quoted for displacement, forest submergence, etc. are taken from government sources, as can be seen from the list of sources.

9. The statement on page 6 of the summary report, "Wherever irreconcilable discrepancies emerged, the case study has tended to take the more conservative estimate in order to maintain the credibility of the data base", shows that negative environmental and social impacts have been added manifold on the basis of doubtful figures provided by the environmental activists and NGOs. Most of the figures relied in the study are not available in the summary report; nevertheless, distortion of some figures can be judged from the enclosed observations regarding the figures of silting of reservoirs..

    The statement quoted above means that where data about negative impacts are concerned, government data are preferred, as they are more conservative. Similarly, where data about benefits are concerned, NGO data are preferred, because they are more conservative. We do not understand the objection to this.

10. The study clearly indicates that there was a paucity of data and the screening of dams by the authors cannot be claimed as a scientific sample. According to them, a letter was sent to 700 NGOs and concerned citizens, alongwith the outline of case studies. It is desired that the stated outline of the case study and the list of NGOs to whom request was sent is critically examined to know how many project authorities, professionals and water resources experts were involved in the process of this study. In the present form, the paper is clearly biased and reflects the viewpoints of only anti-dam environmental activists.

Repeated efforts were made to get data from the Central Water Commission and the World Bank office in Delhi. Letters were sent, people were talked to in person. However, both the CWC and the World Bank refused to give data or access to documents, even after having initially promised both. Despite this, as much of official data as became available from other sources were used and, as described earlier, the number of official references are far greater than the non-official ones.

11. It is necessary that case studies of a few completed large dams should have been covered in the paper to capture experience and lessons learnt from large dams in India.

    The Institute of Public Auditors of India are doing this, as a part of the crosscheck survey. It is not a part of the terms of reference for the country study.

12. The achievement of water resources development of last 50 years in India have been totally neglected in the paper. The beneficial environmental and social impacts of the Bhakra Dam, Hirakud Dam, Ukai Dam, Nagarjuna Sagar Dam, Pong Dam, Ramganga Dam and several other major dams are available in the numerous publications cited above; which should have been covered in the paper. Most of these projects were planned and constructed before the adoption of the procedures of appraisal and monitoring of environmental and social impacts of river valley projects.

    There is a difference of opinion here. We have not found much evidence of environmental benefits. The overall social benefits have been captured in the economics chapter but will also be mentioned in the revised draft.

13. The tremendous environmental and social benefits of Vrindavan, Ukai and Ramganga Gardens, Periyar wildlife resorts, Kalindi Kunj, as by-products of large dams and improved environmental and social conditions in Rajasthan, Punjab, Haryana and western UP after the construction of large dams have been totally left out in the paper.

    There are no "tremendous" environmental benefits when, for example, pristine forests (like those in Periyar) are submerged and replaced by a lake. All one can say is that the environmental damage has been partly made up by providing a wetland habitat. However, in sum, it is still a very environmentally destructive project.

14. On the other hand, the three on-going projects namely, the Tehri, Indira Sagar and Sardar Sarovar Projects have been specifically looked in detail in the paper without associating their project authorities but laying much reliance on the activists struggling against these three projects.

    As already stated in the report, these three projects have been mentioned because they are three of the newest large dams in India. Consequently, they represent the best we have to show in environmental and social planning. As also mentioned in the report, the first author is a member of the Narmada

Control Authority Sub-group on the Environment and of the Narmada (Indira) Sagar Review Committee. Therefore, he has access to most of the relevant data and documents. As he was a member of the committee that reviewed the Tehri project in 1990 and also the one set up by the Ministry of Power to review the Tehri project in 1996, he has relatively good data on the Tehri project.

15. Considering the above and the comment which follows in succeeding pages, the entire paper may have to be recast. Perhaps an independent Expert body with ample expertise in water resources and environment management can review the report of IIPA which may result in a balanced view on the subject aimed at by WCD.

No comments. This is for the WCD to consider.

Even though the entire paper highlights only the exaggerated and assumed negative environmental and social impacts, nevertheless, certain portions of the paper are commented in the enclosed observations.

A. Environmental Impacts

1. Page 9: *"The main impact that has been observed before construction has been the premature cutting of trees in areas that are to be submerged or otherwise deforested. Often the trees are felled much in advance of the actual submergence or need. Consequently, the area is denied the ecological functions of trees even before this becomes inevitable.*

Though,. occasionally, especially in the last few yeas, there has been a stipulation that trees are not to be cut below 2 to 4 m of FRL, there still appears to be no stipulation that the trees should not be cut prematurely. There have been complaints regarding various projects, including Tehri, Narmada Sagar and Sardar Sarovar that tree felling was done much before it was necessitated. This is a totally preventable adverse impact of dams."

Observation: The project authorities do not encourage cutting of trees prematurely for the reason that every tree cut has to be replaced by on an average, three to five trees as compensatory afforestation. However, people in the submergence area may resort to this, essentially because of their traditional needs for firewood, which is possible to be overcome with provision of alternate energy. In fact, hydropower and supply of gas for cooking are aimed at so that the felling of trees are avoided. Environmental education of general public may be of help in this direction. It is possible to exercise full control on tree cutting by people at large 'even without the Project situation' is then feasible.

The requirement for compensatory afforestation has nothing to do with the premature cutting of trees. Compensatory afforestation is done to "compensate" for the forest area diverted. Therefore, the premature cutting of trees does not involve any additional plantations. It is also incorrect to say that these trees are cut by the local people. Much of the felling is done by the project authorities or other concerned government departments.

2. _Page 10:_ *"Most recent projects stipulate that fuel wood or other types of fuel will be supplied to the workers. In recent years the MOEF, for almost all the projects that it has cleared has also stipulated this. Earlier projects, however, were silent on this issue. Even where such alternatives were planned for (for example in Kollimalai Project or Rajghat Project), no indication was found on whether these alternatives were actually provided. In at least one instance it was stated that head-loading occurred in spite of there being a provision for alternative fuel in the design of the project (Subernarekha). It was also recorded that labourers resorted to tree felling for firewood and to sustain their livelihood during the lean season when construction activity was at a standstill (CWC 1991)"*

Observation: In all the new projects, contractors are being asked to ensure supply of alternate fuel for the domestic needs of work force. This is also being monitored by the Project Level/National Level EMCs constituted to oversee the implementation of environmental safeguards. During the last ten years of such monitoring exercise, no case of violation of this stipulation was ever reported. Supply of fuel-wood for labourers' use to be invariably a condition to be fulfilled by Project Authority. This condition is there even in projects like 'Sone Canal Modernisation Project' where only local labourers are to be employed for canal repairs.

However, Subernarekha case has been quoted in the referred paper out of context. On an allegation by Forest Officials, remedial measures were taken by project authorities at the instance of National Level Environmental Monitoring Committee. An isolated case need not cause so much concern and should not be generalised.

> ***There are other cases for which data are available. In any case it is only being stated that this is a possible impact. We have not said that it happens everywhere. Also, the provision of fuelwood to workers is a recent phenomenon.***

3. _Page 10:_ *"After the construction of the dam, where forests and other vegetation are submerged under the reservoir, the pressures on the remaining forests, mostly in the catchments, go up significantly. Also, the construction of roads and other infrastructure and the enhanced activities in the area put an additional strain on the catchment"*

Observation: Roads and other infrastructure are essential for project construction and the submerged forest for such construction is accounted for in the compensatory afforestation. The lush green growth of trees has been experimented around the periphery of reservoirs of most of the major dams.

> ***Even if roads etc. are essential, they still have an impact. Such impact is not compensated for because it is outside the directly affected zone. Besides, as discussed in the report, you cannot really compensate for the loss of natural forests by plantations.***

4. _Page 10:_ *"The impacts of mining/quarrying for construction materials were not assessed as a part of planning of any of the projects studied. In at least one recent project, Indira (Narmada) Sagar, the project authorities have been asked not to allow any mining of quarrying for excavating construction material for the dam, in the catchment."*

Observation: Assessment of such impacts is included in the appraisal of water resources projects. Restoration of construction sites is a common safeguard measure in all the river valley projects. Such aspects are usually taken care of during construction of projects.

We have not come across any such appraisals.

5. Page 12: *"In fact, a study by KG Tejwani, quoted by Verghese (Verghese ibid) suggests that if there was a pre-planned 25% reduction in sediment load it would allow the reduction in dam height, without reducing the benefits, thereby saving on construction and environment costs and avoiding some of the displacement".*

Observation: In the early stages practically no data on silt load was available and based on the scanty data available, assumptions based on thumb rules were made for the design purposes. In many cases, these assumptions have proved correct while in some reservoirs siltation rates were observed high (or even low). All the major projects which were designed with deliberate space allocation for sedimentation as per internationally accepted principles and standards are functioning well and meeting their objectives.

The data in table 2(a) has many discrepancies and in a number of reservoirs the assumed and observed siltation rate are erroneous. The correct siltation rates of some of the reservoirs are given below :

1. Nizamsagar

As per information available in CWC the assumed silting rate was 2.38 ha.m/ 100 sq.km./year against the reported assumed rate 0.29. The observed rate of silting is 3.78 ha.m/ 100 sq.km./year against the adopted rate 6.65 in the report. Observed rate as a percentage of assumed rate as per CWC is 158.82 against 2293.10.

2. Maithon

As per information available in CWC the assumed silting rate was 9.05 ha.m/ 100 sq.km./year against the adopted rate 1.62. The observed rate of silting is 10.75 ha.m/ 100 sq.km./year against the adopted rate 13.10. Observed rate as a percentage of assumed rate as per CWC is 118.78 against reported rate 808.64.

3. Panchet

As per information available in CWC the assumed silting rate was 6.67 ha.m/100 sq.km./year against the adopted rate 2.47. The observed rate of silting is 5.12 ha.m/100 sq.km./year against the adopted rate 10.00. Observed rate as a percentage of assumed rate as in CWC is 76.76 against the reported rate 404.86.

4. Shivajisagar (Koyana)

As per information available in CWC the observed rate of silting was 8.10 ha.m/ 100 sq.km./year against the adopted rate 15.24. The observed rate as a percentage of assumed rate as per CWC is 121.44 against the reported rate 228.19.

5. Beas Unit II

As per information available in CWC the assumed silting rate was 25.29 ha.m/ 100 sq.km./year against the assumed rate 4.29. The observed rate of silting is 21.11 ha.m/

100 sq.km./year against the reported rate 14.30. Observed rate as a percentage of assumed rate is 83.43 against reported 333.33.

The data for reservoir siltation for 46 reservoirs was published by CWC in a compandium on silting of reservoirs in India (Jan.1991). However at present the data of siltation of reservoirs in respect of 139 reservoirs is available in CWC which is being complied and likely to be published shortly.

The silt rate in some reservoirs where variations are large and wrong conclusions have been drawn, in the comparative statement

Comparative statement of sedimentation data of selected reservoirs

Name of reservoir	*year of impounding*	*Annual Assumed rate of silting (Ha. m./100 Sq.km./ Year)*		*Observed rate of silting (Ha.m./100 Sq.km./Year*		*Observed rate as percentage of assumed rate*	
		As per the Paper of IIPA (Draft)	As per data available in CWC	As per the Paper of IIPA (Draft)	As per capacity survey data available in CWC	As per the Paper of IIPA (Draft)	As per information available in CWC
Nizamsagar	1930	0.29	2.38	6.65	3.78 (3 surveys)	2293.10	158.82
Maithon	1955	1.62	9.05	13.10	10.75 (6 surveys)	808.64	118.78
Panchet	1956	2.47	6.67	10.00	5.12 (6 surveys)	404.86	76.76
Shivajisagar (Koyna)	1961	6.67	6.67	15.24	8.10(1 survey)	228.19	121.44
Beas Unit-II	1974	4.29	25.29	14.30	21.11 (14 survey)	333.33	83.47

The data in table 2a were taken from a CBIP publication. Whereas differences in rate of actual silt flow can be understood because of different time periods of measurement, it is not clear how there are differences in the assumed rates. We are trying to reconcile these and other figures. However, it must be remembered that these are all official figures and none of them has been taken from non-conservative sources.

6. <u>Page 13:</u> *"As the justification for a dam is partly based on calculating the maximum amount of water available in the river, once a project is approved, there is often a ban on schemes which divert water from the river upstream of the dam. This results in upstream areas being denied the water they require, with adverse impacts both on the environment and on the well-being of people".*

Observation: This is an incorrect statement. No such ban is put on upstream projects.In fact, projects are planned for use of water in various reaches of the river as per basin plans. There are several examples that where waters have been diverted in upstream projects later on after construction of downstream projects.

> ***Given the fact that the economic viability of a dam is at least partly dependent on the quantity of water it receives, it is difficult to accept that no restrictions are needed to maintain the required flow. Even in inter-state and international rivers, the use of water upstream is a very sensitive issue.***

7. Page 14: *"In fact, as CAT involves extensive afforestation, for which pits are dug, the actual flow of silt into the river increases rather than decreases while CAT work is ongoing. This means that more erosion takes place before CAT is completed (and allowed to stabilise for at least two years), the silting of the reservoir is even faster in the initial years than it would have been without CAT (NCA env)."*

Observation : It is correct that siltation rates in the initial years of project construction is increased due to construction works. In fact treatment of catchment areas is necessitated on account of various objectives and CAT should be undertaken as national priority project rather then tagging in the cost of river valley projects.

> ***The cost aspect can be discussed. The important issue is the timing. It should be done and stabilised (at whom-so-ever's cost) well before impoundment.***

8. Page 14: Treatment of inadequate area: *"The distinction between "directly" and indirectly" draining catchments or watersheds remains an illogical one from the point of view of the impact of the catchment. After all, by definition a catchment is an area from which water and silt flow into the dam, either directly into the reservoir or therefore, no reason to neglect one and focus on the other. Besides, the "indirectly" draining catchment is invariably much larger than the "directly" draining one and, as such, has the greater impact".*

Observation: The Engineering philosophy on catchment gives due consideration to intercepted catchment and combined catchment when dealing with points along a river or stream on which dams are conceived. The run-off where a large catchment has interceptions due to upstream works is different from one where there is no intercetion. While for Up-stream sites, the catchments are limited, progressively, the combined catchment becomes very very large e.g when the river system joins sea, the whole basin will be a vast geographical area. If such a criteria as advocated is used, then in case of Farakka barrage, the catchment of entire Ganga basin covering substantial part of the country would have to be to be treatedat Project cost!

The treatment of catchment areas are also taken up from general schemes like soil conservation, watershed etc. of other departments.

Hence, the policy change for treating indirect catchments at the cost of water resources project is unrealistic.

> ***If catchments are treated so that silt flow is checked and water flows regulated, then the relevant catchment is that which contributes silt and water to the river***

and the reservoir. As already mentioned, who pays for catchment area treatment is not critical, but the time frame is critical.

9. <u>Page 14:</u> *"When a free flowing river meets the relatively static reservoir, there is a build-up of back-pressure and a resultant back-water. This can damage of destroy the upstream ecology and damage property".*

<u>Observation</u>: Reservoir does not remain static. Some water is released for downstream uses. Even while filling up, FRL is attained at the end of monsoon season and in the meantime some capacity is left unfilled to absorb unanticipated floods. Since the water level is fluctuating over the year, damage to ecology is not pronounced.

The build up of backwaters is a well established fact. However, its intensity and damage potential will certainly differ from dam to dam and might be negligible in some.

10. <u>Page 15:</u> *"The results of these studies indicate that there are significant adverse impacts on the aquatic ecosystems and biodiversity at and around the site of the construction. ---- The blocking of a river and the formation of a lake significantly alters the ecological conditions of the river, adversely impacting on the species and ecosystem. There are changes in pressure, temperature, oxygen levels and even in the chemical and physical characteristics of the water".*

<u>Observation</u>: The kind of studies made for such comments should be briefed before offering such comments. The EIA study and environmental appraisal conducted as per broad guidelines provided by MOEF. CWC has also published 'Detailed Guidelines for Sustainable Water Resources Development (1992)'.

This is again an established impact of dams the world over. In at least one project (Tehri) it was also established by studies. What happened in Tehri happens in most of our projects and therefore there is no reason to believe that such impacts do not occur in other projects just because no body has studied them.

11. <u>Page 16:</u> *"In some case, through the introduction of adaptable species, the economic value of the over-all catch can be maintained or even improved. However, in other cases, this does not work. In both cases, the species mix of fish and their natural diversity is adversely affected".*

<u>Observation</u> : Quantifying loss of fish bio diversity may not be feasible. Costs of enhancing commercial fisheries after construction of dams may also be estimated. In most of the projects, pisciculture is developed and there is substantial income from fish production. New varieties of fish are produced in many reservoirs. In case of Ukai Dam in Gujarat, the benefits on account of increased fish production has substantially recovered the cost of Project.

Benefits are often derived from increased fish catch. These are acknowledged in the social section. However, the increase in commercial fisheries is not by itself an environmental benefit and very often is at the cost of fish diversity and the ecosystem.

12. <u>Page 17:</u> *"Data were available regarding forest submergence for 53 dams. On the basis of these, the average forest area submerged per dam works out to approximately 7000 ha. Therefore, in the 1877 dams to be built between 1980 and 2000 would be likely to submerge 13,13,900 ha (roughly 1.3 million ha) of forests."*

<u>Observation</u>: The average forest submergence has been found to be 2,400 ha. per project for 116 projects of which forest submergence details are readily available in CWC. The stated figure of forest area submergence of 7000 ha. in each dam project is exaggerated. Further the average forest submergence for the 53 dams constructed in earlier plans may be high due to pristine nature of locations obtained around that period. Applying the same rate for the ongoing / future 1877 dams would be unrealistic and totally distorts the correct situation. Compensatory afforestation is a necessary condition in each of the river valley project.

In fact, we made a calculation error and the correct submergence figure should have been 13 million and not 1.3 million hectares. However, these figures have been revised in the final report. We find that even if we take the average figure of 2400 ha given by CWC the final figure comes to over 4 million hectares!! It is correct that there might be some variation in the forest areas submerged in earlier projects and in later ones. However, the data we have used to come to the average figure includes both old and recent dams.

13. <u>Page 18:</u> *"Apart from the forests, the reservoir and the dam also affect other eco-systems and various fauna and flora species. Unfortunately, till recently there was little effort to assess the impact on flora and fauna and on non forest ecosystems"*

<u>Observation</u>: This is again a general statement. Specific cases may be quoted where special attention is needed. It may not be possible to make such an assessment for all sizes of river valley projects.

None of the projects cleared prior to 1978 assessed the impacts on flora and fauna. Even today, very little is being done to assess the cumulative impact on the ecosystem. However, we are giving more examples in the revised report.

14. <u>Page 18:</u> *"Also there has been a stress on 'valuable' species, which often means the more prominent or visible species. However some of the less visible species might actually be even more important to conserve. There is also a tendency to focus only on endangered species. Being concerned only about endangered species results in other species also becoming, over time, endangered. Besides, the endangered status is usually applied to species that are nationally or globally endangered. If a proper survey is not carried out it can never be determined which of them were locally endangered and therefore, requiring protection"*

<u>Observation</u>: By making a general statement this aspect cannot be taken care of. If any survey has been done for valuable species, the same can always be taken care of.

Same response as above.

15. <u>Page 20:</u> *"The impacts on rim stability can not be prevented but, in some cases can be minimized if proper measures are taken"*

<u>Observation</u>: The rim stability is checked wherever required.

> ***Unless it is checked, how can it be determined whether such a check was required?***

16. <u>Page 20:</u> *"For reservoirs in the tropical regions of the world, especially those that are below 1000 m elevation, there is a significant threat of vector breeding"*

<u>Observation</u>: Experience over the last 20 years shows that malaria has not assumed epidemic proportions in India, as was the case earlier. There had also not been any report of malaria as epidemic around any reservoir constructed in the country. This clearly shows that increase in reservoirs in the country has not contributed in any way for increase in vector breeding.

> ***Again we have a difference of opinion. There is a lot of evidence to show that dams contribute to the spread of malaria. We will put some more into the revised report.***

17. <u>Page 21</u>: *"However, though the benefits of the anticipated increase in agricultural productivity are taken as a benefit of dams, the resultant costs of pesticides and fertilizers on the environment are very rarely computed or even studied"*

<u>Observation</u>: On one side it is said that the increase in food production is due to fertiliser and on otherside it is denounced. There should be conformity in the report.

> ***Nothing comes in black or white. Therefore, the effort is to see whether the benefits are greater than the costs and whether both have been measured. There is no contradiction in this.***

18. <u>Page 23: Para 3:</u> *"Though-RIS cannot be prevented, the damage it causes can be minimised by strengthening all dam structures and also by strengthening other structures and buildings, old or new, in the region. This has a cost which should be assessed as a part of the project cost, but rarely is."*

<u>Observation</u> : Reservoirs induce seismicity is still a hypothesis yet to be validated beyond questioning. Some researchers are trying to establish that there could be a likelihood for this phenomenon, from observations available. Some other Researchers dispute this claim. Thus, it is still being researched.

Dams are designed to withstand seismic accelerations, determined as appropriate for tectonic activities from various seismogenic sources and these parameters are considerably larger in comparison to those applicable for ground-shaking due to RIS. Various Researchers on RIS have no difficulty to conclude that RIS cannot exceed the tectonic levels and a structure designed to *withstand 'the worst case scenario of tectonic earthquake'* is far more adequate to withstand RIS. It has been argued that RIS causes induced activities and damages in areas surrounding reservoirs though the dam itself may not suffer any damage because of the design precautions. Granting the RIS though not accepting, the RIS quakes are smaller in magnitude and in a way causes a preparedness and readiness of the people in the region to face events of ground shaking of smaller levels. The awakening and necessary precautions in strengthening their structure besides preparedness to earthquake causes much less damages when the tectonic earthquake of a larger intensity occurs. The people are in 'a better preparedness' situation. The suggestions for bearing the cost of strengthening the buildings and dwelling units not designed to withstand earthquakes at Project Cost could be a point that deserves merit.

No dispute

19. *Page 23 to 25*

Observation: The project wise data reproduced on page-25 contains, more or less same project names but figures vary widely in respect of water logged area. Therefore the veracity of figures of both the sources appears doubtful. Even as per this, the waterlogged area is about 2% of the net irrigated area in the country. This has already received attention and remedial measures are being taken. There is no reference of remedial measures being taken in the report.

The comments on waterlogged area given in respect of MIDS work by CWC with actual data will be useful to recast the portion of the chapter by IIPA.

Will look at the other data.

20. *Page 27 to32*

Observations:

- The construction of dams ensure regulated minimum flow in downstream which improves ecology and environment downstream.

  This is not correct. Interference with the natural flow regime of the river causes a lot of ecological damage.

- Dam Break Analysis is being carried out for sensitive projects wherever considered necessary.

  As there is a tendency to argue that no dam will fail, it is rarely considered necessary to carry out such an analysis.

- A Separate Dam Safety Organisation in the Designs and Research Wing of CWC looks after Dam Safety aspects of existing dams. This is an ongoing process and several States have also established their own Dam Safety Cells / Organisation to look after issues arising out of regular review exercise undertaken in a systematic manner. Based on studies, as appropriate, remedial measures are initiated if safety aspects are suspect, wherever necessary.

  We are trying to get data on this so that we can understand its role and contribution.

IV.2 Response to the GOI Response by Shri Himanshu Thakkar, SANDRP

Government of India's comments dated March 10, 2000 on **WCD's India country study** Draft dated March 1, 2000

Some Comments

1. The GOI comments are quite ad hoc, off hand, many times plain untruths and contradictory. Many times what is stated is quite incoherent (many samples are available on page 34, 45 for example). In many cases, what is stated in response does not answer the point being responded to. In other cases, the answer makes unsubstantiated (and mostly unsubstantiable) statements. Some of the Annexure (for example Annexure III mentioned on page 23 top) in the text are not found in the document. For many of the figures given, no reference or basis is given. Such figures would have no credibility. In case of some other figures even years are not given. Some very inappropriate figures are given (for example, single year siltation rates). Some indicative examples of problems with this response are presented below, though it must be added that the list is not exhaustive. The comments show that such a response cannot be taken very seriously.
2. CWC should be asked to provide some of the figures mentioned. For example the time series data of siltation rates (observed and actual with proper references for 139 reservoirs mentioned on page 42), forest submergence data (with references, for 116 projects as mentioned on page 44) and hydrology data of rivers.
3. Some of the comments given on pages 8-17 are quite objectionable as without providing any justification the comments direct that certain statements in the WCD report should be removed or added.
4. To say that rainfall in India falls in a period of 100 hours is at best misleading statement.
5. It is recommended that macro analysis like that of Shri A D Mohile should be used. But macro analysis that is not based on micro information and analysis has no value. Mohile's analysis, as presented in GOI response, does not emanate from micro analysis.
6. Local water harvesting, reuse of water, adoption of two pipe systems, etc, is mentioned relevant for domestic water issues (page 3) but none of it is being practised. On the contrary, when it comes to making recommendations, the paper seems to say that there is no alternative but large dams for urban water supply (page 49). Very unsubstantiated and unbelievable statements (page 33) are made about 10% of water storage in India is being used for urban water supply. And that this figure will go upto 30-40% in next 25 years. Unless full analysis is provided, such figures only discredit the CWC.
7. About contribution of dams to food production, two contradictory claims are made. On page 14 it is said that the contribution is over 90% while elsewhere it is said that the contribution is 30 per cent. Neither is a result of any coherent analysis.
8. Low (operating) cost of hydropower generation (page 14) is stated as indicator of their sustainability!! The cost mentioned does not include most of the crucial costs of the project.

9. Need for storages are equated with storage behind large dams (page 48 and elsewhere). The storage potential as soil moisture, in biomass, in local systems and in groundwater aquifers is not mentioned at all. Some 30 BCM of storage due to minor systems is mentioned on page 5, but it is not clear if this is based on any survey or analysis. Since it is well known that there has been no comprehensive survey of existing or potential storage from local systems for any hydrologic unit like a basin or sub basin, such figures are quite meaningless.
10. At many places (*e.g.* page 32), the paper tries to show that the electricity used in agriculture sector is being provided from hydropower generation. Such a statement not only has no relation with reality, it is a technically wrong statement. In any case, the major stated benefit of hydropower, namely that it can provide peaking energy, is something that is not applicable to agricultural use of power. Agricultural use of power is generally considered non-peaking demand.
11. Projections for storage availability in year 2050 (page 4-5) assumes that siltation will take up about 10 BCM by 2050. However, it is well known that siltation has already taken up more storage space than that.
12. The paper has little to say by way of social justice, equity or even basic resettlement of people affected large dams and related works. On the contrary, the recommendations of the paper go in opposite direction when it is recommended (page 6) that quick availability of land and reduction of risk is required to encourage private investment in hydropower project. It is also indicated on page 6 that legal and procedural changes also would be initiated to facilitate construction of large dams through speedier R&R procedures. CWC needs to be told what is happening on ground in case of the first large privatised hydropower project in the form of Maheshwar project in Madhya Pradesh.
13. The response clearly indicates on page 11 that there is no role for people above the tertiary level of systems. However, on page 19 it contradicts itself when its states, quite untruthfully that "Participatory management even at initial stage is also welcomed and beneficiaries are consulted while planning of projects".
14. In some places, very pious sounding statements are made, but without any indication as to how the stated objective can or will be achieved by the government. Thus regarding reduction in flows in rivers it is stated on page 4: "We would have to ensure that this reduction occurs mostly during monsoon and low flows in fact are improved". On page 6 it is stated that "It is essential that water policies are evolved in such a way as to reduce the decision making capacities of the users in regard to the key decisions of water management and even water planning". On page 7 it is stated that there may have to be a performance analysis in regard to water. Elsewhere it is stated that basin-wise planning and water resources development will be done in future.

15. The paper continues to make unscientific statements that the water going to sea is wastage (page 7) and that wherever sites are available, dams must be built because such sites are rare (page 7, 10, 19)
16. The statement about flood control (page 9, point 9) is quite misleading and wrong. It is stated that floods have been controlled and attenuated wherever dams have been built and floods continue to recur in river basins where dams have not been built. In case of Damodar, Mahanadi and Tapi, in spite of the dams (and in some cases higher floods after the dams) floods continue. Cause for floods in undammed rivers are elsewhere and not in absence of dams.
17. CADA is mentioned on page 9 (point 8) as a measure to bridge the gap between created and utilised potential. But it is not stated (as GOI's Ninth Five year Plan states) that CADA has been quite a failure twenty six years after its inception.
18. The response to (para 1.5.2 - 1.5.3) the contention that CWC has been pushing through large dams without waiting for all mandatory clearance mentioned on page 19 does not answer the issue at all.
19. The TAC cost figures mentioned in Annexure I and referred to on page 19 are not useful unless the relevant documents put to TAC are appended to show that the costs being mentioned are comparable. Moreover, in the annex, arithmetic average of per ha cost for different projects are taken to show that the average costs are low. Firstly, arithmetic average is not valid in this case and weighted average will have to be taken. Secondly, it is also not clear if the costs are for the same base year.
20. It is stated on page 20 that monitoring of major projects have been taken up since 1974. But if the reports of such monitoring activities are not made public, it will be of little use or impact.
21. Annexure II mentioned on page 21 is not found in the document. The point about the created storage not being filled up is not answered by the CWC response. The general basin-wise picture sought to be presented for a specific decade does not answer the issue of overall performance of specific reservoirs.
22. It is claimed by CWC on page 22 (third line from top) that present yield from rainfed area is only about 0.7 ton/ha as against 1 ton/ ha reported in the WCD study. This claim is not substantiated and contradicts other data available. The unfounded claim has been made only to show that contribution from dams has been higher than what it actually is.
23. The claim made on page 28 (para 7) that large dams were the quickest available option and that water harvesting schemes were not known is totally incorrect. The Grow More Food Campaign document (Planning Commission, Govt. of India) of as early as 1948 (and many other documents) mentioned that traditional water harvesting systems were one of the quickest and best options for India's agricultural development.
24. The contention in the same paragraph that the system tanks cannot work without a backup storage is also not true and is unsubstantiated.

25. The attempt made to show in point 9 on page 29-30 that more work is done in minor sector is not correct as the figures of ultimate irrigation potential from minor systems is not based on any comprehensive survey, but based on some ad hoc figures. The response itself accepts later on that comprehensive river basin level planning has not been done for a single basin in India.
26. The point sought to be made in point 10 on page 30 that irrigation intensities in access of 160% has been achieved is not correct as it is based on incorrect data and calculation. First of all, the intensities of irrigation in case of groundwater based systems are much higher. Secondly, to arrive at irrigation intensities achieved from Major and Medium projects, segregated areas based on irrigation source will have to be used.
27. Some rather incoherent statements are made in point 12 on page 30. For example, it is stated that "Procurement of foodgrains under PDS is also responsible to some extent for switching over from wheat to Paddy". But main cropping season of wheat is Rabi and main cropping season of Paddy is kharif. How these can interchange is difficult to understand.
28. It is clear from the flip flop with figures indulged by CWC (India's premier and only organisation that can be expected to have proper figures) response in point 11 on page 30 that CWC does not have basic figures about irrigation provided and food production enhanced due to large dams in India.
29. It is stated by CWC response on page 31 that the cost data about constant prices is erroneous. It would be noteworthy that the cost data for which this comment is passed is from Govt. of India's Ninth Five Year Plan.
30. A strange statement is made on page 34 that "if there were no Large, Medium (and also small) dams, Rabi beyond 10% and Kharif irrigation upto 10% was only possible - rest was rainfed". This statement does not make much sense as such unless it is specified what time period it is talking about. Secondly, this statement will not help support for large dams as it clubs contribution of large and small dams. Most importantly, the statement ignores the reality that over half of all irrigated areas are irrigated by groundwater sources.
31. It is stated on page 34 that small dams cannot control floods. But how many large dams have been constructed and successfully operated for Flood control in India?
32. About siltation rates mentioned on page 34, it may be pointed out that siltation rates do not change with size of dams. If siltation rates are high, the large dams will also get silted up over time. There has not been any successful instance of large dam being dredged to clear the accumulated silt. In fact, once silted up, large dams will be a much greater liability. It is at least possible to desilt smaller dams, as has been achieved by communities in the past.
33. On page 39, it is observed that people in submergence area are responsible for deforestation in submergence area of reservoirs. A more factually wrong and anti people statement would be difficult to find. It is also stated here that "hydropower is

aimed at so that felling of trees are avoided". This again is something difficult to understand. It is not known if hydropower has replaced fuel wood as cooking medium in India.

34. CWC response claims on page 44 that average forest submergence for 116 projects is found to be 2400 ha. This means that these 116 projects have submerged 278900 ha of forests. This cannot refute the figures given in IIPA report, where data is given for 53 projects with average submergence of 7000 ha per project. This comes to 371000 ha, about 33% higher than the figure provided by CWC for 116 projects. Both data can be used to arrive at a more accurate picture and CWC should be requested to provide the data mentioned.
35. A statement is made in CWC response on page 45 that "There had also not been any report of malaria as epidemic around any reservoir constructed in India". This is quite a shocking statement. To give just one instance, under construction Sardar Sarovar Project has already seen such an event, as recorded by the World Bank (Morse report, 1992).
36. The statement on page 45 is a symbol of how mindless this response from CWC is. It says: "On one side it is said that the increase in food production is due to fertiliser and on other side it is denounced. There should be conformity in the report". While it is true that fertiliser use has lead to increase in food production, to point out that this has also lead to environmental impacts including pollution is certainly not contradiction?
37. The first two bullet points mentioned on page 46 are something that will need a lot of substantiation as facts point to contrary. It is claimed here that dams ensure minimum flow in downstream areas and that dam break analysis is being done for sensitive projects. It is well known that dams lead to stoppage of natural flows and in many cases all flows in the downstream areas. Moreover the govt. has been quite reluctant to do disaster management plans for dams, leave aside the question of making them public, which is necessary condition for success of such plans.
38. Regarding Delhi Water Supply scene, as per information just provided by National Capital Region Planning Board:
    - Out of Delhi Jal Board supply of 591 MGD to Delhi, 81 MGD comes from groundwater sources. This amounts to 13.7% of DJB supplies.
    - In addition, a large quantity of groundwater is used by private sources. As per a study done by INTACH in 1998, this amount (DJB has no figure on this, but it has not refuted this figure published in 1998) is about 270 MGD. If we add this to 81 MGD of groundwater in DJB supplies, we see that Delhi gets 41% of its water supplies from groundwater and not 5-10% as mentioned by Shri Hassan on CWC response page 49.
    - Shri Hassan here does not mention that leakage and other losses from DJB supplies amount to at least 30%.

- That Delhi citizens on average already get over 250 lpcd supply when rest of the country gets much less. Even as a large portion of water in Delhi gets used in watering lawns and in washing cars everyday. Moreover, this average figure is quite misleading and vast majority of people gets much lower quantity of water.
- That Delhi citizens do not pay the minimum operating costs of the water supplied to them. If proper water price is fixed, the water use will come down substantially.
- That plans are available with Delhi govt. for use of at least 138 MGD of rainwater that now flows away unutilised. Practically no action has been taken by the Delhi govt. for implementing these plans.

How justified is it to talk about dams for Delhi's needs in such circumstances?

IV.3 Comments of the Central Water Commission, Government of India, made after the finalisation of the WCD Report and posted on the web.

(Given below are extracts that refer to the environmental, social and economic assessments of the India Country Report)

Government of India, Ministry of Water Resources, Central Water Commission
Final Report of the World Commission for Dams (November 2000)
Comments : Er Gopalakrishnan, WCD FORUM member

Limitations of the Knowledge Base

While all documents forming part of the 'so-called' 'Knowledge Base' are not yet available (yet to be published), our concern would naturally be on "India Country Study' which forms a part of it. Hence there are references on this report and our comments on the same in many places in what follows.

The Country paper on India was prepared by a team of Experts majority of whom were not well connected with dams / water resources Engineering; the WCD failed to take into confidence Indian Government or consulted them before award of such studies on Indian Scenario.

The Government of India are one of the largest Dam Builders, only next to China, when we see the current global dam building activity date.

The opinions expressed in the reports on 'Large Dams – Indian Experience' were mainly biased propagating the opponent's views as most of the Authors of the India Country Report were well known opponents of Dams. The data used were not representative in character at a number of places in 'India case study'. An opportunity was given by WCD at a late stage to Govt. of India to review the first draft; however, GoI's comments on the first draft were not utilised for an appropriate revision of the issues brought out where an amendment was warranted.

On a Global level, WCD undertook 'Cross Check Survey' of nearly 100 Projects of which eight were chosen from India. Besides the Cross Check Survey, WCD had brought out detailed review on eight dams around the globe; a majority of these dams are from developed countries. Many of the new dams, which have incorporated environmental concepts in their plans and designs, were not considered in the entire exercise. Recent trends in dam building addressing the areas related to Environmental and social Issues like Public Hearing before Launch of Project as per Environmental Act in India are not discussed. Though some of the recent policies on R& R (like that of Orissa, Packages on Sardar Sarovar, Tehri etc.) were made available, these and other Environmental Safeguards which are being introduced in the Indian system are not at all reflected. Some of the shining examples of the water resources development projects in India like Bhakra are not even listed in the main report. All factual data were made available freely to WCD and their Secretariat in time after GoI became a Forum member. The information supplied, with respect to the positive contribution of all the select Indian Dams like Nagarjunasagar, Bhakra etc., was not properly utilised to bring out a correct picture on positive contribution or this was inadequately covered.

WCD could have profitably drawn upon authentic literature and wealth of data available with International Organisations like ICOLD, IHPA, ICID and also National Level bodies and Organisations from representative countries which are currently the Large Dam Builders like Government of India and Republic of China. Project Evaluation Reports of the World Bank etc. would also have been a meaningful reference in several cases. The Commission (WCD) however, ignored documents and pertinent information in them even when they were supplied and had opted to rely upon submissions and reports of NGOs; several report writers were guided more by their perceptions and views rather than detailed information and knowledge of factual

position around dam projects are the authors of several themes and reviews! A cursory look at the list of presenters at the regional consultations and contributors to the cross check survey reveals that most of them are anti dam activists involved in some campaigns or other against water resources projects.

The exercise has proceeded on a motivated goal and in this process, any thing that which does not reinforce the view point of is relegated in status. The Commission's approach to creation of so called Knowledge Base looks as an able and clever example of the game of inverse research, where "facts are collected to prove the preconceived hypothesis":

WCD and India Country Report

Page 351 of the final report of WCD report quotes as under:

> "The Governments of India and China indicated that they were not prepared to participate in full case studies. Based on a meeting in Beijing in June 1999, China agreed to participate in a country - level review. After a change of institutional responsibilities within the Ministry of Water Resources in China, however, the government withdrew the agreement to participate actively in the country review. The WCD then undertook an external review of dams in China. The Government of India after meetings in New Delhi (June 1999), declined full participation; it subsequently agreed to-cooperate fully with a country review paper on dams in India (February 2000) ".

"India Country Report" was prepared as India Case Study by five independent consultants engaged by WCD (with out consulting Government of India). Government of India was requested to comment on the findings of "India Country Study" in March 2000 after Government of India became a formal Member of the "WCD Forum" (January 2000). As the "India Country Report" draft was full of controversies and lacked factual data, Government of India provided detailed data required for the study and offered exhaustive comments on it (March 2000). While WCD acknowledged the participation of Government of India and committed to revise the "India Country Study" draft at one stage, they ultimately failed to do so. A modified draft titled "Large dams: India's Experience", (a revised version of "India Country Study" draft) with a number of inconsistencies was received by the Government of India in September 2000 and WCD's Consultants/Experts responsible to write "India Country Study" draft themselves could not agree on views other than their own in chapters written by them individually. Having failed to get a consensus report on "India Country Study", through their consultants, WCD informed that the comments of Government of India would be annexed to their consultant's version of "Large Dams - India's Experience." In response, Government of India rejected outright the draft of WCD's consultants' report viz: "Large Dams: India's Experience." This aspect has not been reflected in final report and thus the coverage.

The Government of India after meetings in New Delhi (June 1999), declined full participation; it subsequently agreed to-cooperate fully with a country review paper on dams in India (February 2000) as above on India is only partial.

WCD's Dams Debate

According to the WCD, the 'dams' debate' is complex as well as simple. It is complex because the issues are not confined to the design, construction and operation of dams themselves but embrace the range of social, environmental and political choices on which human aspiration to development and improved well being depend. It is simple because behind the array of facts and figures of economics statistics and engineering calculations lay a number of basic and easily understood principles.

WCD has concluded that:

1. Dams have made an important and significant contribution to human development, and the benefits derived from them have been considerable. Nothing further than this statement is reflected in the Report.
2. In too many cases an unacceptable price has been paid to secure unnecessary price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities d/s, by taxpayers and by the natural environment. (social, environmental, equity).
3. Lack of equity in distribution of benefits has called into question the value of many dams in meeting water and energy development needs when compared with the alternatives (options).

4. By bringing to the table all those whose rights are involved and who bear the risks associated with different options for water and energy resource development, the conditions for a positive resolution of competing interests and conflicts are created.
5. Negotiating outcomes will greatly improve the development effectiveness of water and energy projects at an early stage, and by offering as a choice only these option.

Some impressions that the Final report in its Chapters on 'Technical, Financial and Economic Performance' convey are:

Irrigation and flood control dams have not performed well and therefore, other options must be explored.

Hydropower dams may continue to be built ; however, it is elsewhere broght out that GHG emissions of Hydro Projects are as much as thermal and should be the last resort of options.

Large storages may be required for water supply to mega cities.

Irrigation has been subordinated in playing an active role in Agriculture and food production.

It would not be out of place to bring out a few important aspects that the India Country Study attempted to bring forth on Irrigation aspects. In the para on 'Final summing Up' in the last Chapter on Some Agreed Conclusion, the Draft Report of WCD acknowledges the contribution of Large Dams as follows: (to quote)

"Large Dams have made important contributions to the development of irrigated agriculture and improved productivity and the production of food. They have also contributed hydro-electric power and enhanced domestic water supply and industrial water supply."

However, elsewhere in the report one finds that (see Para 7.1 of Large Dams - Indian Experience).

IV.4 Response of Dr S Maudgal, Sr. Adviser (CT)
Government of India, Ministry of Environment and Forests
Paryavaran Bhavan, C.G.O. Complex, Lodhi Road, New Delhi-110003

I have gone through the three reports received from you on the subject. I must compliment you and your colleagues for a thorough job done and I am fully in agreement with most of the observations in these reports. My comments are enclosed specially on the Summary Report dealing with environmental and social impacts of large dams.

Subject: Environmental and Social Impacts of large dams- comments.

I. Planning Process

Planning of river valley projects by different State Irrigation Departments in respects of their location in the upper middle or lower reaches of a river is still being done on the assumption that water would be "available in abundance and in perpetuity". The reality that water is already a "Limiting Resource" in many parts of the country is not considered in the planning and utilization of water resources with the result that its optimal utilization is not attempted. For example, the sum total of water demand for irrigation, drinking and industrial use in the States of UP Bihar from the river Ganges is much more than even the "total flow" in the river Ganges. The casualty of such an approach is always the non-availability of the project and its projected benefit stream.

The reasons for this type of planning approach are:

- Unreliable database regarding flow sedimentation and competing demands on water.
- Absence of a basin plan agreed to by all the beneficiary States along the river with the result that each State has its own portfolio of water resources projects which are often in conflict with other projects within the same or other States.
- There does exist a Basin Planning Unit in CWC. In reality Basin approach is, however, not adopted at the State level with the result that while there is a mix of large, medium and small dams, the emphasis is mostly on executing large dams only. Basin Management Authorities comprising of professionals, and not the Chief Ministers, could be created for ensuring integrated development of the region.
- Notwithstanding the fact that creation of reservoirs can seriously damage the biodiversity and genetic stock, the guiding criteria for selection of a dam site continue to be the engineering and geological features. This approach is often adopted in the absence of clear demarcation of are as which need to be protected outside the national parks and sanctuaries, etc. The list of flora and fauna provided by GSI/ZSI is of little use in shifting the location for safeguarding biodiversity. Indeed, reservoirs are known to have permanently submerge mineral reserves which could have been salvaged through proper sequencing of the project or by shifting the location.

II. Equity

- The objective of achieving equity is laudable so that even the poorest of the poor can benefit form the development effort. But, equity need not attempt to make everyone equally poor thereby defeating the very purpose of development. Similarly, an attempt to view equity on the basis of gender also needs to be treated with caution. The suggestion that the small and marginal farmers should be at the center of the plan for the water distribution network would work well both at the tail end and also near the head reach if the requirement of water well both at the tail end and also near the head reach if the requirement of water was calculated on a scientific basis, keeping land capability, cropping pattern and corresponding water requirements in view.

III. Land Use Policy

- Irrigation inputs are considered a prerequisite for ensuring Food Security. Planning of irrigation work on the basis of theoretical cropping pattern has not proven realistic essentially for two reasons:
  - Enough data is not available on land capability status, and
  - There is no land-use policy in the country.

Realising the importance of fertile agricultural land in the economy and for survival of a nation Code Civil de' Napoleon prescribed long back that fertile agricultural land must not be put to any other use so much so that the son of a farmer who does not want to cultivate land will not inherit this land which can only be sold to a practicing farmer at a pre-determined nominal price set for agricultural land.

Our agricultural land today is under tremendous pressure from property developers and other non-agricultural demands. Optimal resource utilization has to address the interface between land and water which in turn demands synergy between National Water Policy and land use policy in the country. This is all the more essential to ensure continued availability of surface and ground waters for meeting our survival need by earmarking land not just for agriculture but also for recharging of aquifers.

IV. Catchment Area Treatment

- While Catchment Areas Treatment is considered an integral part of water resources development projects the formulation of Catchment Area Treatment plans their implementation and institutional mechanism is still not streamlined. Introduction of arbitrary concepts like "directly draining" and "indirectly draining" catchments further dilute the efforts. Catchment Area Treatment is a combination of both biological and engineering measures with more emphasis on biological measures so that soil erosion is minimised and flood mitigation and recharging of aquifers is maximised. Ideally sequencing of Catchment Area Treatment and reservoir creation needs to be done in such a way that Catchment Treatment is completed before stating the filling operation. It is often observed that Catchment Area Treatment works keep lingering long after the reservoir is already in operation. There is a misplaced notion that investment made on Catchment Area Treatment does not benefit the water resources development project and is a drain on the resources. This is reflected in the attitude of the water resources development authorities towards:
- Identification of critically degraded areas in the catchment for priority treatment.
- A time-bound plan for treatment and post-treatment care.
- Absence of a Catchment Area Treatment agency or even a mechanism to interface with the Forest department which is often provided funds to undertake Catchment Area Treatment works.
- Ambiguity about treating the degraded land in the catchment belonging to the private owners.

The result obviously is that while money gets spent the results are not commensurate. There is an absolute need to create an effective Catchment Area Treatment Institutional set-up with a clear mandate and responsibility to deliver the goods.

V. Command Area Development

Command Area Development is an integral component of the irrigation projects to ensure that benefits of irrigation are maximised through proper levelling, grading and draining of the agricultural fields. While Command Area Development authorities exist they conveniently forget to execute these responsibilities. All the Command Area Development authorities proceed on the assumption that an irrigation project will invariable improve the agricultural output and therefore, concentrate only on creating marketing infrastructure in the form of development of Mandis. With such neglect, the farmer invariably indulges in flood irrigate on which in turn leads to water logging and salinity of the soils rendering them over time unit for agriculture. The benefits of agricultural extension agencies in the form of high yielding varieties judicious use of insecticide pesticide and chemical fertilizers etc. is also not available to the farmers. The Command Area Development institutional mechanism requires to make it effective and responsive to the needs of farmers.

VI. Rehabilitation

The Revenue Department has traditionally handled rehabilitation in the irrigation projects on the plea that it involves acquisition of land and payment of compensation. The existing rehabilitation units are, therefore, insensitive to the social, cultural, ethnic and economic considerations which are a pre-requisite for handling rehabilitation in a realistic, sensitive and effective manner. The turnover of the rehabilitation officer is so frequent that he hardly has time even if he so wanted, to understand the problems and needs of the oustees. There is a strong need for creating a responsive and effective institutional mechanism for rehabilitation manned by professionals who are in tune with the needs of the effected population.

VII. Accountability

Given the track record of water resources development projects where the projected benefits are seldom achieved and time and cost over-runs are a matter of routine it is necessary that accountability and responsibility is fixed for delivering the project as stipulated failing which the concerned officers must be held responsible and suitably penalized.

IV.5 Response of Dr Girish Sant, PRAYAS, Pune

I am focussing only on the issue of hydro-power and mainly on the paper by Pranab Banerjee (Financial, Economic and Distributional Analysis of Dams in India).

The paper quotes cost benefits of SSP from two studies. It also quotes the conclusion from the annual report of DVC that the hydro power is the least cost (the coal plants being the next costly). The study goes on to use these numbers to arrive at the total economic benefit of hydro-power. Followed by that it presents a section on increase in capital costs of dam projects. Lastly the study talks about the official figures of peaking capacity shortages.

It would be desirable that in a major report such as this, where results of a study are used, the present status of the assumptions and comments on methodology are included (or the author should satisfy him self that the there are no major weaknesses).

For example, the paper could mention that the SSP critiques point out that official studies do not consider issues such as *(a)* the true cost of project, *(b)* likely decrease in generation due to already lower water flows, *(c)* cost of NSP and likely delay in NSP construction. It appears from preliminary reading that the SPIESR report has used a very low discount rate or has not accounted for decrease in power generation over years. Our report on comparison of SSP with other options of power generation / power saving is enclosed * mailed to you separately.

Coming to the DVC annual report. One wonders if the report has studied several hydro-projects and has compared them with all the available options for the peaking power. The cost-benefit analysis by govt. departments (that appear in the project appraisal studies) usually have following major limitations. These studies do not analyse the complete set of options. Most options of energy saving and demand management are not analysed, even the conventional generation options such as DG sets, Gas turbine (or CCGT), pumped hydro (hydel battery - charged by coal plants), and conversion of base load hydro to peaking hydro stations are also not considered. This additional issue (to the above mentioned problems) make the comparative costing done by several official studies very unreliable.

For example, in case of the DPR of Maheshwar Hydro project, we found coal project working at a very low PLF (Plant Load Factor) was considered as an option. The author should examine if the concerned report of DVC is free of these lacunae. Our study of SSP indicated that the coal project indeed costs more than hydel (if considered to operate at a low PLF) but other options mentioned above were found to be less costly than the SSP.

In fact, it is worth noting that official power planning is not based on a least cost Integrated Resource Plan (IRP). The govt. agencies have not carried out any IRP for the planning purpose. Whenever, the WB / other external agencies or independent researchers have carried out such plans, the conclusion has usually been similar. The most economical plan (without consideration for the externalities) would fulfill a third of the capacity addition needs from energy saving technologies, another third from dispersed generation (including co-generation and renewable) and conventional large coal and hydro would be chosen as a last resort (being the costliest) to fill the gap of remaining one third. Example of such studies include (DEFENDUS by AKN Reddy and others, Least Cost plan for Maharashtra by Sant and Dixit, recent study by ESMAP for India *).

Usually, the official power planning exercises talk a lot about the power shortages and project the high capacity addition need to avoid the brown-outs. But the shortage psychosis created by these plans needs to be factored in, while commenting on the power sector future. A recent example of this is the 8th five year plan. As mentioned in our presentation to the WCD (at Sri Lanka), the plan had over-estimated the capacity needs by 38% (as pointed out by the 9th plan document. In effect, the 8th plan over-projected the capital need by as much as Rs * crores p.a.

Some of following figures elaborate on the impacts of issues such as *(a)* non-inclusion of all options, *(b)* wrong assumptions about say $ rate, *(c)* non differentiation of average cost and peak cost.

Figure 1 describes the effect of assumptions related to $-Rs rate. The three cases considered here are (1) official, i.e. $=Rs 32, (2) present rate of $, $ = 42, (3) $ = 42 with annual appreciation of 4% p.a.

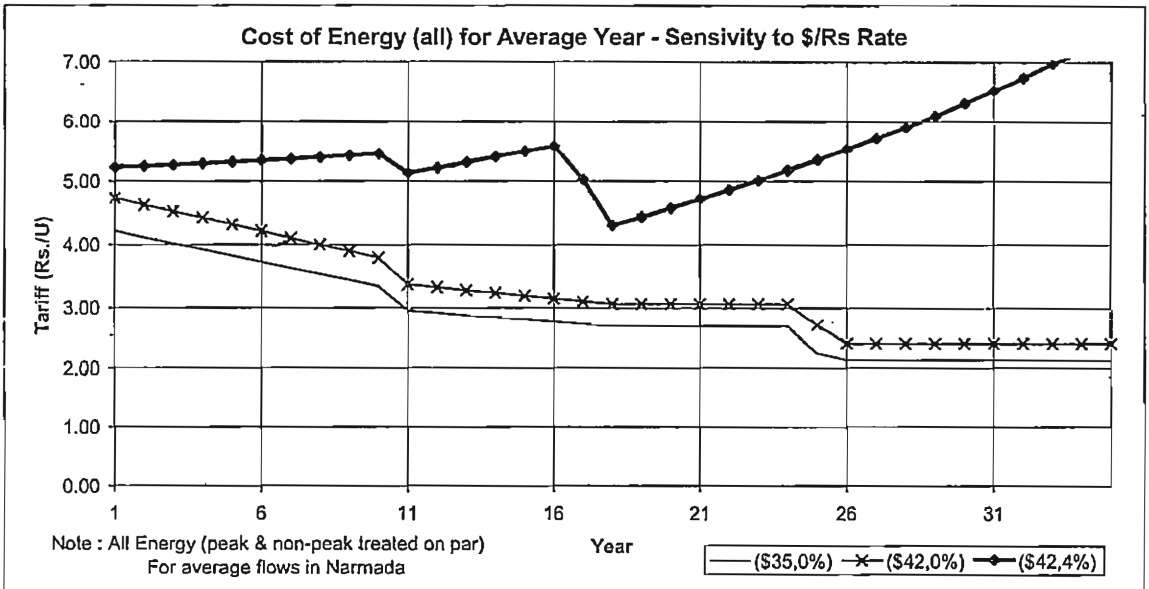
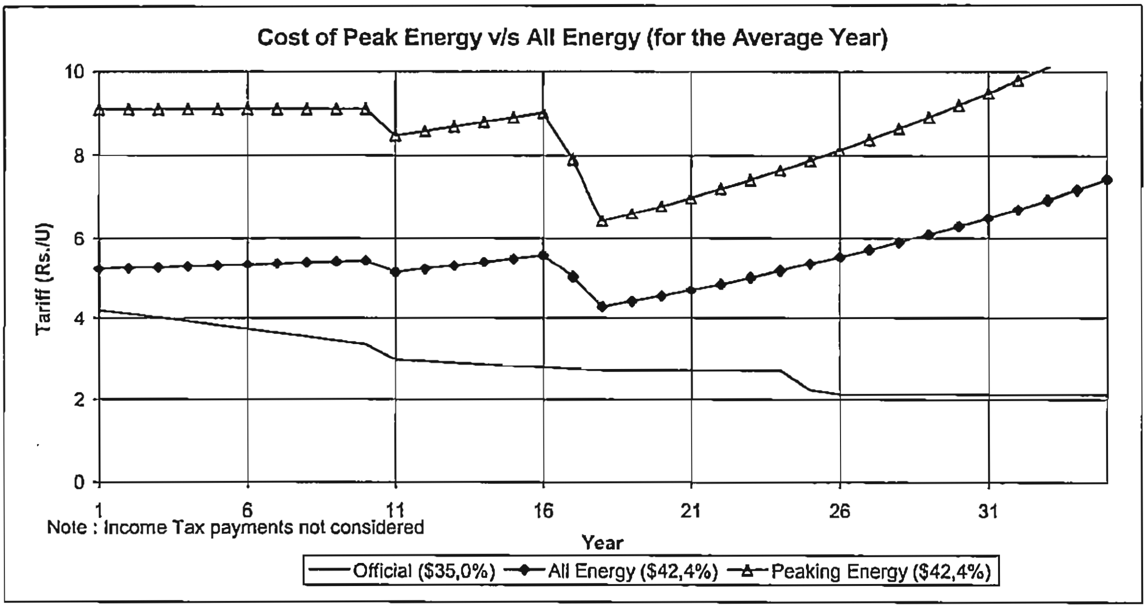
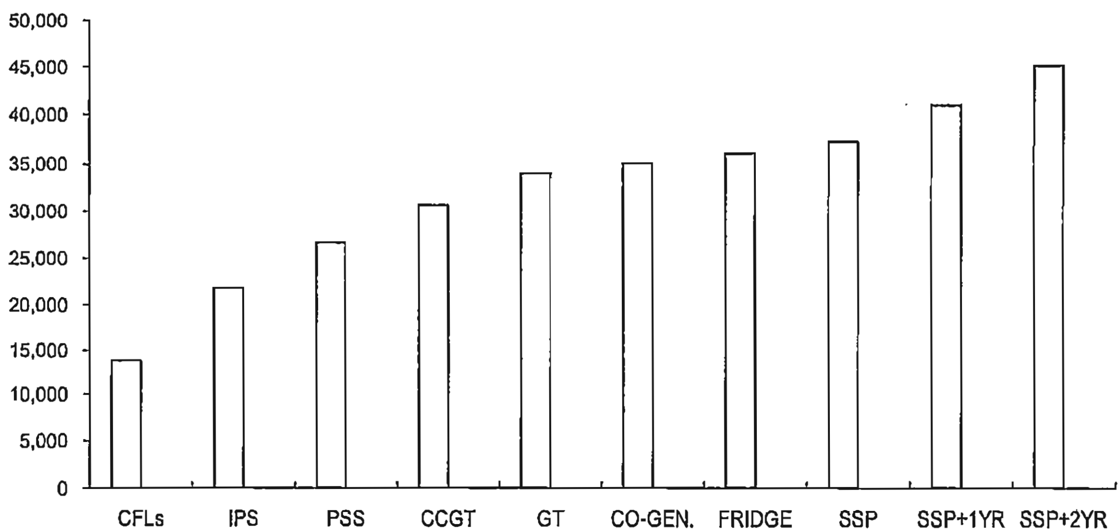


Figure 2 shows the impact of separating the peak and off-peak costs. The off-peak cost is equated to the CEA norm of fuel cost of thermal plants 9which have to be backed down in the off-peak time)

The paper on SSP indicates that several options cheaper than SSP are not even considered in the offical planning. Figure 3 shows the annualised cost in Rs/kW (Options include Lighiting improvements (CFLs), Agri Pump improvement (IPS), Pumped Storage Scheme, Gas turbines and Combined cycle gas turbines, Refrigeration improvement (this would yield base load benefit but still, its cost in Rs/kW is lower than SSP), SSP, SSP delayed by one year, and SSP delayed by 2 years) The paper was written in 1993 and those costs cost are reflected in the following figure.

The file cannot be included with this text (as it is only available in the hard copy). The paper shows that the submergence (Ha per MW) at typical 'Pumped-hydro" scheme in Konkan area in Maharashtra is order of magnitude lower than just the regulating ponds at the Canal head of SSP. The option of pumped storage was found to be low cost and sites are abundant in several states.





Similarly, our analysis for Task Force indicates that even the conventional options of DG set based power plants can be better used to meet the peak demand (rather than planning to use them as base load plants.). The famous Enron plant for example, is a ideal candidate for intermediate load plant, but the LNG contract is done at 82% PLF implying a base load plant.

IV. 6 Response of Mr Sujit Patwardhan, NBA
LARGE DAMS IN INDIA: THE INDIA CASE STUDY
(For the World Commission on Dams)

General

- The report is comprehensive, covers many aspects of the area that has a vast scope.
- Authors provide a good over view of the past experience with large dams, drawing insightful conclusions based on that data with varying levels of analysis.
- Individual authors giving their perspective and analysis – without full consensus leads to internal contradictions and the report does not make a statement that is cohesive. Revision of this first draft will have to resolve these contradictions if this report has to stand together meaningfully.
- Papers written for WCD at India level, which fed into respective thematic reviews –
  1. Displacement, rehabilitation, reparation and development by Harsh Mander 2. Dams and tribal people in India by Amrita Patwardhan 3. Irrigation options by Himanshu Thakkar are ready papers, directly relevant for the India Case Study. I felt, this available data base and analysis in above mentioned papers has not been utilized by the team.
- The report does not mention wrong hydrological estimates. There are many cases, like Jayakwadi in Maharashtra where the reservoir has not filled for many years. Even in case of the Narmada river, estimate of water in the river is highly debated. This point needs to be mentioned somewhere.
- Issues raised by strong people's movement in the country questioning the desirability of large dams is needs to be mentioned clearly. Who decides a project serves 'public purpose' or the larger good of the nation? Who is the nations? Who decides? On what basis? At whose cost? These are some of the fundamental questions which should find place in the report.

Chapter wise Comments

I. Economic analysis by Pranab Banerji

- Identifying externalities, taking example of specific projects or otherwise –with some details would help us identify the kind of costs that have not been accounted for. What are these – externalities? Why are they external to economic analysis, what implications it has? These are some of the questions which can be touched upon.
- Mentioning the implication of the private sector coming into power generation with Maheshwar being taken up by S Kumars, along with the role of funding agencies will be useful.
- Some data is mentioned about the potential hydroelectric generation of the Sardar Sarovar Project (as 1450 MW). There are many researchers who have challenged the potential of SSP's electricity generation (e.g. see Rahul Ram, 1993, **Muddy Waters**. Delhi: Kalpavriksha; Dharmadhikari, 1995 (?), **Sustainable development.**

(Ed) W. Fisher). SSP has been taken as an example to make some point which is of a general nature, but is it not clear as what is author's opinion about the claim regarding SSP, which has been challenged. It will be useful to state that clearly. It can be mention that planned and actual benefits (specifically in case of SSP or other cases) differ widely. In SSP it is suggested that that the difference between the planned and actual is likely to be very high – as much as 1400 MW.

II. Social and environmental impacts by Shekhar Singh

- Chapter tries to cover many important issues and illustrations related to social and ecological aspects of large dams.
- Some examples of people's resistance in less well know dams – (see the submission made by Nandini Oza of NBA for examples in Gujarat) can also be included, may in the appendix.
- Will it be worthwhile, mentioning in a paragraph, long history of people's resistance to displacement- dating back to Mulsi dam in Maharashtra in 1920s?
- Issue of affected people's consent for the project – in the light that 74th amendment accepts 'consultation' in case of tribal areas can be discussed.
- The chapter mentions clearly that a very large proportion of people displaced by dams are tribal. A brief section on the impact of displacement on tribal communities – their special vulnerability in terms of socio-cultural impact, sudden change in subsistence economy based on natural resource base – should be mentioned.

IV.7 Response of Ms. Medha Patkar, NBA
The Environmental and Social Impacts of Large Dams (India Case Study)
Summary by **Shekhar Singh and others**
Comments on the section on SOCIAL IMPACTS

General Comments

Part I on Social Impacts

1. The paper is most elaborate, covering almost all the issue we all have been discussing all those years. The special contribution is to give a guideline on specific aspects (such as provisions for R&R) as well as broad perspective in the area of displacement, resettlement and rehabilitation. Research team has also done a real job by analysing / compiling data from 84 projects.
2. I found some very well known / talked about examples related to different projects missing though… e.g. Sardar Sarovar Project, Bargi, now Maheshwar, Koyna, Suvarnarekha, Bodhghat, Jayakwadi, Gandhisagar, Hirakud…
3. The issue of prior informed consent of the affected communities to take cognisance of this demand by the people at increasingly large number of dams (and development projects or rather displacement projects) which goes beyond right to information and right to participation. This arises from, but not necessarily succeeding right to resources

asserted by communities which is, as we see it, totally justifiable in the conflict between natural resource- base and money-market-based (ideal type). I am only saying you may take a position or atleast recognise the issues.

4. How come many specially elaborate aspects are not specified as more relevant for tribal communities, I was wondering while reading e.g. community integration affected by displacement.
5. Remember our points presented in the meeting called by NC Saxena? Land as a capital / benefits etc. was one. Adv. Venkatramani presented his views as there should be no land acquisition (and relatedly forcible eviction) if only it's considered as changed and land use. Of course, this is an issue of economic - political rights, but very critical.
6. No longer zone-planning as needs to be done under Town and Regional Planning Act, duly and properly made public etc...affected dam related planning whether of R&R or in the command area. New plans, projects, redistribution/ use of resources upset some of the efforts / works related to land is diverted to no-agricultural use etc. (for this paper, only R&R related implications may be useful, tough it's a wider point.)
7. A little more elaboration of options assessment process and the place of social equity criteria in the same may be useful.
8. In our WCD - London meeting on Social Impacts, Equity and Distributional Analysis, there was a discussion as to whether this topic should include all positive impacts or be content with negative alone. You have mentioned a few positive impacts. E.g. in health or agricultural productive and employment, but only tangentially. This may be discussed in the stakeholders' meeting.
9. In the social equity analysis, you are right in pointing out inadequacy of data and yet with the statistical and non-statistical information available, your analysis covers lot many issues and bring out the complex reality.

   I was only wondering what does it indicate? How does it help us in decision-making for the future? What guideline emerges out of this? I would pose here a few questions based on empirical data and analysis-

   (a) When the social impacts are found to have been serious enough and not easily compensated with and with out policy-provisions, other preparedness do we accept such projects in the past or future as development effective?

   (b) As land for land and appropriate substitution of resources-base to provide an alternative source of livelihood is necessary but not quite feasible, how do we proceed? Will mere minimising displacement and optimising benefits help in resolving such a major issue? What decision shall we take in a major dam where the requirements for R&R planning too are not fulfilled?

   (c) What are ways to minimise social impacts? Are those to be found within a dam-proposal, large or small? Or, can we consider all possible options in technology and related development process towards water and energy need fulfilment to avoid iniquitous distribution of resources and benefits?

(d) Can we suggest comparative view of options to assess social impacts and equity factors other than those within a dam-project (that too, medium and major)?

(e) Can we presume that reforms and revolutionary measures to achieve better results in terms of equitous distribution is feasible? If it's yet to be tried in any major way, can we rationally suggest that those (such as equitable water supply, rules for canal head reaches demand management of hydro or even other power-generated for the grids etc be tried immediately with the present existing dam-project especially medium and major, and an assurance that equitable use of such central projects would be possible, be given to those to be in the queue for 'sacrifice'? Will this then tell us that the present projects be completed, managed and evaluated with all the concerns and criteria of social impacts / compensating social equity as a priority?

(f) There isn't much suggesting 'reparations' for the already affected, which may be included as a small sub-section as this is the only paper on social environmental.

Again, if some of these points need not be much considered, covered in this but other papers (say, Nirmalji's) let those be considered by others please.

Specific Comments

1. "It is difficult to measure trauma" ... yes, trauma can't even be fully valuated, leave alone be 'compensated'. It can be mentioned that for example, in NSP, compensation of trauma has been equated with 2 years of annual income, which is ridiculous.
2. "But then, all dams might become unacceptable" - it will be all 'big' dams. All dams don't cause displacement. Small dams, (not just check dams), can be without any displacement.
3. Status without the project to be considered while compensating, compared to the future possibilities with resettlement entitlements. The latter should be better.
4. "giving land to PAPs in the command area"... problems are dispersed. Consolidation is not possible - compulsory acquisition leading to further inequalities among the sharecroppers and landholders, leading to litigation by the farmers in the command area can be mentioned.
5. "so that their social cultural identities are disrupted to the least extent possible" - why not put this positively?
6. "fault is either in the package being offered..." - also due to lacking in execution with no tangible resources like land available as policy provisions / promises are made without assessing their availability.
7. Timing of policy making, planing is crucial.
8. "trained PAPs" - trained at what level? What about highly illiterate population? It starts with literacy in their case.
9. PAPs to include adult married sons,agriculturists,
10. "Land and other assets, where relevant, should be provided in the joint names of both spouses" - why say "where relevant". Traders and other occupation categories to have different package appropriately worked out.

11. To add:
    (a) All categories of project affected related to various project works to be included as PAPs.
    (b) Communities with amenities (those acquired) destroyed due to the project and those necessary for fulfilling basic needs socio-cultural, physical - of the communities also some common property resource such as grazing land and cemetery to avoid conflict with the host and fulfil the needs met by common property resources in the original affected area.
    (c) House plots / housing schemes rebuilt houses (why not, except in the case of tribal who may prefer to build their own?)
    (d) Irrigated land in case of irrigated projects.
    (e) Share in the electricity generated.
12. "dam structure" - and also infrastructure causes displacement.
13. "number of people affected by the dam... usually much greater than that affected by canals" - this is not true. In Sardar Sarovar Project canal affected land is 4 times the reservoir affected.
14. Section can have a note on the concept of development.
15. <u>(in Laws and policies)</u> - "only two" - central- national laws pertain to ...
16. Laws and policies section to include - River Valley Guidelines of 1986 - a landmark? Process of clearance to Sardar Sarovar Project came in after that.
17. "submission of R&R plans to MoSJE" - is this done for projects other than Narmada (Sardar Sarovar Project?).
18. "MoSJE also does not seem to prescribe any basic package" - their draft policy is ready. (It's bad!).
19. Drafts of R&R by Ministry of Rural Development, Social welfare and now, SJE are unable to receive sanction of other ministries till date.
20. Reference to Maharashtra and Madhya Pradesh state R&R acts? GRs / policy in making in some states such as Gujarat, Orissa, Karnataka.
21. Different policies for the PAFs of the same inter-state project also exist e.g. Sardar Sarovar Project.
22. Apart from the master plan, benchmark survey not only of titled / owned property but also of accessible resources including the common property resources. Is this included in 'planning'?
23. Condition to propose the project, then the R&R policy and plan not just the alternative land:
24. Process and Institutions - "planning and implementation.....own agencies" - that too mostly manned by engineers.
25. "This ensure that people are at least informed.." - The process is not at all upto the mark... can we elaborate?
26. " Though in recent years.." - sanctions come much later than the year of commencement of work when project becomes more or less, a fate accompli.

27. "Lack of information about the project" - It also deprives people of any opportunity for them to challenge the project plan, its planning, options assessment etc.
28. Inadequate "costing" - also assessment of resource-base? Mention: policy-provisions, family package for R&R.
29. "In terms of the 'head of the family' or the eldest...in Tehri" - as in most other rural and tribal communities in India.
30. "All married males"?

    Cut off date - (year at which 18 age is required) is an important factor. Land Acquisition Act considers the date of issue of sanction notice. This comes out to be unjust. Even with the amended Land Acquisition Act, which reduces the time gap but the first notice and final act of displacement. It should ideally be, just the year of resettlement and rehabilitation. (if there is delay in the resettlement or rehabilitation, the authorities, will be compel to cover the newly grown).
31. "...access t to water and other resources of the river" - add riverbed land, fish. Regular cash earning from forest produce and fulfilment of needs never included in valuation / substitution of resource-base / source of livelihood.
32. "... not easy to compensate in monetary terms" - not even proper to compensate in cash e.g. grazing.
33. "...first places of worship were constructed"- Is that true? Monuments were shifted out in some other dam, may be Nagarjunsagar?
34. ".....In any case....must be computed as a cost of the dam"- this also must be incorporated in the criteria and guidelines for sanctioning a project.

    To mentions:

    (a) No archaeological studies

    (b) Legal precondition on this. No excavation - a great historical heritage lost e.g. In Sardar Sarovar Project only 3 major temples.

    (c) Recognised monuments don't cover many culturally valuable sites for the local population and from archaeological- historical as also architectural point of view.
35. Loss of home and hearth: It is meagre and not at all adequate for replacement of a house. A clear recommendation is needed - house plot of magnitude with a minimum and maximum appropriate for the community concerned appropriate for the equivalent to the replacement value.
36. "... lot of trauma and social dislocation" - affects social security and support, community decision making and political process.
37. "Where the change is to a much poorer..." - poorer in what sense?
38. Issue of relationship with the host community.
39. For a natural resource-based community at alternative which is poorer in natural resource- base / matrix has enormous impact. Special mention of tribals in this (& in other aspects) is necessary. Change from less monetised economy and lifestyle to much more monetised is also traumatic and leads o exploitation at the hands of the market

forces. (Can mention Amrita Patwardhan's paper submitted to WCD on 'Dams and tribal people in India).

40. Compensation, also cash does not ensure purchase of land even if adequate. (Is mostly much inadequate). Market lobbies work against PAPs.
41. 'Land' for agriculturists communities, who can't be easily absorbed in the industrial market economies needs to be specified.
42. " ...assess the quality of land...." - refer to WB's principle for R&R in SSP "land of quality equivalent to or better than that before, resettlement'. Viable unit accepted by many official agencies is 2 hectares.

(a) Nutrition availability within their cultural choice for food is not available for tribal and rural PAPs a sites.

(b) Mortality rates in R&R site, very high for cattle and human both (Ref. Parasuraman TISS, report 16 on Sardar Sarovar Project). Loss of traditional health practices, not always substituted by acceptable other systems and institutions of health care.

43. WB's principle: higher or equal standard of living without proper and comprehensive operationalization, it has very little meaning.
44. "Sometimes... land they are occupying" - or cultivating (landless sharecroppers).
45. Common property resource which are already meagre, get affected due acquisition for R&R or get additional human / cattle pressure ... resulting in the conflict (in Bisalpur, Sardar Sarovar Project).
46. In Sardar Sarovar Project, forest was released for resettlement without surveying and granting land rights of the local tribal cultivators and assessing the impact on local tribal users of forest produce. Conflict between forest department and local tribal (1993: one killing of Dhanibai), one murder (1998) began many violent incidences.
47. Other points:

(a) No electricity when sacrifice is for power project (Rihand, Bargi, Koyna).

(b) There may be a community centre but no integrated community. Cultural centre but no possibility of Holi-festivals...for example.

(c) Change in the ways and means to fulfil needs create different problems. E.g. no extra place near the house for thrashing and storage of grains, but a common store is not easily adjusted to.

48. Estimates of displacement: Dams, canals, transmission lines, sanctuaries, tourism, thermal power projects etc.
49. Multiple displacement within a single displacement? (Rihand, Koyna, Sardar Sarovar Project) due to no zonal plan / ad-hocism etc.
50. "Based on these we have attempted an estimate" - does this area affected include the canal affected and other categories? Id not, even if we calculate those CAFs who lose major chunk (25 % and above of their land to canals, it would be a large no. (In Sardar Sarovar Project that number of CAFs is just above 50 % of Reservoir affected (RAFs)

who are the only recognised PAFs. Other categories include, the total figure of PAFs other than RAFs come to the same as RAFs that is official figure for PAFs get doubled.

51. Irrigation in the catchment rarely considered in valuation / loss...
52. "Eligibility": Lack of benchmark survey or desire to underestimation is also the reasons.
53. "Availability and inadequacy of other inputs" - Years long legal action with large percentage of commission to the advocates help get the compensation amount increased in many cases.
54. What protective structure do you suggest? Embankments? Those are known to have created havoc in Bihar. The issue is also about policy to acquire lands upto level and that is generally not considered. Only the houses between MWL (maximum water level), beyond full reservoir level (FRL).
55. "Social economic impacts.. " Access is affected due to filling in the tributaries also. Siltation causes problem in reaching out to water sources as silt occupies upto a height of 6 and more feet! The situation in Narmada is very problematic.
56. Pending project (time beyond the planned schedule ... and not due to people's projects, except in a few cases) suggest also unnecessary early eviction of people and destruction of natural resources, unjustifiable cost (similar to wasteful financial inputs).
57. Impact on the marriage possibility for the girls in the affected areas also well known (heard e.g. in Bargi, Suvarnarekha, and projects in Maharashtra).
58. Impact on property prices and market occurs in the command area too. Considering the gross water resource to be ushered in, sudden appropriation of land, transaction which are manipulative and in any case, affecting the agriculturist population especially the small and marginal, takes place. (Film,Yugandhar brought it out well). The class of beneficiaries thus changes fast...
59. Health impacts: Just for information, there is study on this aspect of Tawa project (Narmada). The book is tilted 'Bandh aur bimariyan'.
60. You may mention the result of the people's (PAPs) struggle in Bargi and Tawa dam projects: reservoir fisheries to the organization of the PAPs since 1994 and 1995 respectively. Also may note that growth in fishing activity in the upstream is with a change: big travellers and fishing contractors come in for commercial fisheries at the cost of the local fish-workers and fish consumers.
61. Wherever you may cover it, but the village around reservoir and canal also lose their lands, if not titled, common property and non-tilted lands to afforestation. (Sanctuary, National park also come up in the same area, cutting people access to natural resources threatening them of eviction /displacement e.g. Koyna, Sardar Sarovar Project.
62. Impacts on cemetery, water resources are to be included.
63. Many of the PAFs resettled were again affected by the earthquake ... in Koyna.
64. Water logging salinity, affected PAPs land if allotted in those areas adding to their troubles.

65. Impact on fisheries affects sources of livelihood of downstream fish-workers who can be residents of the basin or even seasonal migrants. They are never recognized as PAPs - this just needs to be clearly stated. Sardar Sarovar Project, it is estimated, will affect 10,000 fish workers downstream.
66. Health impacts downstream- through polluted water with quantum of downstream flows much reduced, also due to fertiliser - pesticide based agriculture.
67. Relative socio-eco status: Again, tribal or farmers in the catchment could be resource rich but not with high monetary income. Those resource-rich but not with high monetary. Those resources are depleted and result is impoverishment. (This may be clarified since the attempts of the project authorities is to project the affected as paupers and hence needing eviction from that environs to be brought into the development stream. Downstream population may include the affected also hence beneficiary (area) population when the affected-beneficiary status-position before and after are considered. One can conject, the gap increases.
68. Net impacts: Using reservoir water for drinking water supply or irrigation to the population on the banks many a times, PAPs settled there is never really planned. Nor is the downstream land or land adjacent to reservoir affected used for PAFs.
69. Forest loss is also due to release of forest for resettlement. Before 1980, it must be more. Even after 1980, again in Sardar Sarovar Project 4200 hectares, of forest was given for resettlement, affecting local tribal inhabitants, forest produce gatherers as well as old forest land cultivators claiming land rights (through regulation - of cultivated land) It also lends to conflict. Any other such example? In Koyna and Bargi also, PAFs who are still in the basin, have had to resettle on forest land with no other land / sites offered to them.
70. The equity analysis of power has come out quite well.
    (a) Check the % of rural households not electrified. Is it 69 % (Reddy) or 80 % (H Thakkar).
    (b) In the table on categories' consumption, % of commercial should be 5 and not.5.
    (c) Can we provide data on major dam's contribution to peaking power vis-à-vis base-load, even though it's known for the former?
    (d) I remember AK N Reddy's analysis showing 50 % subsidy for urban electricity supply. The almost equal % of agricultural use of power (compared to industry) can be deceptive, it is said as much theft occurs in the name of agriculture
    (e) Another equity issue in hydropower is the loss of source energy available to the PAFs (such as bio-mass) without replacement of those. These are examples of PAFs of originally electrified villages of houses electrified villages houses getting resettled with no electricity and some vice versa. In Bargi, PAFs had to fish a long (4 yr.) battle just to get replacement of sub-station that were removed due to submergence resettled near the reservoir for PAFs resettled there and the population of the near by villages who also borne the loss. It is yet to be completed.

71. Among those who lose:
Net impacts: The small category of DPs shown as 'benefiting' - landless receiving land in resettlement - is probably in only in Sardar Sarovar Project. In which other dam is it? In Sardar Sarovar Project too, not al the land less in Madhya Pradesh are to be given land if resettled in Gujarat. Those settled in Gujarat are labourers, landless only from fully affected villages to reduce their number entitled for land in Gujarat. The landless tribals from Maharashtra, Gujarat or Madhya Pradesh affected villages except a very very insignificant number, are not actually land less but forest land cultivators many having a due a right away to get revenue titles to their lands. More land than in pre-dam situation is also probably only in Sardar Sarovar Project? Here also, very few families have those at the cost of much non-titles land of their major sons and common property resources including forest and waste land, and scope for further expansion of families (legally approved or not). I could not get, (I don't know which 2-3 recent projects you refer to as having good practice (if title to women, additional good land etc.) in this aspect which shows some equitable distribution of resources. I will only like to know as curiosity. I may also just mention here that land in Command area principle also has rarely word in Maharashtra and not executed at all in Madhya Pradesh (the two sates that have R&R Act).
72. Land distribution in the command area change towards greater disparity: A study of Tawa command area by MN Buch shows this.
73. Not just land reforms, but water reforms would be needed in which water to be supplied not according to land holding but per capita (for the landless also to get the right ... may be to bargain that to use as irrigation) control on water-intensive cropping no sale transfer of land permitted, land ceiling limits strictly extended, and such other radical measures. Can you propose these? With what feasibility in the given political-economic context?
74. Leaving out the tail end region, as I know happened even in the case of Bhakra where Rohtak district of Haryana (mostly drought prone) was left out high and dry.

IV. 8 Response from Cmdr. Sureshwar D. Sinha Chairman, *PAANI MORCHA*, New Delhi

I was happy to attend the stakeholders meeting of the World Commission on Large Dams hearing on the India Country Study, held on 3rd March 2000. I have following comments to offer:-

Basic Concepts

1. It is my view that an important aspect of large dams which must be taken into account is that pertaining to hydrology. This is because large dams tend to destroy the natural hydrology maintained by rivers, glaciers, forests, wetlands and ground water reserves. They are extremely harmful to these natural systems and badly deplete ground water resources. The technology of large dams belongs to the 19th century when there was

unsufficient knowledge about the natural hydrology of river basins. and only the evidence found on the suface was recognised. The research during the 20th century has shown that rivers have a major role to play in the recharge of ground water. Several important papers have been written on this subject and mathematical formulae and graphs have been produced to indicate how the rate of recharge of ground water depends on the level of water in rivers and their rate of flow. Regrettably dams builders have totally ignored the evidence.

2. In India about ninety percent of the heavy rain falls during some twenty days of the year in the monsoon season. These water resources bestowed through heavy downpours are stored in the glaciers, in the roots of forests, and in major ground water reservoirs through out the country. Waters flowing through rivers also recharge the ground water as well as surface wetlands, which are usually connected to ground water aquitards. But a great part of the monsoon downpours flow down to sea. Traditionally flood canals were used to divert the monsoon flow into "valley" reservoirs, and distributory canals from these reservoirs used to irrigate the command areas.
3. However, it was the British who introduced the perennial canal system for irrigation, and this led to the first major famine of the Ganga basin. Prior to the advent of these canals, the wells of the basin did not dry up even if the monsoons failed. This was because the lean season flows of rivers continued to recharge ground water. Regrettably large dams interfere with and greatly deplete the lean season flows of rivers, and often run them totally dry. This greatly reduces the recharge of ground water. Increased consumption of ground water due to tube-well irrigation and increase in population and greater withdrawals for domestic use, have also led to virtually no recharge for eight months. The water table in most parts of India has fallen alarmingly, and water contaminated with harmful chemicals and salts has begun to be pumped to the surface.
4. Since a greater part of the population depends on wells or tube wells, dams have done a great disservice to India by reducing the irrigation potential from ground water. Fall in the water table levels have increased the cost of tubewell irrigation, as well as of those from traditional open wells. It is thus the poorer farmers who have suffered most from this phenomenon of large dams restricting or often destroying the flow in rivers.

Lack of Cost-Effectiveness of large Dam Based Irrigation:

5. It is regrettable that the dam builders, in their keenness to get approval for their dam projects {as these provide huge sums for expenditure, and help maintain large establishments}, most promoters of large dams tend to justify these with bloated figures for accruing benefits and reduced ones pertaining to costs.
6. In many cases the irrigation efficiency is taken as high as 60% when the national average is about 35%. It has been found from statistics of the Ministry of Agriculture that the actual irrigation achieved is of much lower order and is about 30 to 40%.

Lack of Consultation with People

7. It has been provided in amendment No. 73rd and 74th of the Indian constitution that rural councils known as "Panchayats" would look after governance at the village level and some states have passed acts to enforce this clause of Constitution, providing also for control of local water resources and irrigation works by the local people. Regrettably present management authorities of the major and medium dam schemes, dependent on the large dams for their authority, do not care much for peoples participation in local water resource management. So far the schemes have been planned and executed without consultation with local people. The bureaucracies of the water department of states are averse to handing over control to the panchayats.

Absolute Value of Certain Environmental Issues Not Considered

8. There are certain environmental matters of 'Absolute' values that have been greatly harmed due to the construction of large dams. These pertain to the bio-diversity maintained by rivers and wetlands that are being destroyed through the execution of large dam projects. They disturb the ecology which maintains flora and fauna that protect life and enhance important elements of the food chain. Disregard of these issues is totally unacceptable. Areas where maximum destruction has taken place are as follows:-
   (a) Depletion of the forest cover due to submergence is the most destructive aspect of the large dam projects. Whilst the upper part of the trees clean the air, roots of forests are the great stores house of water, releasing it to flow gradually. Destruction of forests leads to depletion of the total water resources of a territory.
   (b) Destruction of bio-diversity of micro-organisms, leading to loss of many life forms.
   (c) Intervention with the life patterns, migration to breeding areas and the food resource of many living creatures, including fish, which are of great value to humanity.

Other Adverse Impacts

Among the other adverse impacts of large dams are:-

(a) Huge departments set up to build dams remain in existance, even when no longer required, putting additional burden on the state.

(b) Due to very low returns on investments, the indebtedness of the nations increases, with other adverse effects.

(c) The very large sums sanctioned for the projects results in increased corruption and consequent evil results socially.

(d) Often large tracts of good cultivable land with well established economics supported by agriculture is lost to the nation due to submergence in dams' reservoirs.

(e) Owing to huge amounts committed for these large projects, many smaller and more cost effective and more beneficial projects cannot be taken-up.

(f) Rehabilitation of project affected people is never satisfactory and their move to other ares for rehabilitation destroys well established communal life.

(g) Large dams for providing perenial irrigation, reduce flows in rivers, and often run them dry, with only sewage of cities flowing into them. This pollutes ground water, leading to terrible impacts on the health of communities living in the riparian areas. Child mortality has increased in these area.

(h) Other uses of the river, such as navigation, fisheries, tourism etc. are destroyed.

(i) Perennial irrigation using canals across the drainage pattern of the basin leads to water logging in upper basin and rise in salinity and lowering of the water table down-stream of canals.

(j) There is also increase in siltation of rivers, leading to more floods.

Alternative Solutions

It is now clear that the traditional water harvesting practices, in vogue in ancient India, were far superior to the ones devised by man in the late middle ages and during the industrial revolution. Remains of a canal to transfer flood waters built in 1400 BC are still in existance in central India. The various types of water harvesting practices that stored monsoon waters for irrigation in the earlier period our history, and which also recharged ground water without disturbing lean season flows of rivers are mentioned below. These needs to be urgently revived.

(a) Weirs constructed in a part of the river bed, diverting flood waters into canals leading to "valley" or command area reservoirs.

(b) Channelising of rain water to fill tanks wells and natural lakes. The artificial tanks had a bore in each connecting them to ground water acquifers.

(c) Local administration ('panchayats') were responsible for water distribution on an equitable basis. The system needs to be urgently revived.

(d) Roof-top harvesting can also now be introduced.

(e) Restoration of forests cut down during the development process, needs to be urgently undertaken. Catchment areas of all streams needs to be afforested, and areas on their banks should be reserved for orchards.

CONCLUSION

Experience in India has shown that large dams are harmful, and have many adverse impacts that might take centuries to correct. Therefore such projects should never be taken up, and those already completed or being built should be dismantled or scaled down after careful studies of each situation. The only dams that are viable today are <u>small</u> ones for producing hydro-electric power. These should be limited to areas of steep gradient, where the river also passes through a gorge.

IV. 9 Response from Prof. Kamta Prasad

Chairman, *Institute for Resource Management and Economic Development*

Comments on the Paper on Financial, Economic and Distributional Analysis of Dams in India by Shri Pranab Banerji.

This is an excellent paper providing comprehensive information on all the aspects covered by the aspects covered by the author. Most provided in the paper. This is undoubtedly the most comprehensive the most comprehensive paper on the subject available so far. The author deserves to be congratulated for the outstanding work that he has done in a short period of time.

Almost all the basic problems facing planning of the water resource sector have been highlighted quite forcefully. These are – inadequate investigation, enormous cost and time over runs, unrealistic cost estimates and under utilisation of irrigation facilities created, substantially low actual benefit cost ration as compared to the projected ones, relative decline of hydro-power, poor commercial returns form the hydro-power projects etc...

It may, however, be useful as well as necessary to mention that most of these problems are not confined to water sector alone but are found in developmental projects in India as a whole and in both large and small projects. It may be useful to examine whether the problems are more acute in water sector as compared to other sectors and in large projects as compared to small projects. Such an examination would require the World Commission on Dams to sanction a separate study on this aspect.

Shri Pranab Banerji, on P.49 of his paper, has developed an entirely new point wherein while calculating annual capital costs, the interest cost which is now calculated on entire capital cost only. This point deserves to be highlighted more prominently since it has serious implications for financial aspects of projects. And it deserves to be enquired further whether it is equally important for the economic analysis of the projects.

While discussing benefits of dams, the paper does not take into account the considerable benefit of flood moderation and river management. Dams, of properly designed and well executed and maintained, are universally acknowledged to provide the best protection from flood. The evidence of this can be obtained from the report of the National Commission of Floods, which unfortunately finds no mention in the report.

The study relies more no macro studies including data from national income accounts statistics some of which are themselves based on dubious assumptions. Such studies have less relevance for a country like India having diverse physical and socio-economic situation. It is somewhat unfortunate the World Commission on Dams without being fully aware of conditions in India opted for a National Paper for the country whereas project specific as well as basin-wise approach would have been more useful. The study could have obtained real located in different agro-climatic zones could have been evaluated within a common analytical framework.

While quoting secondary data related to specific projects for specific years as has been done in this as well as other studies included in the volume, it is necessary to ascertain whether these could be treated as representative projects and the years studied are the representative years. The second aspect is very important for countries under monsoon type of climate like India having sharp fluctuations in weather. It is for this reason that an average of three consecutive years is often required. But most studies cited have used only one year's data. Their utility, therefore, remains quite limited. This aspect has to be kept in view while interpreting results and deriving lessons from them.

In order to arrive at a representative picture, some example of good and successful projects also should have been included. This could be useful for deriving lessons for the future.

On page 51, the study approvingly quoted the observation of the Planning Commission that in the case of minor irrigation schemes, there is hardly any difference in potential created and potential realised. This is not correct. There are innumerable cases in minor irrigation schemes including the State tube wells where substantial gaps between potential created and potential utilised exists.

Much reliance has been placed on cost of cultivation data (p.62). However, such data is not available for irrigated area alone but for an average of both irrigated and no-irrigated areas and to that extent the usefulness of this data for a study on irrigation becomes less useful.

On p.54, it is suggested that the "real impact of big dams is mostly distributional". Why are dams being singled out for this purpose? The impact of every project in any sector or of any size is distributional. But the impact is also n growth. There is inadequate evidence to prove that the impact on growth is only minor. Hence such statements should be avoided.

On p.54, a statement is made that "there is no net gain to the economy from major and medium irrigation projects" without giving convincing evidence for the same. A statement of this type should be avoided since we can find several projects, which have provided net gain to the economy.

On p.57, a statement is made that hydropower is not a preferred option. One cannot make such a statement without a thorough examination of other options. This exercise has not been done. Such statement, therefore, should be avoided.

On p.67, an erronous conclusion has been drawn by comparing irrigation and large sizes farms. This is an example of spurious correlation. It does not take into account climatic and hydrological factors, which are more important for the purpose.

With regard to rise in costs without commensurate rise in area under irrigation, the study misses an important factor namely an ever increasing proportion of recent projects are modernisation and consolidation projects. Their impact cannot be measured through a macro analysis of BD Dhawan's type. In such cases the benefit would include loss of benefit prevented rather than additional benefit accrued.

Some of the problems highlighted in the paper have been known for a long time. Several measures have been suggested from time to time to deal with them. One would like to find out why these measures were not implemented and what measures should be suggest to facilitate their implementation. The most recent approach in this connection is that of the National Commission on Integrated Development of Water Resources Plan which submitted its report in September 1999. A Complete overhaul of the institutional framework with regard to planning and policy formulation machinery for Water Resources has been suggested in this report. It would be helpful if some extracts from this report are provided in the paper.

Similarly, many of the problems, especially with regard to oustees can be taken care of it the critieria for selection of projects which is based on Hicks-Kaldor compensation principle, as reflected in benefit cost analysis, is replaced by the Gandhian concept of Sarvodaya i.e. benefit to all. A similar change is implied for functioning of the State, which works on the basis of greatest, good to greatest number, thereby ignoring the interests of the miority. An operational mechanism in consonance with the Sarvodaya concept can be worked out.

IV.10 Response from Major Singh, Director, (HP&I), Central Electricity Authority

Comment on Document of WCD Cases Study (Draft Report)

Reference	*Comment from CEA*
Para 1.51 Page 9 (b) Clearance amount has been revised as high as 1 billion.	Projects with capital cost above Rs.2.5 billions require CEA clearance. In case of projects through competitive bidding the limit in Rs. 10 billions. For H.E. projects involving inter state aspects there is no financial limit and these projects require processing by CEA.
1.7.1 Power Sector – Salient Features Page:- 13 - Large projects having capital expenditure about 4 billions required technical approval of CEA (In 1996 limit raised to 10 billion)	Projects with capital cost above Rs. 2.5 billions require CEA clearance. In case of projects through competitive bidding the limit in Rs. 10 billions. For H.E. Projects involving inter state aspects there is no financial limit and there is no financial limit and these projects require processing by CEA
1.7.1 (Page – 14) - Till September 1998 only 4 plants with a total capacity of 1346 MW in operation by private sector.	Regarding H.E. projects in private sector, 8 Nos. of H.E. projects are in operation with aggregate I.C of 473.25 MW (as on 1.3.2000)
1.8 (c) Page 21 The MNES is given the responsibility of development of small hydropower of up to 3 MW capacity.	Schemes up to IC of 3 MW is already under purview of MNES. According to Policy on Hydro Power Development announced by MOP (Aug 1998) schemes up to 25 MW IC has been proposed for development by MNES.

Table (Contd...)

Table (Contd...)

Reference	*Comment from CEA*
4.5.2 Page – 45 Future Potential of water resource development (table 5 – hydro electricity at 60% load factor) Potential developed and under development = 18758 MW Developed not developed nor under development = 65286 MW Of which Potential not yet explored and cleared = 62452 MW	The updated status of Region wise H.E Potential Development as on 1.4.2000 is given at annex – 1.
2.4.4 Country has added 22000 MW I/C. Share of hydro has come down to 25%.	Country has added 23019.15 MW. Share of Hydro has come down to 24.7%.
3.2.4 Page – 52 CEA has identified 63 sites for the development of pump storage with estimate potential of 94000 MW.	CEA has identified 63 sites for the development of Pumped Storage Schemes. Out of which 7 nos. schemes where already in operation or under construction that the time of the study. The I.C of the rest 56 nos. schemes was about 94000 MW.
3.4.1 Page – 57 Management of Multi purpose Project Irrigation has been reduced to a by produced "in Bhakra Canal System letting power, letting power potential take precedence.	All major MPP are Irrigation controlled. The peak generation from major MPP discharges is generally re-regulated from a downstream dam having adequate storage capacity to regulate the releases for Irrigation. A part of the storage in Bhakra reservoir was specially reserved for power generation originally.
4.3.1 Page (68) Small Hydro: MOP has classified Micro Hydel (less than 100 kw) Mini Hydel (0.1 MW to 2MW) Small Hyel (2 to 15 MW) Out of 10000 MW, 700 MW is identified by CEA and about 2039 MW by MNES.	As per hydropower policy of MOP, schemes up to 25 MW station capacity will be dealt by MNES. There are 1512 nos. of small H>E. Schemes with total installed capacity of 6781.81 MW identified by CEA.

Draft Report - The India Country Study

Draft Report	*Comments from CEA*
Page – 9 Hydro Power and Large Dams IC as on March, 1998 stood at 8900 MW, 2/3rd of hydro IC is attributed to storage backed scheme, 1/3rd from ROR schemes.	As on 1st Feb., 2000, the total IC is 95242 MW, in which hydro share is 23527 MW i.e. 24.7%.
Page – 10 HE Power Potential of India Table 1.6 Probable IC = 148699 MW (Indus 33842 MW, Brahmaputra 66005 MW, WFR 9418 MW.)	Probable I.C. = 148701 MW (Indus 33832 MW, Brahmaputra 66065 MW, WFR 9430 MW
Page –28 As already mentioned there is no clear constitutional or legal prescription of approval of such state projects by Central Government.	All the MPP after TAC clearance have to be processed for CEA clearance, wherever hydropower component is involved.
Page-39 The target of Govt. is completion of most of the storage potential by 2025 and addition of 52000 MW of hydel power capacity within 12-13 years.	Govt. has also undertaken Renovation Modernization and uprating of old HE schemes. 55 Nos. Schemes (9653 MW) have been identified, out of which 24 Nos. have been completed and remaining are ongoing.
Page-41 Total potential of small hydro power has been estimated as 10000 MW.	According to studies carried out by CEA. The small Hydro Potential is estimated as 6782 MW in terms of Installed Capacity.

Future Potential of Water Resource Development

(As on 01.04.2000)

Region	*Hydroelectricity at 60% L.F.*		
	Potential developed and under development	*Potential not development nor under development*	*Of which Potential not yet explored and cleared*
North-eastern	3.48	47.83	49.20
Northern	36.05	35.83	34.99
Eastern	8.53	6.11	5.65
Western	17.78	3.58	3.36
Southern	34.16	6.65	6.80
Total p.c.	100	100	100
Actual	18812.48	65231.52	62428.00

Shekhar Singh is currently on the faculty of the Indian Institute of Public Administration. He is a member of the Narmada Control Authority's Sub-Group on the Environment and of the Indira (Narmada) Sagar Review Committee. He has been a member of the Environmental Appraisal Committee for River Valley Projects, and Chairman of the Environmental Appraisal Committee for Thermal Power Stations, of the Ministry of Environment and Forests, Government of India. He was also a member of the Expert Committee on Tehri Project set up by the Ministry of Power, Government of India and Advisor (Environment and Forests) to the Planning Commission. Email: shekharsingh@vsnl.com

Pranab Banerji is currently on the faculty of the Indian Institute of Public Administration. He has earlier been a Professor at the Lal Bahadur Shastri National Academy of Administration, Mussoorie and has also taught at the University of Delhi. He is an economist by training and has, for many years, been running training programmes on the economic analysis of irrigation projects, for officers of the Ministry of Water resources, Central water Commission and state irrigation departments. Email: iipaitc@nda.vsnl.net.in

An unspoiled mountain stream

Indian Institute of Public Administration
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