

"ECO-ENVIRONMENTAL AND WILDLIFE MANAGEMENT STUDIES
ON THE SARDAR SAROVAR SUBMERGENCE AREA IN GUJARAT"

INTERIM REPORT - I
(Nov. 15, 1989 - June 15, 1990)

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with these
studies?
S.D. SABNIS
@ early listings - what about analysis
of submergence?

PREAMBLE

I am presenting this first interim report on behalf of my research group comprising 6 Principal Investigators, 7 Research Assistants and a Consultant who is closely and constantly associated with the project.

Works on the various aspects of the submergence and part of the catchment area in Gujarat have been progressing at great pace.

The study area lies between 21'.38°N and 22'.54°N and between 73'.4°E and 74'.10°E on either side of the river Narmada. Narmada has Vindhyan mountain ranges along its right banks and the Satpura ranges along the left banks. The forests of the area form part of Gora and Piplod ranges of Rajpipla east forest division and Gadhboriyad and Kawant ranges of Chhotaudepur forest division. The left and right banks are quite distinct in their geological formations, soil types, rainfall patterns and also the vegetal cover, avifauna and insect fauna. Even in terms of population, both human and cattle, the right banks carry a much heavier load than the left banks, which are steeper and less hospitable.

The entire ecosystem is under great stress burdened with enormous cattle and human populations as well as many destructive biotic activities. At many places, the green is replaced with brown and yellow. Such a degraded ecosystem is sought to be revived under the present project. Such a restoration effort requires intimate knowledge of the past and present of these systems as also a careful evaluation of causes and trends of deterioration and goals of the new system to be evolved with thoughtful human intervention at least in the initial stages.

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Our research group has been during the past seven months, carrying out number of diverse investigations with a view to accumulating a wide data base so essential for the eventual revamping and rebuilding of the damaged ecosystem.

Right at the beginning, maps of Sardar Sarovar study area were prepared in the scale of 1 : 50,000. The areas was divided into 1241 grids of one sq.km. each. 120 of these grids were randomly selected for intensive studies on the flora and fauna, their linkages and the biomass production of the various degraded forests.

Later, deep ground truth traverses were made to the study area in the absence of latest aerial photographs. An ecosystem classification or gradation, thus, resulted which not only considered the prevalent land use pattern but also the magnitude of human interference and erosion patterns. These details will be dealt with by one of my colleagues later but let me assure you that it provided a frame work into which all the diverse data could be stored and interpreted. It also resulted into our understanding of the ecology of the area as also the sub-areas (grids) within the whole area in the shortest possible time. It helped us fix our priorities in terms of action plans for restoration of the total ecosystem as a means of assuring adequate life span for the dam and its irrigational potential. It has been painfully observed that the system at present is not producing 1/6th of its real potential and that the right banks with 3 times the area is not producing even 1/3rd of what the left banks produce. The reasons for these

right-left differences, more than the habitat factors, should be sought in terms of human populations and their activities. A socio-economic probe, thus, becomes necessary and steps have been taken to initiate a survey of this nature. More and more areas will be critically studied during the rest of the project period to verify and refine the results obtained so far.

The project work involves three important inter-connected aspects:

1. Biological Resources Inventory (flora and fauna).
2. Forest biomass studies including wildlife migration/management and,
3. Eco-enhancement studies and development of a new ecosystem.

Let me briefly put before you the salient features and future direction of work in each one of them. There is always an effort to stick to the Terms of Reference as strictly as possible. Sometimes incursions into other areas have been made for proper interpretations and perspectives with respect to the biological well-being of the entire area.

As usual, the research approaches employed are

1. Data generation, through field studies, sample collections and analysis,
2. data retrieval/acquisition through reference to published literature and,
3. referral system through consultations with subject experts.

Floristic and faunal studies have been organised for primary data generation spread over a number of field trips all over the area. Clear-cut

differences and linkages have been established in various ecosystem grades on both the banks. Thus linking the floristic and faunal data to various edaphic and biotic parameters. Plant and animal collections have been properly preserved and/or documented. Critical studies on certain interesting and rare plant and animal species are also a major function of the project. In vitro propagation of some rare plants and the experiments with a rare amphibian are cases in point.

The biomass production data is being increasingly compiled and combined with data on availability of fodder resources and water holes to provide guidance and direction to the studies on wildlife migration and management. This part of the work is to be handled by a separate cell closely linked academically to our research group. The biomass production in the various ecosystem grades ranges from 73.17 T/ha. to 3.66 T/ha. and serves as a pointer to the magnitude of human interference. This picture has to be viewed again and again in terms of additional data to gain deeper understanding of the operative system.

The research group is just not satisfied with creation of a broad data base for academic purposes. Its ultimate goal is to make suggestions and develop action plans for rebuilding of the ecosystem. Experiences are being accumulated at the Narmada environs and also at Ukai. The process of proper and clear understanding of the causes and trends of the ecosystem decay has started. To begin with, an area of 125 sq.km. abutting the right banks of Narmada in Gujarat (also similar areas along the left banks in

Maharashtra) which drains into the Sardar Sarovar is recommended for detailed stabilization efforts. The degree of slope, soil types, erosion patterns are being studied with a view to suggesting suitable plant species for stabilization of reservoir periphery. Additionally the group is trying to assess the requirements of inputs in terms of food, fuel and fodder of the local populations by launching on a socio-economic probe. This is essential to gain insight into a proper planning for the future. Members of the research group do not leave any opportunity to enlighten people about the ecological fall outs such a human action and the rational approach adopted by them.

During the course of deep travels in the study area it was found that a wide variety of ecological conditions were prevalent in the region. Consequently, it was decided to treat the area as a collection of closely related eco-systems that interact with each other rather than a single large eco-system. A multisystem approach has the advantage of being easily able to identify many localised factors that influence the eco-system. Second, it provides a convenient framework in which large amount of data can be classified and compared. Finally it also provides a more suitable medium for evaluating human interference and planning of the new eco-system that will replace the old deteriorated one.

A eco-system classification, suitable for both the left and the right bank areas was developed. It is based on the prevalent land use pattern and also takes into account degree of human interference and erosion. Table-1 contains main features of each of the eight grades of classification system. Of these, seven grades are concerned with forestry and agriculture, while the grade 8 was reserved for areas in which organised agriculture was practised. The classification runs parallel to the existing forest classification as far as forest density is concerned. However, since it takes into account other parameters, it is not comparable to forest classification. It may be possible to use aerial pictures taken from around 5000 feet or even an aerial survey, to rapidly classify the eco-system without having to travel in hard inaccessible areas. But it is not likely that satellite imagery can be

used for this purpose. The ground truth used by observers to classify an eco-system includes a wide variety of factors; these are not likely to be detected in satellite pictures.

The project team went to each of the 1241 grids and graded the existing eco-system as per classification. Table-2 shows the distribution and area of each grade. The most prevalent grade on the right side of the Sardar Sarovar is no. 7; and the grades 1 to 4 are absent. Of the total right side area of 924 sq.km., 567 sq.km., graded in the 7 category; 519 sq.km., of these are hilly and marked as 7h. Agriculture was practised in 222 sq.km. and the remaining area was divided into 5 and 6 categories. The high lands of the system 7h drain in four different directions. Areas, south of a line running east to west in the southern portion of the right bank, drain directly into the Sardar Sarovar. They comprise approximately 115 sq.km. and need to be stabilised to reduce silting of the Sardar Sarovar. Along much of the central portion of the right bank area, the high lands drain from east to west. They also drain towards north west out of the study area. In the east, the high lands drain first to the east and then to north and north west. The hills of the area have barren or lightly wooded peaks, scratch agriculture along most of the hill sides and plateaus and some sparse vegetation along streams: they are included in the hilly 7 system.

The left bank hilly area is 317 sq.km. Every grade from 1 to 8 is represented here; but the most prevalent grades are 2 and 6. They are 157 and 98 sq.km. Areas of the no. 2 eco-system are well forested and contribute nearly half the forest biomass present in the entire study area.

The hills on the left bank are higher, and they generally drain into Devganga river which ultimately drains into Sardar Sarovar. The danger of silting from this area is less than that from the right bank area because of greater forest cover and longer and indirect drainage routes. Moreover, in the southern portion, some of the streams do not drain into Sardar Sarovar but run west and join Karjan river.

CLASSIFICATION IN BIOMASS DETERMINATION

A large number of quadrats were sampled in each of the eco-system areas and the forest biomass of the quadrat was determined. A combination of methods designed to estimate the bole volume and branch to bole ratios were used for this purpose. The results (Table-3) indicate a smooth gradation of diminishing forest biomass as one proceeds from one grade eco-system to 7 grade eco-system. 73.17 tons/ha. of wood biomass was present in the grade 1 eco-system. Corresponding figures for other eco-systems are 56.54, 32.23, 26.60, 15.53, 8.02 and 3.66 tons of wood/ha. respectively. Cumulatively, the entire study area had 14,17,009 tons. of forest biomass; of this the left bank system accounted for 10,86,107 tons. and the nearly three times bigger right bank had only 3,30,812 tons. The extent of the degradation of the system can be judged by a simple comparison. Had all the areas of the study been forested to 1 grade eco-system level, the resulting biomass would have been well over 90 lacs tons; instead it is only 14 lacs tons.

The task of determining the productivity of these areas is a complex

one. The productivity of agriculture lands and herbs and shrubs in forest areas can be determined by studying their annual production. However, several difficulties appear when attempts are made to determine forest productivity. First the forests are mixed and the stands of mixed ages co-exist in the same area. Second the rainfall pattern here varies considerably from year to year and the cycle of lean and good years is irregular. Therefore, the growth fluctuates from year to year. Finally, in many of the eco-systems of the area, the standing biomass does not reflect product accumulation over a number of years. It is more a result of what was produced minus what was removed.

We have attempted to bypass these difficulties by calculating primary production potential of these eco-systems and comparing them with that of a Montana forest system that was stable. The assumptions involved in these calculations are 1. that only about 3% of the incident solar energy was trapped and 2. that there were about 100 days in a year in which the plants of the present eco-systems can achieve full production capacity. Both are reasonable assumptions. The data was reported in terms of wood equivalent; 4×10^9 calories being taken as one tonne of wood.

The results (Table-4) indicated that the primary production potential of the Sardar Sarovar grade 1 eco-system was 3.51 tonnes of wood per year per Ha. This was 3 times lower than that of the Montana system of the U.S.A. Both systems are considered to be stable. As the systems deteriorate, their productive potential also comes down primarily because of loss of plant

populations. In the final 7h grade the primary potential of production is only a small portion of the original 1st grade eco-system, and therefore, the system can be described as destructed.

Several factors can be cited to accounts for the differences of the right bank and the left bank eco-systems. These include differences in rainfall, topography, access to regions and past history of the left and right banks. The left bank areas were a hunting preserve of a princely state and were later converted to a game sanctuary whereas the right bank did not enjoy such protection. However, when the populations of these areas is compared (Table-5) it is clear that the primary difference between the two regions is in the human populations of the two areas. Both in terms of absolute numbers and the population density the right bank is several times more crowded. Consequently, the reasons for the differences in two systems must be sought in terms human populations and their activities. A survey of this aspect of eco-system then becomes necessary, and steps to undertake it have been initiated.

TABLE- 1
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ECOSYSTEM CLASSIFICATION

GRADE	DESCRIPTION		USE
	WOODED	NOT WOODED	
1	All	-	All wooded, no agriculture or domestic grazing. Human interference limited to roads or guard personnel.
2	Peaks, gorges, plateaus, streams hill sides	Flood plains Valley bottoms	Forestry Agriculture
3	Peaks, gorges, higher plateaus streams hill sides	Flood plains Valley bottoms Lower plateaus Lower hill sides	Forestry Agriculture
4	Peaks, gorges, streams higher hill sides	Flood plains Valley bottoms Low & high plateaus Lower hill sides	Forestry Agriculture Grazing
5	Peaks, streams, gorges	Flood plains Valley bottoms Hill sides plateaus	Erosion seen Agriculture Grazing Reduced Forestry
6	Lightly wooded peaks, medium density streams	Not wooded flood plains, Valley bottoms hill sides & plateaus gorges	Medium Erosion patterns
7	Sparsely wooded to barren peaks, Lightly wooded streams	Flood plains Valley bottoms hill sides plateaus	Agriculture Deep Erosion
8		All agriculture	

TABLE - 2

AREA OF DIFFERENT ECOSYSTEMS OF SARDAR SAROVAR
ENVIRONS IN GUJARAT

ECOSYSTEM GRADE	LEFT	BANK RIGHT	ECOSYSTEM GRADE	LEFT	BANK RIGHT
1	15	0.0	6	98	115.0
2	137	0.0	7	0	48.0
3	28	0.0	7h	9	519.0
4	6	0.0	8	11	222.0
5	13	20.0			
TOTAL				317	924.0

1 = Area in Sq. Km.

2h = Hilly

TABLE - 3

ESTIMATES OF FOREST BIOMASS OF ECOSYSTEMS OF
THE SARDAR SAROVAR ENVIRONS.*

ECOSYSTEM GRADE	ECOSYSTEM BIOMASS/HA.	LEFT BANK TOTAL BIOMASS	ECOSYSTEM BIOMASS/HA.	RIGHT BANK TOTAL BIOMASS
1	73.17	1,09,755	-	-
2	56.04	7,68,159	-	-
3	32.23	90,244	-	-
4	26.60	15,960	-	-
5	15.53	20,139	15.53	31,060
6	8.02	78,596	8.02	92,230
7	-	-	3.66	17,568
7h	3.66	3,294	3.66	1,89,954
TOTAL		10,86,197	TOTAL	3,30,812
			G.T.	14,17,009

* BIOMASS IN TONNES OF DRY WOOD EQUIVALENT.

TABLE - 4

ESTIMATES OF PRIMARY PRODUCTION POTENTIAL OF FORESTS OF DIFFERENT ECOSYSTEMS (IN TONNES OF WOOD EQUIVALENT PER HA. PER YEAR).

ECOSYSTEM	PRIMARY PRODUCTION	STATE
MONTANA, U.S.A.	10.53	STABLE
SARDAR SAROVAR ENVIRONS IN GUJARAT		
GRADE 1	3.51	STABLE
2	2.90	NOT STABLE
3	2.34	NOT STABLE
4	1.77	DETERIORATING
5	1.15	DETERIORATING
6	.58	DAMAGED
7 & 7h	.10	DESTRUCTED

TABLE - 5

ESTIMATES OF HUMAN POPULATION OF THE ECOSYSTEMS OF SARDAR SAROVAR ENVIRONS. (1981 CENSUS)

ECOSYSTEM GRADE	LEFT BANK	RIGHT BANK
1	303	-
2	427	-
3	1,898	-
4	301	-
5	919	891
6	941	4,942
7	140	60,856
8	149	45,475
TOTAL	5,078 (6,804)*	1,11,714 (1,49,696)
POPULATION Sq.Km.	16.0 (21)	121 (162)

* FIGURES IN BRACKETS 1990 ESTIMATES.

FOREST BIOMASS

S.J. BEDI

The present investigation is to assess the status of autotrophic aerial forest biomass in the vicinity of proposed Sardar Sarovar (20 km. north and south of the Narmada river) with a view to locating highly productive forests. The data would, thus, provide guidelines for the eco-enhancement of the system, which is presently exhibiting various stages of degradation. It will help to locate probable wildlife migratory routes endowed with high tree density close canopy cover, richer fodder and water resources. It will also be utilized by the wildlife management group in census and management of wildlife.

The data presented here is partial, based on study conducted during late winter and summer on 32 sites for forest biomass of trees. More data will be generated during monsoon and post-monsoon for herbs, shrubs and trees from more representative sites. The comprehensive data, thus, will be immensely useful to the wildlife team associated with the project in their migration studies and management efforts.

The forests along the Narmada river system form part of Gora and Piplod ranges of the Sapitla east division on the left bank; however, part of the Gora range extends to the right banks also. The right bank forests - degraded, mutilated and deformed - belong to Gadhboriyad and Kawant ranges of Chhotaudepur forest division. All

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these forests generally belong to Tropical dry deciduous mixed teak forest types. Some moist deciduous mixed teak forests are located along the left bank.

METHODOLOGY

The area under investigation is classified on the basis of land use pattern, degree of erosion, intrusion of agriculture, biotic stresses and forest cover into 7 grades. Standard methods with some modifications were adopted to obtain present data. 89 quadrats, 48 along left banks and 41 along right bank were laid on 32 sites representing different eco-system grades. About 10 quadrats each of 1000 M were laid in each grade of forest. Phytosociological data like absolute and relative values of frequency, density and dominance and for biomass estimation, bole circumference at breast height (CBH), bole height (H_b), total height of tree (H_t) and Canopy cover (C) were recorded. From the few felled trees belonging to different species bole and branch volume was obtained by actual measurement. Branches less than 30 cm. circumference were weighed, their sub-samples were oven-dried, weighed and added to the branch biomass. Volume was converted to biomass with the help of conversion tables. Total tree biomass of each species in a quadrat was determined with standards prepared from felling data, and figures thus obtained were added to get total biomass in Kg/Q. This converted to tonnes/Ha. In each forest grade there is certain percentage of open or denuded area without cover. For calculation of forest biomass this was taken into consideration. The open area always increased from

grade 1 to 7 and concurrently the forest cover decreased and higher degree of agricultural intrusion was recorded.

Dried bamboos of average girth and height were weighed and this weight was multiplied with total number of bamboos per quadrat to get approximate biomass of bamboos per quadrat. Agricultural and the biomass of other cultigens have not been studied during the report period.

More data on tree, shrub and herb biomass will be collected during monsoon and post monsoon period from various representative sites in all grades of forests and added to the present data to make it more relevant to the project objectives.

With greater availability of data, even biomass estimation methodology will have to be further modified to get accurate picture of the biomass distribution in various grades of forest.

RESULTS AND DISCUSSION

The data on the aerial forest biomass, canopy and the density in different grades of forests are presented in Table 6 to 13.

LEFT BANK

The forests along left banks of the river are comparatively richer due to lesser biotic stresses (mainly grazing and illicit cutting) and intrusion of agriculture. The forests are of dry deciduous mixed

teak forest. some of the best forests of the Rajpipla forest division forming part of the Piplod range are at Namgir and Mohbi and they are of grade 1, exhibiting high forest biomass production (74 T/Ha.) Table - 6 & 7. Teak is the chief dominant in (contributing about 26% biomass) having relative density and dominance of 63.4 and 51.17% respectively and Importance Value Index (IVI) is 134.21. The other common associates of teak are: *Terminalia crenulata*, *Anogeisus latifolia*, *Mitragyna parviflora*, *Bridelai retusa*, *Lagerostroemia lanceolata* and *Dendrocalamus strictus*. They contribute to major biomass production in this grade (about 75%) Table - 7. Second grade forests cover large area of southern part of left banks (64 T/Ha.) Table - 8.

Teak is dominant in all the 7 grades, the biomass contributed by different species show somewhat similar pattern with decreasing trend from grade 1 to 7 (Table - 7 to 13). 1 to 4 forest grade is totally absent along the right banks. Along the left bank there are small forest areas of 3 and 4 grade where biomass production is about 33 and 26 T/Ha. respectively (Table - 9 & 10). Large area on left bank and a few forest patches towards right bank (at Vadia, Jantar and Amba) show biomass production about 16 T/Ha., they represent grade 5 forest (Table - 11).

Some patches on the southern side along left bank and major part of the northern side are covered by 6th and 7th grade of forest exhibiting poor biomass production 8 & 4 T/Ha. respectively (Table - 12 & 13).

The riverine forests along Devganga and along other forest streams show closer canopy and better biomass production. At few places due to high soil erosion and exposed rocks with poor tree cover low biomass production are noted. These areas can be improved by better management practices to facilitate migration of wildlife through the Devganga river to the richer and safer areas in grade 1 or 2 type ecosystems.

The forests on the northern part of the left bank are of 6th grade with poor water resources and biomass production. Some of these high hilly slopes are more steep and further deterioration of vegetal cover will accelerate the rate of erosion exposing baren rocks. The probability of migratory routes through this region is poor.

RIGHT BANK

North and north western part of the large area towards right bank is plain and under well established agriculture for fairly long time, biotic stresses are fairly high.

Towards south and south east, these plains intermingle with low hilly forests having very sparse tree cover. There are some forest patches of 5th grade (biomass production 16 T/Ha.). Table - 12, at Banganga, Moti Khadi near Vadia, Jantar, Amba and on the road to Hampheshwar. Some of these forests have a history of rich wildlife during the past and upto first half of this century. These forests have

the potentials to be improved and the residual wildlife may move to these pockets through Vadia and Moti Khadi streams. Most of the forests around these places are under high biotic stresses and intruded primitive agriculture systems. They belong to 7th grade, and have biomass of around 4 T/Ha. Some forest area towards south east is not easily accessible. They are a part of Gadhboriyad and Kawant forest ranges and are of slightly better quality belong to 6th grade with biomass production about 9 T/Ha. (Table - 13).

1 to 4 grade of forests are absent along right bank and some small patches along streams are covered with 5th grade. About 80% of the area under forest is covered with 6 and 7th grade with low to very low biomass production. Wildlife along right bank is very poor. The forest on the left bank are richer with higher biomass production (grade 1 to 4). There are more chances of wildlife migrating to grade 1 and 2 type of forests through Deveganga, Sankli and allied streams.

TABLE - 6
AUTOTROPHIC BIOMASS PRODUCTION IN
DIFFERENT FOREST GRADES

FOREST GRADE	TONNES/HA.	LOCALITY
1	< 74	NAMGIR, MOHBI
2	< 57	WAGHUMAR, SAGAI, DABKA, KOKKAM
3	< 33	PATAVALI, MATHAVALI
4	< 27	KHAMAN
5	< 16	VEDCHIA, JANTAR, AMBA
6	< 9	SURPAN, PANCHALA, CHAPAT, GULWANI
7	< 4	GADHER, KATKHEDI, VADGAM

TABLE - 7
~~FOREST GRADE - T~~
AUTOTROPHIC BIOMASS PRODUCTION

NAME OF THE PLANT SPS.	BIOMASS TONNES/HA.
TECTONA GRANDIS	22.9
TERMINALIA CREMULATA	12.69
ANOGEISSUS LATIFOLIA	11.34
MITRAGYNA PARVIFOLIA	9.78
BRIDELIA RETUSA	6.99
LAGERSTROEMIA PARVIFOLIA	6.37
ADINA CORDIFOLIA	4.90
DENDROCALAMUS STRICTUS	6.29
TOTAL	81.27 - 10 %* = 73.14 T/Ha.

* OPEN AREA

TABLE - 8
FOREST GRADE - II
AUTOTROPHIC BIOMASS PRODUCTION

NAME OF THE PLANT SPS.	BIOMASS IN TONNES/HA.
TECTONA GRANDIS	18.33
LAGERSTROEMIA PARVIFOLIA	12.74
ANOGAEISSUS LATIFOLIA	11.35
TERMINALIA CREMULATA	8.46
ADINA CORDIFOLIA	7.36
BRIDELIA RETUSA	4.66
MITRAGYNA PARVIFOLIA	2.55
ACACIA CATACHU	2.45
DENDROCALAMUS STRICTUS	2.15
TOTAL	70.05 - 20%* = 50.04 T/Ha.

* OPEN AREA

TABLE - 9
FOREST GRADE - III
AUTOTROPHIC BIOMASS PRODUCTION

NAME OF THE PLANT SPS.	BIOMASS IN TONNES/HA.
TECTONA GRANDIS	22.92
MITRAGYNA PARVIFOLIA	4.89
BRIDELIA RETUSA	4.66
LAGERSTROEMIA PARVIFOLIA	6.37
ADINA CORDIFOLIA	3.69
ALBIZIA LEBECK	.33
LANNEA COROMONDELICA	.85
HOLARRHENA ANTIDYSENTRICA	.92
DENDROCALAMUS STRICTUS	1.34
BOSWELLIA SERRATA	.86
ANOGAEISSUS LATIFOLIA	11.34
TERMINALIA CREMULATA	4.23
TOTAL	62.4 - 41.5%* = 36.5 T/Ha.

TABLE - 10
FOREST GRADE - IV
AUTOTROPHIC BIOMASS PRODUCTION

NAME OF THE PLANT SPS.	BIOMASS IN TONNES/HA.
TECTONA GRANDIS	18.33
MITRAGYNA PARVIFOLIA	2.44
TERMINALIA CREMULATA	4.23
BRIDELIA RETUSA	2.33
ANOGEISSUS LATIFOLIA	11.34
LAGERSTROEMIA PARVIFOLIA	6.37
ADINA CORDIFOLIA	2.45
BOSWELLIA SERRATA	.85
TOTAL	48.34 - 45%* = 26.6 T/Ha.

* OPEN AREA

TABLE - 11
FOREST GRADE - V
AUTOTROPHIC BIOMASS PRODUCTION

NAME OF THE PLANT SPS.	BIOMASS IN TONNES/HA.
TECTONA GRANDIS	22.91
LAGERSTROEMIA PARVIFOLIA	6.37
MITRAGYNA PARVIFOLIA	2.44
BRIDELIA RETUSA	2.33
ANOGEISSUS LATIFOLIA	1.12
LANNEA COROMANDELICA	1.02
ACACIA CATACHU	1.32
PONGAMIA GLABRA	.85
DENDROCALAMUS STRICTUS	.47
TOTAL	38.83 - 60%* = 15.53 T/Ha.

* OPEN AREA

TABLE -12
FOREST GRADE - VI
AUTOTROPHIC BIOMASS PRODUCTION

NAME OF THE PLANT SPS.	BIOMASS IN TONNES/HA.
TECTONA GRANDIS	17.32
TERMINALIA CREMULATA	2.13
ANOGEISSUS LATIFOLIA	2.10
LAGERSTROEMIA PARVIFOLIA	5.50
BOSWELLIA SERRATA	2.26
HOLARRHENA ANTIDYSENTRICA	.54
PONGAMIA GLABRA	1.01
BRIDELIA RETUSA	1.25
TOTAL	32.11 - 75%* = 8.02

* OPEN AREA

TABLE - 13
FOREST GRADE - VII
AUTOTROPHIC BIOMAS PRODUCTION

NAME OF THE PLANT SPS.	BIOMASS IN TONNES/HA.
TECTONA GRANDIS	13.75
LAGERSTROEMIA PARVIFOLIA	2.10
TERMINALIA CREMULATA	1.80
BOSWELLIA SERRATA	2.00
DIOSPYROS MELANOXYLON	1.79
ANOGEISSUS LATIFOLIA	1.08
BUTEA MONOSPERMA	1.15
DENDROCALAMUS STRICTUS	.14
ACACIA CATACHU	.82
TOTAL	24.63 - 85%* = 3.66 T/Ha.

* OPEN AREA.

FLORISTIC ANALYSIS

R.P. BHATT

During the report period 10 field trips were undertaken to study floristic composition of different selected sites, covering 152 grids of the ecosystem grades both on right and left banks and adjoining 20 kms. area. The sampling covered 36 of the randomly selected 120 sites. Localities, number of grids covered in different ecosystem grades, number of plant collections made have been summarised in Table -1. Data concerning phenology, distribution, density, abundance and associations of the existing plant species have been recorded.

So, far, 900 collections distributed in nearly 300 angiospermis species have been made. The catalogue depicting family wise distribution of plant species has been prepared (Appendix - 1). Scruting of the plant collections, for proper identification, revealed the presence of interesting and rare species of Sida, Portulaca (large flowered variety), Ventilago, Mimulus, Costus, Bauhinia, Pueraria, Varients of Butea and Tecomella (Yellow flowered) and elite plant of Bombax. These are being critically looked into for confirmation and distribution in the area under investigation. Seeds, seedlings and other plant materials of these have been collected for ex-situ and in-situ propagation and preservation of germplasms. Moreover, phytochemical screening of these and allied taxa has been initiated to identify sources of pharmacological active compounds and to locate chemical differences if any. So far, we have

not come across any species of plants which can be considered as endangered or threatened. A few samples of Algae and phytoplanktons collected are being identified by experts.

The main components of vegetation of this region are forest vegetation, aquatic plant communities, agricultural crops and weeds. As a result of biotic pressure, during last 40 years or so, there is an overall degradation of the entire ecosystem, which more glaring on the right bank and not so conspicuous on left bank. This point has been clearly brought out by other investigators. The species composition of the forest of both the banks does not differ markedly, except for the presence of a few evergreen species on left bank. However, the condition of plants in general is much healthier on left bank in comparison to those of right bank where, degradation by biotic interferences has been more intense. Progressive degradation has ultimately resulted in presence of relatively barren areas which show presence of mutilated forms and coppicing of shoots of Butea, Tectona (teak) and a few others.

In course of time, human settlement and associated agriculture has resulted, in further clearance of forest areas. In these areas, trees species of Madhuca (Mahuda), Borassus (Talipot palm), Delonix, Boswellia (Saledi), Ficus sps. (Vad, Piple Umardo) and Tamarind (Amali) are quite conspicuous. They meet the basic requirements (food and

shelter) of the inhabitants and their cattle. On the right bank area, increased biotic activity is also reflected in the general presence of anthropogenic plant communities of annual weeds like Xanthium, Digera, Tephrosia, Amaranthus, Cassia sps., Martynia along road sides and in open areas near human habitations. Occasionally, these plants are also found on the left bank and indicate the beginning of biotic interference.

The common Kharif crops grown on cleared plains and low hillocks are Tur Cajanus, Juwar Sorghum and Maize Zea mays. However, at places where irrigation facilities are available, in addition to above mentioned crops cultivation of Cotton (Gosipium), Wheat (Triticum), Rice (Oryza), Bajara (Pennisetum) and Banana (Musa) is undertaken.

Besides riverine vegetation, the aquatic flora also include vegetation in water bodies such as, small ponds, puddles, streams and waterholes. The riverine vegetation along the banks exhibits marked zonation and the composition of different zones differ at different places. Aquatic vegetation has been studied under different heads viz. Perennials and annuals occurring on elevated banks and in rocky crevices, vegetation of exposed sandy and muddy beds, submerged plant communities of stagnant and running waters. The components met with under different heads have been listed in Appendix - II. It may be mentioned that so far, in the area surveyed, Pistia and waterhyacinth, having gregarious growth and high colonizing potential, are not present in any water bodies.

The forests are the ultimate source for the total requirement of timber and fuel woods for the human beings at large. But the tribal inhabitants by and large are completely dependent on forests for all requirements including food, fuel, timber and medicine. The minor forest produce collected by the tribals is the only source of revenue for them. The data pertaining to important timber and fuel plant species, minor forest produce like gums, resins, oil seeds, tanins, fodder grasses, beedi leaves and other medicinally useful plant parts have been collected. Ethnobotanical data of 31 plants used for medicine and food, from the tribals in this region have been collected before this treasure of knowledge is lost for ever due to displacement of the tribal communities. List of plants, classified under different heads according to their uses is included in Appendix - III.

It may be emphasised at this juncture that denudation and degradation of the existing flora at many places on the right banks have adversely affected the fauna which depends on these primary producers (plants) for their sustenance, survival and dwelling. Probably, the needed food-chains and food-webs linking the different pyramids get disturbed. In contrast to this, the situation appears much encouraging on the left banks where if, proper steps as a whole for its betterment seems feasible.

TABLE - 14
RIGHT BANK - PLANT COLLECTION SITES

PLACES VISITED	ECS GRADE	NO. OF GRIDS COVERED	NO. OF PLANTS COLLECTED
NIMKHETAR	5	5	33
JANTAR		6	
HAMPHESHWAR	6	16	101
AMBA		14	
GULWANI		3	
PANCHALLA		3	
VADGAM	7h	15	75
KATKHADI		3	
GADHER		5	
BUMACHIYA		3	
AMROLI	8	3	35
SANDHIYA		4	
KASUMBYIA		3	
TANKHALA		3	
KAWANT		4	

LEFT BANK - PLANT COLLECTION SITES

PLACES VISITED	ECS GRADE	NO. OF GRIDS COVERED	NO. OF PLANTS COLLECTED
NAMGIR	1	5	14
PIPLOD	2	4	68
SANKLI		2	
WAGHUMAR		2	
SAGAI		5	
PATVALI	3	3	13
KHAMAN	4	5	-
GUMINA	5	4	-
VEDCHHA		5	
DUMKHAL	6	5	50
SHEKBAR		4	
SURPAN		6	
SARIBAR	7	4	-
-	7h	3	-
SAMOT	8	5	-

APPENDIX - I

- | | |
|--|--|
| 1 - <u>ANONACEAE</u>
Anona squamosa L.
Miliusa tomentosa (Roxb) Sindair. | Sida cordata (Burm. F.) Borss
Sida cordifolia L.
Urena lobata L. |
| 2 - <u>MENISPERMACEAE</u>
Cissampelos pareira L.
Cocculus hirsutus (L) Diels. | 12- <u>BOMBACACEAE</u>
Bombax ceiba L. |
| 3 - <u>PAPAVERACEAE</u>
Argemone mexicana L. | 13- <u>STERCULIACEAE</u>
Helecteres isora L.
Sterculia urens Roxb. |
| 4 - <u>BRASSICACEAE</u>
Brassica juncea (L) Coss.
*R.B. Cochlearia cochlearioides (Roth) S. & M. | 14- <u>TILIACEAE</u>
Corchorus olitorius L.
Triumfetta rotundifolia Lam. |
| 5 - <u>CLEOMACEAE</u>
Cleome gynandra L.
Cleome viscosa L. | 15- <u>ZYGOPHYLLACEAE</u>
Tribulus terrestris L. |
| 6 - <u>CAPPARACEAE</u>
Capparis grandis L.f.
Capparis sepiaria L.
Capparis zeylanica Forsk.
Crateva nurvala Buch. Ham. Var. <u>nurvala</u>
Maerua oblongifolia (Forsk) A. Rich. | 16- <u>OXALIDACEAE</u>
Biophytum sensitivum (L) DC. |
| 7 - <u>POLYGALACEAE</u>
Polygala erioptera DC. | 17- <u>RUTACEAE</u>
Aegle marmelos corr. |
| 8 - <u>PORTULACACEAE</u>
Portulaca oleraceae L.
*L.B. Portulaca sp. | 18- <u>SIMAROUBACEAE</u>
Ailanthus excelsa Roxb. |
| 9 - <u>TAMARICACEAE</u>
Tamarix ericoides Rottl. | 19- <u>BURSERACEAE</u>
Boswellia serrata Roxb.
Garuga pinnata Roxb. |
| 10- <u>ELATINACEAE</u>
Bergia ammannioides Roxb. | 20- <u>MELIACEAE</u>
Melia azaderachta L.
Azadirachta indica A. Juss. |
| 11- <u>MALVACEAE</u>
Abelmoschus manihot (L) Medic.
Hibiscus lobatus (Murr) O. Ktze.
Sida acuta Burm. f.
Abutilon indicum G. Don. | 21- <u>CELASTRACEAE</u>
Cassine glauca (Rottb) O. ktze.
Hampeshwar, R.B.
Maytenus emarginata (Willd) O. ktze. |
| | 22- <u>RHAMNACEAE</u>
*R.B. Ventilago denticulata Willd.
*L.B. Zizyphus xylopyra (Retz) Willd. |
| | 23- <u>SAPINDACEAE</u>
Cardiospermum helicacabum L. |

- 24- ANACARDIACEAE
Lannea caromandeliaca (Houtt.) Merrill.
- 25- MORINGACEAE
Moringa conccanensis Nimmo.
- 26- FABACEAE
Abrus precatorius L.
Aeschynomene indica L.
Alysicarpus monilifor (L) DC.
Alysicarpus vaginalis (L) DC.
Butea monosperma (Lam.) Taub.
Butea monosperma Yellow variant Vonig.
Crotolaria medicaginea Lam.
C. notonii W. & A.
C. retusa L.
Dalbergia latifolia Roxb.
Derris indica (lam.) Bennet.
Erythrina variegata L.
Indigofera argentea Sanju Thaker.
I. astragallina DC.
I. Linnei Ali
I. cordifolia Heyne ex. Roth.
I. linifolia Retz. Var.
I. tinctoria L. linifolia
*R.B. Pueraria tuberosa DC.
Rhynchosia minima (L) DC.
Sesbania bispinosa (Jacq.) W.F. Wight.
Tephrosia purpurea (L) Pers.
Tephrosia villosa pers.
Teramnus labialis (L.f.) spr.
- 27- CAESALPINIACEAE
Bauhinia recemosa Lam.
* Bauhinia vahli W. & A.
Caesalpinia pulcherrima (L) Sw.
Cassia auriculata L.
Cassia fistula L.
Cassia occidentalis Linn.
C. siamea Lam.
C. tora L.
Delonix regia (boj.) Raf.
Hardwickia binata Roxb.
Parkinsonia aculeata L.
Tamarindus indica L.
- 28- MIMOSACEAE
Acacia torta (Roxb.) Craib.
Albizia lebbeck (L) Bth.
Mimosa hamata Willd.
Pithocellobium dulce (Roxb.) B. & K.
Samanea saman (Jacq.) Merr.
Acacia nilotica (L.) Del ssp.
indica (Bth.) Brenar
- 29- VAHLIACEAE
Vahlia digyna (Retz.) O. ktze.
- 30- COMBRETACEAE
Anogeissus latifolia (Roxb) Wall ex Bedd.
Combretum ovalifolium Roxb.
Terminalia bellerica (Gaertm) Roxb.
T. crenulata Roth.
- 31- MYRTACEAE
Eucalyptus globulus Labill
Syzygium cumini (L) Skeels.
- 32- LYTHRACEAE
Ammannia baccifera L.
A. multiflora Roxb.
Lagerstroemia lanceolata Wall ex W.&A.
Lawsonia alba Lam.
Woodfordia fruticosa (L) Kurz.
- 33- ONAGRACEAE
Ludwigia parviflora Roxb.
- 34- CACTACEAE
Opuntia elatior Mill.

- 35- MOLLUGINACEAE
Glinus lotoides L.
Mollugo cerviana L.
M. nudicaulis Lam.
M. pentaphylla L.
- 36- ALANGIACEAE
Alangium Lamarckii Thw.
- 37- RUBIACEAE
Adina cordifolia Bth & Hk. f.
Borreria stricta (L. f.) Schum.,
B. articularis (L. f.) F.N. Willd.
*R.B. Mitragyna parvifolia (Roxb) Karth.
Morinda tinctoria Roxb.
Oldenlandia corymbosa L.
Randia dumetorum Lam.
Dentella repens (L.) Forst.
- 38- ASTERACEAE
Acanthospermum hispidum DC.
Ageratum conyzoides L.
Amberboa ramosa (Roxb.) Jafri
Blumea malcomii (Cl) Hk. f.
Caesulia axillaris Roxb.
Cyathocline purpurea (D. Don) O. Ktze.
Emilia sonchifolia (L) DC.
Eclipta prostrata L.
Echinops echinatus Roxb.
Gnaphalium indicum L.
Parthenium hysterophorus L.
Pulicaria wightiana Cl.
Sphaeranthus indicus L.
Spilanthes calva DC.
Synedrella nodiflora (L. DC. Willd) Gaertn.
Tridax procumbens Linn.
Verononia cinerea (L) Less.
Vicoa indica (L) DC.
Xanthium strumarium L.
- 39- PLUMBAGINACEAE
Plumbago zeylanica L.
- 40- SAPOTACEAE
Madhuca indica J.F. Gmel.
- 41- EBENACEAE
Diospyros melanoxylon Roxb.
- 42- OLEACEAE
Nyctanthes arbotristis L.
- 43- APOCYNACEAE
Holarrhena antidysenteica (Heyne ex Ro
Wall.
Plumeria rubra L.
Wrightia tomentosa R & S.
- 44- ASCLEPIADACEAE
Calotropis gigantea Br.
Cryptostegia grandiflora R. Br.
Hemidesmus indicus (L) Schult.
Pergularia daemia (Forsk) Chiov
- 45- GENTIANACEAE
Canscora diffusa R. Br.
Enicostemma hyssopifolium (Willd.)
Verdoon.
- 46- BORAGINACEAE
Heliotropium ovalifolium Forsk.
Heliotropium supinum L.
Rhabdia lycioides Mart.
Trichodesma amplexicauli Roth.
Trichodesma indicum (L) R.Br.
- 47- CONVOLVULACEAE
Evolvulus alsinoides (L) L.
Ipomoea aquatica Forsk.
I. carnea auct, non Jacq.
I. nil (L) Roth.
I. palmata Forsk.
I. quamoclit L.
Merremia tridentata (L) Hall.
Subsp. tridentata.
- 48- SOLANACEAE
Datura metel L.

- Nicotiana tabacum* L.
Physalis minima L.
Solanum indicum L.
S. nigrum L.
S. surattense Burm. f.
- 49- SCROPHULARIACEAE
Bacopa monnieri (L) Pennell.
Kickxia ramosissima (Wall) Janch.
Lindenbergia muraria (Roxb ex D. Don)
P. Bruchl.
Lindernia ciliata (Colsm) Penn.
Mecardonia procumbens (Mill) Small.
Mimulus strictus Bth.
Stemodia viscosa Roxb.
Sopubia delphinifolia (L) G. Don.
Sutera dissecta (Del) Wall.
Verbascum Chinense (L) santapau.
- 50- BIGNONIACEAE
*R.B. *Oroxylum indicum* vent.
*L.B. *Radermachera xylocarpa* (Roxb) K. Schum.
Tecomella undulata (sm) Seem.
- 51- PEDALIACEAE
Sesamum indicum L.
- 52- ACANTHACEAE
Andorgraphis echioides Nees.
Barleria prionitis L.
Eranthemum roseum (Vahl) R. Br.
Haplanthus verticillatus (Roxb) Nees.
Hemigraphis lutebrosa Nees.
Haplophragma adenophyllum (Wall.) P. Dop
Heterophargma adenophyllum
Hygrophila auriculata (Schum) Heine.
Justicia diffusa willd. var *prostrata*.
Justicia procumbens L.
Lepidagathis trinervis Nees.
Peristrophe bicalyculata (Retz) Nees.
Rungia pectinata (Linn.) Nees.
- 53- VERBENACEAE
Clerodendrum multiflorum (Burm)
O. ktze.
Lantana camera L
Phyla nodiflora (L) Greene
Tectona grandis L.
Vitex negundo L.
Gmelina arborea Roxb.
Clerodendrum inerme (L.f.) Gaertn
- 54- LAMIACEAE
Anisomeles indica (L) O. ktze.
Hyptis suaveolens (L) Poit.
Lavandula bipinnata (Roth) O. ktze.
Leonotis nepetifolia Br.
Leucas aspera (willd) spr.
Leucas biflora Br.
Leucas cephalotes (Roxb ex Roth) spr.
Ocimum americanum auct. non. L.
O. canum sims.
O. sanctum L.
Salvia plebeia R. Br.
- 55- NYCTAGINACEAE
Boerhavia diffusa L.
- 56- AMARANTHACEAE
Achyranthes aspera L. var. *aspera*.
Aerva lanata (L) Juss
Alternanthera sessilis (L) DC.
Amaranthus spinosus L.
Celosia argentea L.
Nothosaerva branchiata (L) wt.
Alternanthera triandra Linn.
- 57- POLYGONACEAE
Polygonum glabrum willd.
Polygonum plebeium R. Br.
- 58- CHENOPODIACEAE
Chenopodium album L.

- 59- LORANTHACEAE
Dendrophthoe falcata (L. f.) Etting.
var pubescens (HK. f.) Sant.
Viscum articulatum Burm. f.
- 60- EUPHORBIACEAE
Bridelia retusa (L) spr.
Chrozophora prostrata Dalz.
Emblica officinalis Gaertn.
Euphorbia geniculata Ort.
Euphorbia hirta L.
Euphorbia prostrata Ait.
Euphorbia heterophylla L.
Euphorbia Milli ch.
*R.B. Homonoia riparia Lour.
Jatropha curcas L.
Kirganelia reticulata (poir) Baill.
*R.B. Mallotus philippinensis Muell.
Phyllanthus maderaspatensis L.
Phyllanthus niruri L.
Acalypha indica Linn.
- 61- ULMACEAE
Holoptelea integrifolia planch.
- 62- URTICACEAE
Trema orientalis (L) Bl.
- 63- MORACEAE
Artocarpus heterophyllus Lam.
Ficus recemosa L.
Ficus religiosa L.
F. hispida L.
- 64- HYDROCHARITACEAE
Vallisneria spiralis L.
- 65- ORCHIDACEAE
Vanda tessellata (Roxb.) Hk.f.ex.G.Don.
- 66- ZINGIBERACEAE
Costus speciosus sm.
- 67- COMMELINACEAE
Commelina benghalensis L.
- 68- DIOSCORIACEAE
Dioscorea bulbifera L.
- 69- LILIACEAE
Agave americana L
Asparagus dumosus Baker.
- 70- TYPHACEAE
Typha angustata Bory & Chaub.
- 71- ALISMATAACEAE
Sagittaria sagittifolia L.
- 72- PALMAE
Borassus flabellifer Linn.
- 73- CYPERACEAE
Cyperus arenarius Retz.
C. compressus L.
Fimbristylis littoralis Gaud.
- 74- POACEAE
Apluda mutica L.
Chloris barbata sw.
Coix lachryma jobi L.
Cymbopogon citratus (DC.) Stapf.
Dactyloctenium agyptium (L) P. Beauv.
Dendrocalamus strictus Nees.
Dichanthium annulatum (Forsk.) Stapf.
Echinochloa colonum (L.) Link.

APPENDIX - II

VEGETATION OF BANKS, CREVICES AND ESCARPMENT

Vitex negundo Linn.
Tamarix ericoides Roth
Kirganalia reticulata (Poir) Baill.
Nyctanthus arbortritis Linn.
Woodfordia fruticosa (Linn.) Kurz.
Helicteres isora Linn.
Urena lobata Linn.
Cassia occidentalis Linn.
Homonoia riparia Lour
Tridax procumbens Linn.
Canscora diffusa (Vahl) R. Br.
Lindenbergia muraria (Roxb. ex D. Don.) P. Bruchi.
Celosia argentea Linn.
Kickxia ramosissima (Wall.) Janch.
Barleria prionitis Linn.
Boerhavia diffusa Linn.
Borreria articularis (L.f.) F.N.Will
B. stricta (L.f.) Schum.
Enicostema hyssopifolium (Willd.) Verdon.
Woodfordia fruticosa (Linn.) Kurz.
Vicoa indica (Linn.) DC.

VEGETATION OF SANDY RIVER BEDS

Xanthium strumarium Linn.
Solanum surattense Burm. f.
Borreria articularis (Linn. f.) F. N. Will.
Indigofera linifolia Retz. Var. Linifolia

Enicostema hyssopifolium (Willd.) Verdon.
Cleome gynandra Linn
Ammania multiflora Roxb.
Salvia plebeia R. Br.
Mecardonia procumbens (Mill.) Sm.
Alternanthera sessilis (Linn.) Dc.
Cochleria cochlearioides (Roth) Sant & Mahesh
Rungia pectinata (Linn.) Ness.
Bacopa monnieri (Linn.) Pennell.
Phyla nodiflora (Linn.) Greene
Cyathocline purpurea (Don.) O. Kuntze
Cuesulia axillaris Roxb.
Physalis minima Linn.
Cyperus compressus Linn.

VEGETATION OF MUDDY RIVER BEDS

Ammania baccifera Linn.
Ludwigia perennis Linn.
Phyla nodiflora (Linn.) Greene
Alternanthera triandra Linn.
Bacopa monnieri (Linn.) Pennell.
Cyathocline purpurea (D. Don.) O. Kuntze.
Caesulia axillaris Roxb.
Hygrophylla auriculata (Schum.) Heine.
Eclipta prostrata Linn.
Indigofera cordifolia Heyne R. Roth.
I. linnei Ali
Polygonum glabrum Will
Marselia quadrifolia Linn.
Ipomoea aquatica Forsk.

Lindernia crustacea (Linn.) F. Muell.

Chrozophara rottleri (Cies.) Juss.)

Coldenia procumbens Linn.

Cressa cretica Linn.

Polygonum plebium R. Br.

Glinus lotoides Linn.

Mollugo cerviana (Linn.) Scr.

Heliotropium supinum Linn.

Cyperus laevigatus Linn.

SUBMERGED PLANTS COMMUNITIES

Potamogeton pectinatus Linn.

Najas minor All.

Hydrilla verticillata Linn.

Vallisneria spiralis Linn.

Chara Sp.

Sagittaria sagitifolia Linn.

APPENDIX - III

USEFUL PLANTS

Timber and Fuel Plants

Tectona grandis.
Dalbergia latifolia.
Tamarindus indica.
Terminalia crenulata.
Hardwickia binata
Adina cordifolia
Ailanthes excelsa.
Alangium lamarckii.
Anogeissus latifolia.
Gmelina arborea.
Madhuca indica.
Mitragyna parvifolia.
Oroxylum indicum.
Morinda tinctoria.
Lagerstroemia lanceolata.
Bridelia retusa.
Diospyros melanoxylon
Aegle marmelos
Boswellia serata.
Butea monosperma.
Crateva nurvala.
Helicteres isora.
Lanea coromandelica
Mallotus philippinensis
Nyctanthes arobtritis.
Sterculia urens.
Wrightia tomentosa.

Fodder Plants

Apluda mutica
Themeda quadrivalvis
Echinochola colonum.
Chloris barbata
Coix-lachryma jobi.?

Oil Yielding Plants

Aegle marmelos
Argemone mexicana
Azadirachta indica
Madhuca indica
Pongamia glabra

Gums, Resins and Tannin Yielding Plants

Acacia catechu
Acacia arabica
Azadirachta indica.
Ficus benghalensis
Jatropha curcas.
Zizyphus xylopyra

Medicinal Plants

Abrus precatorius
Aragemone mexicana
Acacia arabica
Azadirachta indica
Boerhavia diffusa
Boswellia serrata

Cassia fistula
Crateva nurvala
Cymopogon citratus
Datura metel
Eclipta prostrata
Emblica officinalis
Helecteris isora
Holarrhena antidysenterica
Jatropha curcas
Lawsonia inermis
Madhuca indica
Mallotus philippinensis
Ocimum sanctum
Sphaeranthus indicus
Syzigium cumini
Terminalia bellerica

MISCELLANEOUS PLANTS

Alanthus excelsa	Match stick industry
Bombax ceiba	
Dendrocalamus strictus	Paper industry
Diospyrus melanoxylon	
Bachinia racemose	Making Bidees

AVIAN FAUNA

B. PILO

GENERAL ASPECTS OF FAUNA OF RIGHT AND LEFT BANKS:

Animals which are associated with green vegetation (frugivores, herbivores) and moist-soil dependent animals (such as amphibians and insects) are found in the left bank while animals adapted to dry and arid conditions are found in the right bank. Moreover, since right bank is mainly a cultivated and thickly populated region, grain eaters (birds and rodents); tender shoot and grass eaters (hares) and those carnivores that live on the rodents and small birds (raptors and snakes) are found more on the right bank.

The different soil conditions prevailing in the right and left banks have a profound influence on the amphibian fauna. The spadefoot toad, that dig in loose gravelled soil, are found to be exclusively distributed in the left bank. The deep black soil with larger sand and silt particles of the left bank is ideal for these species, which remains buried during day time and comes out in the night to feed on insects. This species of amphibian is seen on the banks of small streams and rivulets which have retained a good amount of moisture even in the month of April/May.

The difference between the fauna of left and right banks of Narmada is more conspicuous with respect to bird population.

AVIAN FAUNA

The avian fauna of right and left banks are clearly distinguishable in terms of number as well as species of birds. So far, we have spotted about 115 different species of birds in the study area (Table-15). Of these, 39 are carnivores, 16 are omnivores, 40 are insectivores, 9 are frugivores and 11 are graminivores (Table - 16 & 17). Although the total number of bird species found in the right bank is only slightly more than that spotted in the left bank (88 in the right bank and 80 in the left bank), there are clear cut distribution of species on either banks. The right bank has more carnivores (34 out of 39) and the left bank has more insectivorous birds (34 out of 40) (Table - 18). The presence of more carnivores in the right bank is explainable in terms of more human habitation with the concomittant presence of fuse, garbage, cattle feeds, poultry, rodents, and other animals (pets and domesticated). Most of these carnivores are raptors and hence soar in the sky on thermals and swoop down to pick up small animals with their powerful claws. The birds such as kites, eagles, hawks, falcon, harriers and vultures need open lands for aerial survey and feeding. However, such birds also need tall trees for roosting and nesting. Small patches of woodlands on the right bank provide this requirement.

Ecologically, the entire study area has been graded into 1 to 8 based on the vegetation, human settlement and cultivation. When the distribution of bird species is viewed from this ecosystem grading, we find

that the carnivorous birds are found more in grades 6 and 7, omnivores in grades 6, 7 and 8; insectivores on 5, 6, 7 and 8; frugivores in 5 and 6; and graminivores in 6, 7 and 8 (Table - 19). The number of species recorded from grades 1 to 4 are very meagre. The most abundant bird species found in these comparatively more wooded areas are insectivorous species. Grain eating birds are by and large conspicuous by their absence.

The avian fauna explained above is compiled from the field trips conducted between November 1989 to May 1990. This is more or less a summer population. The number of species may vary soon after monsoon. Many birds have their breeding periods in the post-monsoon months. There will be a total shift of population of some birds for breeding as they have to select the trees and nesting sites as well as for ensuring availability of food for the young.

The avian fauna so far described are more or less residents or at best local migrants. Only very few migratory species are spotted in the study area. The fact that there are no static shallow water bodies in the study area at present may be the reason that there only very few migrants seen in the area.

So far no exotic species are spotted nor there are any species that could be endangered by the construction of dam or due to submergence.

AVIFAUNA OF NARMADA VALLEY

PHALACROCORACIDAE

R : Little Cormorant (Phalacrocorax niger)

ARDEIDAE

R : Grey Heron (Ardea cinerea).

LR : Pond Heron or Paddybird (Ardeila grayii).

R : Cattle Egret (Bubulcus ibis).

R : Large Egret (Ardea alba).

R. : Little Egret (Egretta garzetta).

R : Night Heron (Nycticorax nycticorax)

ACCIPITRIDAE

LR : Blackwinged Kite (Elanus caeruleus).

R : Honey Buzzard (Pernis ptilorhyncus)

R : Pariah Kite (Milvus migrans govinda)

LR : Shikra (Accipiter badius)

LR : Sparrow-Hawk (Accipiter nisus melaschistos)

LR : White-eyed Buzzard-Eagle (Butastur teesa).

LR : Indian Whitebacked Vulture (Gyps bengalensis)

R : Pied Harrier (Circus melanoleucos)

R : March Harrier (Circus aeruginosus)

LR : Crested Serpent Eagle (Spilornis cheela)

R : Osprey (Pandion haliaetus)

FALCONIDAE

R : Shahin Falcon (Falco peregrinus peregrinator).

R : Kestrel (Falco tinnunculus)

PHASIANIDAE

LR : Grey Partridge (Francolinus pondicerianus)

R : Quail Sp.

LR : Common Peafowl (Pavo cristatus)

RECURVIROSTRIDAE

R : Blackwinged Stilt (*Himantopus Himantopus*)

CHARADRIIDAE

LR : Redwattled Lapwing (*Vanellus indicus*)

R : Little Ringed Plover (*Charadrius dubius*)

R : Blacktailed Godwit (*Limosa limosa*)

R : Redshank (*Tringa totanus*)

R : Greenshank (*Tringa nebularia*)

R : Common Sandpiper (*Tringa hypoleucos*)

LARIDAE

R : Indian River Tern (*Sterna aurantia*)

COLUMBIDAE

R : Yellowlegged Green Pigeon (*Treron phoenicoptera*)

LR : Blue Rock Pigeon (*Columba livia*)

LR : Indian Ring Dove (*Streptopelia decaocto*)

LR : Spotted Dove (*Streptopelia chinensis*)

LR : Little Brown or Senegal Dove (*Streptopelia senegalensis*)

PSITTACIDAE

R : Alexandrine Parakeet (*Psittacula eupatria*)

LR : Roseringed Parakeet (*Psittacula krameri*)

LR : Blossombeaded Parakeet (*Psittacula cyanocephala*)

CUCULIDAE

LR : Crow-pheasant or Coucal (*Centropus sinensis*)

STRIGIDAE

LR : Eagle-owl or Great Horned owl (*Bubo bulo*)

L : Brown Fish owl (*Bubo zeylonensis*)

LR : Spotted owlet (*Athene brama*)

CAPRIMULGIDAE

R : Common Indian Nightjar (*Caprimulgus asiaticus*)

APODIDAE

- R : House-Swift (*Apus affinis*)
- R : Palm Swift (*Cypriurus parvus*)

ALCEDINIDAE

- LR : Lesser pied Kingfisher (*Ceryle rudis*).
- LR : Common Kingfisher (*Alcedo atthis*)
- R : Whitebreasted Kingfisher (*Halcyon smyrnensis*)

MEROPIDAE

- LR : Green Bee-eater (*Merops orientalis*)

CORACIIDAE

- LR : Indian Roller (*Coracias bengalensis*)

UPUPIDAE

- LR : Hoopoe (*Upupa epops*)

CAPITONIDAE

- LR : Crimsonbreasted Barbet, Coppersmith (*Megalaima haemacephala*)

PICIDAE

- L : Lesser Goldenbacked Woodpecker (*Dinopium benghalense*)
- L : Yellowfronted Pied Woodpecker (*Picoides mahrattensis*)
- L : Heartspotted Woodpecker (*Hemicircus canente*)
- L : Larger Goldenbacked (*Chrysocolaptes lucidus*)

PITTIDAE

- L : Indian Pitta (*Pitta brachyura*)

ALAUDIDAE

- LR : Redwinged Bush Lark (*Mirafra erythroptera*)
- R : Ashycrowned Finch-lark
- R : Rufoustailed Finch-lark (*Ammomanes phoenicurus*)
- R : Crested Lark (*Galerida cristata*)

HIRUNDINIDAE

- LR : Dusky Crag Martin (*Hirundo coucolor*)
- LR : Swallow (*Hirundo rustica*)
- R : Wiretailed Swallow (*Hirundo smithii*)

LANIDAE

- L : Grey Shrike (*Lanius excubitor*)
- LR : Baybacked Shrike (*Lanius vittatus*)
- LR : Rufousbacked Shrike (*Lanius schach*)

ORIOOLIDAE

- LL : Blackheaded Oriole (*Oriolus xanthornus*).

DICRURIDAE

- LR : Black Drongo (*Dicrurus adsimilis*).
- L : Whitebellied Drongo (*Dicrurus caeruleus*)
- L : Racket Tailed Drongo (*Dicrurus paradiseus*)

STURNIDAE

- LR : Bramminy Myna (*Sturnus pagodarum*)
- LR : Rosy Pastor (*Sturnus roseus*)
- LR : Common Myna (*Acridotherus tristis*)
- LR : Bank Myna (*Acridotherus gingianus*)

CORVIDAE

- LR : Indian Try Pie (*Dendrocitta frontalis*)
- LR : House Crow (*Corvus splendens*)
- LR : Jungle Crow (*Corvus macrorhynchos*)

CAMPEPHAGIDAE

- L : Common Wood Shrike (*Campodornis pondicereanus*)
- L : Large Cuckoo Shrike (*Corucina novaenollandiae*)
- L : Small Minivet (*Pericrocotus cinnamomeus*)

IRENIDAE

- L : Common Iora (*Aegithina tiphia*)
- L : Goldmantled Chloropsis (*Chloropsis cochinchinensis*).

PYCNONOTIDAE

- L : Redwiskered Bulbul (*Pycnonotus jocosus*)
- LR : Redvented Bulbul (*Pycnonotus cafer*)

MUSCICAPIDAE

TIMALINAE

- R : Common Babbler (*Turdoides candidus*)
- LR : Large Grey Babbler (*Turdoides malcolmi*)
- L : Jungle Babbler (*Turdoides striatus*)

MUSCICAPINAE

- L : Redbreasted Flycatcher (*Musciapa parva*)
- L : Tickell's Blue Flycatcher (*Musciapa tickelliae*)
- LR : White-browed Fantail Flycatcher (*Rhipidura aureola*)
- LR : Whitethroated Fantail Flycatcher (*Rhipidura albicollis*
albogularis)
- L : Paradise Flycatcher (*Terpsiphone paradisi*)

SYLVIINAE

- L : Streaked Fantail Warbler (*Cisticola juncidis*)
- LR : Asny Wren Warbler (*Prinia socialis*)
- L : Tailor Bird (*Orthotomus sutorius*)

MUSCICAPIDAE

TURDINAE

- L : Bluethroat (*Erithacus svecicus*)
- LR : Magpie Robin (*Copsychus saularis*)
- LR : Black Redstart (*Phoenicurus ochruros phoenicuroides*)
- LR : Indian Robin (*Saxicoloides fulicata*)
- R : Blue Rock Thrush (*Monticola solitarius*)

PARIDAE

- L : Grey Tit (*Parus major*)

MOTACILLIDAE

- LR : Yellow wagtail (*Motacilla flava*)
- LR : Grey wagtail (*Motacilla cinerea*)
- LR : White wagtail (*Motacilla alba*)

DICAEIDAE

LR : Tickell's Flowerpecker (*Dicaeum erythrorhynchos*)

NECTARINIIDAE

LR : Purple Sunbird (*Nectarinia asiatica*)

POLCEIDAE

PASSERINAE

LR : House Sparrow (*Passer domesticus*)

L : Tree Sparrow (*Passer montanus*)

POLCEINAE

LR : Baya (*Pleoceus philippinus*)

ESTRILDINAE

R : White headed Munia (*Lonchura malabarica*)

R : Spotted Munia (*L. punctulata*)

EMBERIZIDAE

R : Crested Bunting (*Melophus lathami*)

TABLE -16
DISTRIBUTION OF BIRDS ON LEFT AND RIGHT BANKS

CLASS	SL No.	SPECIES EXCLUSIVELY ON	
		RIGHT BANK	LEFT BANK
<u>CARNIVORS</u>	1.	Little Cormorant	1. White Eyed Buzzard Eagle
	2.	Grey Heron	2. Great Horned Owl
	3.	Cattle Egret	3. Brown Fish Owl
	4.	Little Egret	4. Grey Shrike
	5.	Large Egret	5. Common Wood Shrike
	6.	Night Heron	
	7.	Honey Buzzard	
	8.	Pañiah Kite	
	9.	Pied Harrier	
	10.	Marsh Harrier	
	11.	Osprey	
	12.	Kestrel	
	13.	Black winged Stilt	
	14.	Little Ringed Plover	
	15.	Black-tailed Godwit	
	16.	Red Shank	
	17.	Green Shank	
	18.	Common Sandpiper	
	19.	Indian River Teru	
	20.	White-breasted Kingfisher	
<u>OMNIVORES</u>	1.	Quail sp.	1. Lesser Goldenbacked Woodpecker
	2.	Common Babbler	2. Jungle Babbler
	3.		3. Grey Tit
			4. Tree Sparrow
<u>INSECTIVORES</u>	1.	Common Indian Nightjar	1. Yellowfronted Pied Woodpecker
	2.	House Swift	2. Large Goldenbacked Woodpecker
	3.	Palm Swift	3. Heart spotted Woodpecker

-
4. Crested Lark
 5. Wiretailed Swallow
 6. Blue Rock Thrush

4. Indian Pitta
5. Whitebellied Drongo
6. Racket tailed Drongo
7. Small minivet
8. Common Iora
9. Red Wiskered Bulbul
10. Tickell's Blue Flycatcher
11. Red -breasted Flycatcher
12. Paradise Flycatcher
13. Streaked Fantail Warbler
14. Jungle Wren Warbler
15. Blue Throat
16. Blue Throat

UGIVORES

1. Yellowlegged Green Pigeon
2. Alexandrine Parakeet

1. Black-headed Oriole
2. Large Cuckoo Shrike
3. Goldmatted Chloropsis

AMINIVORES

1. Ashy Crowned Finchlark
 2. Rufous Tailed Finch-lark
 3. White throated Munia
 4. Spotted Munia
 5. Crested Bunting
-

TABLE - 17
 FOOD AND FEEDING HABITS OF BIRDS OF NARMADA VALLEY
CARNIVORES

Sr. No.	Species	Food and Feeding	Observed Feeding on
1.	Little Cormorant	- exclusive on fish	-
2.	Grey Heron	- Tadpoles, Frogs and Fishes	-
3.	Pond Heron	- Tadpoles, Frogs, Fish and Insects	- Tadpoles & Insects
4.	Cattle Egret	- Grass-hoppers, Blue bottle flies & other insects, frogs & lizards	- Grasshopper & small insects
5.	Little Egret	- Insects, Frogs & Small reptiles.	-
6.	Large Egret	- Insects, Frogs & Small reptiles	-
7.	Night Heron	- Crabs, fish, frogs & aquatic insects	-
8.	Blackwinged kite	- Locust, crickets, Mice lizards, fledgelings.	-
9.	Honey Buzzard	- Rodents, snakes, lizards, & small birds.	-
10.	Pariah Kite	- Offal & garbage, earth-worms, winged termites, lizards, Mice, disabled or Young birds.	-
11.	Shikra	- Lizards, Mice, Squirrels, Small birds, also chicken lifter.	-
12.	Sparrow Hawk	- Large insects, Mice lizards, frogs & Young ones of small birds.	- Mice and Nestlings
13.	White-eyed Buzzard Eagle	- Locust, grasshoppers, crickets, mice, lizards and frogs	-
14.	Indian Whitebacked Vulture	- Carrion feeder-animal carcasses.	-
15.	Pied Harrier	- Lizards, field Mice, frogs nestlings or disabled birds.	-
16.	Marsh Harrier	- Lizards, field mice, frogs nestlings or disabled birds	-

Sl No.	Species	Food and Feeding	Observed Feeding on
17.	Crested Serpant	- Frogs, lizards, rats, snakes jungle-fowl & Peafowl.	-
18.	Osprey	- Mainly on fish	-
19.	Shahin Falcon	- Ducks, partridges, para- keets and Pigeons	-
20.	Kestrel	- Field Mice, lizards, Locust & other large insect.	-
21.	Blackwinged Stilt	- Molluscs, Worms, & aquatic insects	- Molluscs and Worms.
22.	Red Wattled Lapwing	- Insects, Mulluscs.	- Insects
23.	Little Ringed Plover	- Insects, Grasshoppers, small crabs	-
24.	Black tailed God- wit	- Worms, Molluscs, Crabs, insects-	-
25.	Red Shank	- Worms, Molluscs, aquatic insects	-
26.	Green Shank	- Worms, Molluscs, aquatic	-
27.	Common Sandpiper	- Insects, Worms, Molluscs.	-
28.	Indian River Tern	- Tiny fishes, tadpoles, insects, small crustaceans	-
29.	Crowpheasant	- Catterpillar, large insects lizards, young mice, birds egg and nestlings	-
30.	Great Horned Owl	- Small mammals, birds, reptiles- fish and crabs	- Analysis of food pellet revealed that it had fed on shrew, squirrel & crabs
31.	Brown Fish Owl	- Fish, frogs, crabs, small mammals, birds, reptiles, occasionally carrion feeder	-
32.	Spotted Owlet	- Chiefly beetles and other insects, also young birds Mice and Lizards	-
33.	Lesser Pied King- fisher	- Fish, tadpoles, frogs & aqua- tic insects.	-
34.	Common King- fisher	- Small fish, tadpoles and aquatic insects	- small fishes.
35.	White Breasted kin fisher	- Fish, tadpoles, lizards grass hopper & other insects, occasionally small birds and Mice	- Small fishes

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- | | | |
|------------------------|---|-----------------|
| 36. Grey Shrike | - Locusts, Lizards & Mice | - Grasshopper |
| 37. Baybacked Shrike | - Locusts, large insects
lizards & Mice | - Large insects |
| 38. Common Wood Shrike | - Lizards, mice, moths, Beetles -
Caterpillars | |
| 39. Jungle Crow | - Eggs, chicks of other birds -
young of small | |

OMNIVORES

- | | | |
|--|---|---|
| 40. Grey Partridge | - Grains, seeds, termites,
beetles, larvae. | |
| 41. Quail sp. | - Grains, grass seed, termite -
etc. | |
| 42. Common Peafowl | - Grains, vegetable shoots | - |
| 43. Lesser Goldenback
ed Woodpecker | - Beetles, ants, other insects -
pulp of ripe fruit as well
as flower nectar. | |
| 44. Brahmni Myna | - Chiefly berries, Wild figs
& insects | - Banyan figs |
| 45. Rosy Pastor | - Grains particularly juwar
Banyan & Peepal figs,
Lantana, peploo (Salvadora)
and other berries nectar
of small flowers (Salmalia)
& Insects mainly locusts. | - mainly seen feeding on
Pataecil bium fruit &
Banyan figs. |
| 46. Common Myna | - Fruits, figs, insects,
earthworms | - Tit-bits of food, small
ripe fruit. |
| 47. Bank Myna | - Tit-bit of food, insect &
ripe fruit. | - Small insects and
banyan figs |
| 48. Indian Tree pie | - Fruits, insects, lizards,
frogs. | - Petals of Butea flowers. |
| 49. House Crow | - Lead sewer rat, offal, carrion-
kitchen scraps, locusts,
termites, fruits, grains, egg
and fledgling. | |
| 50. Common Babbler | - Feeds on spiders, cock
-roaches & other insects
& larvae | - Small insects. |
| 51. Large Grey Babler | -- Wildflies, berries, grains
& nectar of flowers & | - Small insects & grains |
| 52. Jungle Babler | - Coral & Silk Cotton Trees | - Insects, spiders, nectar
of flowers of coral tree |

-
53. Grey Tit - Insects, their eggs and larvae - Small insects
flower buds, fruits kernets
of small nut & seeds.
54. House sparrow - grains, insects, fruit buds, - juwar, bajra & small
flower nectar & kitchen insect
serape.
55. Tree sparrow - grains, grass seeds, berries,
flower nectar, moths and
other insects.

INSECTIVOROUS

56. Common India - Insects, beetles & motis - Insects.
Nightjar
57. House swift - Dipterous insects -
58. Palm swift - Small insects -
59. Green Bee Eater - Insects mainly depterans and -
hymenopterans
60. Heartspotted - Ants, termites & grubs -
Woodpecker
61. Indian Roller - Locusts, termite & other - grasshopper
insects
62. Hoopoe - Insects, grubs & peepae -
63. Yellow Frowted - Insects & grubs -
Pied Woodpecker
64. Large Golden - Beetles, insects, black ants -
backed Woodpe- ripe fruit
cker
65. Indian Pitta - Insects and Grubs -
66. Crested - Grains, seeds, small insects -
beetles
67. Dusky Crag Martin- Winged insects -
68. Swallow - Winged insects -
69. Wriretailed - Insects -
Swallow
70. Rufousbacked - Moths, beetles, Caterpillars - Moths
Shrike
71. Black Drongo - Insects & flower nectar -
72. Whitebelied - Chiefly insects, also nectar - Butea flowers
Drongo of Buetea Salmalia & Erythrina-
73. Racket tailed - Moths and large insects also -
Drongo flower nectar
74. Small Minivet - Insects & their Larvae -

- | | | |
|--|---|----------------------------|
| 75. Common Iora | - Insects their eggs and larvae | - |
| 76. Red Whiskered Bulbul | - Insects like termite, fruits & berries, peas and such like vegetables & flower nectar | - |
| 77. Red-vented Bulbul | - | - |
| 78. Redbreasted Flycatcher | - Winged and crawling insects | - |
| 79. Tickell's Blue Flycatcher | - Flies, gnats and other dipterous insects. | - |
| 80. White-browed Faintail Flycatcher | - Winged & Crawling insects & Spiders | - |
| 81. White throated faintail flycatcher | - Winged & crawling Insects & spiders | - |
| 82. Paradise Flycatcher | - Flies-gnats and other dipterous insects | - |
| 83. Streaked Faintail Warbler | - Small insects & Caterpillars | - |
| 84. Ashy Wten Warbler | - Insects | - |
| 85. Jungle Wren Warbler | - Insects spiders | - |
| 86. Tailer Bird | - Tiny insects, their eggs & grubs-flower nectar of slamalia, Erythring & other trees. | - |
| 87. Blue throat | - Mostly on caterpillar, tiny beetles, & other insects. | - |
| 88. Magpie Robin | - Chiefly crawling insects and flower nectar of salmalia & Erythrina. | - |
| 89. Black Redstart | - Crawling insects & spiders, flying insects | - |
| 90. Indian Robin | - Insects & their eggs, spiders | - |
| 91. Blue Rock Thrush | - Mainly insects & berries | - |
| 92. Yellow Wagtail | - Tiny insects | - |
| 93. Grey Wagtail | - Tiny insects | - |
| 94. White Wagtail | - Tiny insects | - |
| 95. Purple Sunbird | - Nectar, insects & spiders | - |
| <u>FRUGIVORES</u> | | |
| 96. Yellow legged green Pigeon | - Fruits, berries, esp. of Maduca and Ficus | - Madhuca buds & |
| 97. Alexandrine | - Fruits berries, nuts vegetables | - Fruits of Pitha celobium |

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- | | | |
|------------------------------|---|--|
| 98. Rose ringed parakeet | - | |
| 99. Blossom headed parakeet | - | |
| 100. Crimson breasted barbet | - | Fruits and berries esp. banyan & peepul figs, sometimes termites |
| 101. Blackheaded Oriole | - | Fruits, berries, flowers' nectar and insects |
| 102. Large Cuckoo Shrike | - | Berries & figs large insects. |
| 103. Goldmantled Chloropsis | - | Flowers' nectar, fruits, berries, sometimes insects & spiders |
| 104. Tickell's flower-pecker | - | Berries of Loranthus & Viscum. |

GRAMINIVORES

- | | | | |
|-----------------------------------|---|---|---------------|
| 105. Redwinged Bush-lark | - | Green Seeds and Insects | - |
| 106. Ashy Crowned Finch lark | - | Grass and weed seeds, grains insects | - |
| 107. Rufous fat-tailed Finch lark | - | Grass and Weed Seeds paddy and other grains and insects | - |
| 108. Blue Rock Pigeon | - | Sereals, Pulses, Groundnut | - |
| 109. Indian Ring Dove | - | | - |
| 110. Spotted Dove | - | Seeds, sereals, pulses | - |
| 111. Little Brown Dove | - | Soft nuts | - |
| 112. White throated Munia | - | Grass Seeds and Grains | - |
| 113. Spotted Munia | - | Grass seeds, grains & occasionally winged termites | - Bajra seeds |
| 114. Baya | - | Grains, sereals and other Insects. | - |
| 115. Crested Bunting | - | Grains, grass seeds, etc. | - |
-

Table -18 Distribution of birds on the right and left banks of Narmada River: Numbers represents the species spotted:

BIRDS WITH SPECIFIC FOOD HABITS	TOTAL NUMBER OF SPECIES	RIGHT BANK	LEFT BANK
CARNIVORES	39 (34%)	34 (30%)	19 (11%)
OMNIVORES	16 (14%)	12 (10%)	14 (13%)
FRUGIVORES	9 (8%)	6 (5%)	(6%)
GRAMINIVORES	11 (9%)	11 (9%)	6 (4%)
TOTAL	115	88 (76%)	80 (64%)

Table-19 Distribution of species of birds in different ecosystem grades: Numbers represents the species spotted:

ECOSYSTEM GRADES	CARNI-VORES	OMNI-VORES	INSECTI-VORES	FRUGI-VORES	GRAMINI-VORES
1	6	1	9	2	-
2	3	1	11	2	-
3	3	2	10	4	-
4	7	3	11	5	2
5	12	5	18	7	4
6	28	10	25	7	6
7	32	7	15	3	6
8	22	11	23	2	11
TOTAL NUMBER OF SPECIES	39	16	40	9	11

INSECTS

Totally ¹⁰⁵ species of insects representing 16 Orders of Insecta have been found in the Narmada valley during the period from December, 1989 to May, 1990. Habitat wise these insects can be divided into terrestrial, aerial, semi aquatic and aquatic. Of the total 105 species, 37 are purely terrestrial, 24 are aerial, and 44 are either semi-aquatic or aquatic. (Table - 20 & 22)

According to feeding habits, out of the total 105 species of insects, 35 species are phytophagous, 36 are predaceous, 11 are omnivorous and 25 species are fluid feeders. Amongst the fluid feeders, 6 species are vectors of various diseases of human beings as well as the domestic animals, especially cattles. However, 17 fluid feeders are important pollinators of various flowering plants around the region. (Table - 23)

The number of species found in the two banks of the river shows variation which could be directly correlated to the density of plants on either side of the river. More trees and vegetation are found on the left bank and so does the insects. About 95 species of insects are found on the left bank compared to 84 species on the right bank. Of these, 21 species of insects are found exclusively on the left bank while only 10 were exclusive to the right bank. (Table - 24)

From the economic point of view, only 30 species of insects are important while the remaining 75 are economically un-important. Amongst the 30 economically important species of insects, 7 species are pests of agricultural crops, 6 are vectors and 17 species are pollinators. Important vectors of human diseases are House flies, three species of mosquitoes, flesh fly, *Phlebotomus* and Stable fly, *Tabanus*. These insects are well known for spreading diseases like typhoid, cholera, malaria and kala-azar in humans and Anthrax in domestic animals. (Table - 25)

Amongst the 17 species of insect pollinators, major ones are three species of honey bees, few species of wasps, butterflies and moths. Honey bee population is much more on the left bank as flowering plants are seen more in this region.

Entomophilous plants are *Bridelia*, *Terminalia*, *Adina*, *Holopterna*, *Madhuca*, *Mitragyna*, *Lagerströmia*, *Bauhinia*, *Butea*, *Ficus* and *Erythrina*.

In addition to honey bees, one wild variety of silk moth namely, *Antheraea paphia* is seen exclusively on the right bank. Of the remaining 75, economically unimportant species of insects are concerned, the majority of them play a role as food links in both short and long food chains as well as food webs of both terrestrial and aquatic ecosystem. Hence, these insects may be significant in maintaining the ecological balance of the

area. As these insects form the major source of food of fishes, amphibians, reptiles, birds and mammals, their population density may affect the number as well as the species, of these vertebrate in the region.

OTHER INVERTEBRATES

As far as other invertebrate species are concerned, we have recorded about 9 species during the period. Of these, 2 species are crustaceans, 2 species annelids and 5 species are mollu^scs. Most of these invertebrate fauna are seen near and around water bodies. They include filter feeders, predators, phytophagous and detrivores. Earthworms (*Pheretima* sp.) are abundant in the area. (Table - 21)

TABLE - 20

INSECT FAUNA OF NARMADA VALLEY

CLASS - INSECTA

(a) APTERYGOTA

ORDER - 1 THYSANURA

LEPISMATIDAE

Lepisma saccharina

Lepisma collaris

ORDER - 2 COLLEMBOLA

PODURIDAE

Achorutes armatus

(b) EXOPTERYGOTA

ORDER - 3 EPHEMEROPTERA

EPHEMERIDAE

Ephemera sp.

ORDER - 4 ODONATA

CORDULIIDAE

Somatochlora sp. (Red)

Somatochlora sp. (Greenish yellow).

Somatochlora sp. (Grey)

@ Somatochlora sp. (Green)

@ Somatochlora sp. (Grey-Green).

Tetragoneuria sp.

LESTIDAE

@ Lestes sp.

COENAGRIONIDAE

Enallagma sp.

Argia sp.

GOMPHIDAE

@ Gomphus sp.

AESHNIDAE

@ Anax sp.

ORDER - 5 ORTHOPTERA

ACRIDIDAE

Acridium melanocorne

Atractomorpha crenulata

Tryriasis turrata

Chrotogonus lugubris

* Teratodus moticollis

Tylotropidius didymus.

TITTIGONIIDAE

Liogryllus bimaculatus.

Conocephalus indicus

GRYLLIDAE

@ Oecanthus sp.

Gryllus bimaculatus

Nemobius sp.

GRYLLOGALPIDAE

Gryllotalpa africana.

TETRIGIDAE

Acridium sp.

ORDER - 6 DERMAPTERA

FORFICULIDAE

Labidura bengalensis

Forficula sp.

ORDER - 7 EMBIOPTERA

EMBIIDAE

Embia major

ORDER - 8 DOCTYOPTERA

ELATTIDAE

Blatta germanica

Blatta orientalis.

FAM - MANTIDAE

- * 3. Deiphobe ocellata.
- * 4. Hierodula coartica.
- * 5. Humbertiella indica.

ORDER - 9 - ISOPTERA

FAM - TERMITIDAE

- 1. Odontotermes obesus.
- 2. Microtermes sp.

ORDER - 10 - HEMIPTERA

FAM - ENICOCEPHALIDAE

- * 1. Gnat bug.

FAM - NOTONELTIDAE

- 2. Enithares templetoni.

FAM - GERRIDAE

- 3. Gerris spinole

FAM - PYRROCORIDAE

- * 4. Dysdercus cingulatus.

FAM - HYDROMETRIDAE

- 5. Hydrometra martini.

FAM - PENTATOMIDAE

- 6. Antestia anchora.
- 7. Halyomorpha picus.
- 8. Placosternum dama.

FAM - LYGAECIDAE

- 9. Pamera vineta.

FAM - BELOSTOMATIDAE

- 10. Sphaerodema molestum.

FAM - NEPIDAE

- 11. Laccotrephes maculatus.
- 12. Ranatra filiformis.

FAM - MEMBRACIDAE

- 13. Oxyrhachis tarandus.

FAM - CICADIDAE

- ⊙ 14. Platypleura mackinnoni.

FAM - APHIDIDAE

- * 15. Nyzus nerii.
16. Aphis odusta.
* 17. Aphis gossypii.
18. Aphis brassica.

ORDER - 11 - THYSANOPTERA

FAM - THRIPIDAE

1. Thrips tabaci.
2. Thrips major.

(c) ENDOPTERYGOTA

ORDER - 12 - NEUROPTERA

FAM - MYRMELEONTIDAE

1. Myrmeleo singulare.

FAM - ASCALAPHIDAE

2. Helicomitus dicax.

ORDER - 13 - COLEOPTERA

FAM - CARABIDAE

1. Pheropsophus dilaris.

FAM - DYTISCIDAE

2. Cybister confusus.
3. Cybister sp.

FAM - SCARABAEIDAE

4. Melolonthidae sp.

FAM - CERAMBYCIDAE

5. Hypoeshrus sp.

FAM - BUPRESTIDAE

- * 6. Sternocera chrysioides.

FAM - TENEBRIONIDAE

- ⊙ 7. Platynotus perforatus.

FAM - HYDROPHILIDAE

3. Hydrophilus lolivaceus.

FAM - COCCINELLIDAE

- * 9. Epilachna vigintiocto punctata.
10. Chilomenes sexmaculata,
11. Coccinella Septumpunctata.

ORDER - 14 - DIPTERA

FAM - BOMBYLIIDAE

1. Exoprosopa flammea.

FAM - SYRPHIDAE

- ⊙ 2. Melophilus bengalensis.

FAM - ACILIDAE

- ⊙ 3. Laxenecera flavibarbis.

FAM - SARCOPHAGIDAE

4. Sarcophaga lineatocollis.

FAM - PSYCHODIDAE

- ⊙ 5. Psychoda bengalensis.
- ⊙ 6. Phlebotomus argentipes.

FAM - CULICIDAE

7. Anopheles stephensi.
8. Anopheles elegans.
9. Culex fatigans.

ORDER - 15 - LEPIDOPTERA

FAM - DANAIDAE

1. Euploea core.
2. Danaus chrysippus.

FAM - NYMPHALIDAE

3. Nymphalis orsis.
4. Melanitis ismene.

FAM - PIERIDAE

5. Eurema hecabe
6. Dalies eucnaris
7. Colotis danae

FAM - ACRAEIDAE

8. Acreae violae

FAM - SATURNIDAE

* 9. Antheraea paphia.

FAM - PSYCHIDAE

10. Psyche vitrea.

ORDER - 16 - HYMENOPTERA

FAM - POMPILIDAE

⊙ 1. Pseudogenia honesta.

FAM - VESPIDAE

2. Icaria ferruginea.

FAM - XYLOCOPIDAE

3. Xylocopa aestuans.

FAM - SPHECIDAE

⊙ 4. Stizus prismaticus.

⊙ 5. Sceliphron madraspatanum.

⊙ 6. Sphex lobatus.

7. Philanthus puleherrimus.

FAM - APIDAE

⊙ 8. Apis dorsata.

9. Apis indica.

10. Apis florea.

FAM - EUMENIDAE

⊙ 11. Eumenes eruriens.

FAM - CHRYSIDIDAE

⊙ 12. Chrysis oculatum.

FAM - FORMICIDAE

13. Camponotus compressus.

14. Oecophylla smaragdina.

15. Iridomyrmex anceps.

- * Name - Species present only in right bank.
⊙ Name - Species present only in Left bank.
Name - Species present in both the banks.

Table - 21

Invertebrate fauna of Narmada Valley

PHYLUM - ANNELIDA

Class - OLIGOCHAETA

Order - Oligochaeta

LUMBRICIDAE

Glyphidrilus turberosus

Class - HIRUDINEA

Order - RYNCHOBDELLIDA

GLOSSIPHONIDAE

Glossiphona complanata

PHYLUM - ARTHROPODA

Class - CRUSTACEA

Order - Decapoda

ATVIDAE

Caridina nilotica

POTAMONIDAE

Paratelphusa jaquemonts

PHYLUM - MOLLUSCA

Class - PELECYPODA

UNIONIDAE

Lamellidens marginalis

Limnaea luteola

PLANORBIDAE

Planorbis exustus

SUBULINIDAE

Opeas gracile

Table-22. Number of insect species according to habitats

TERRESTRIAL	AERIAL	MIXED
37	24	44

Table 23. Number of insect species according to its feeding habit

	PHYTOPHAGOUS	PREDACEOUS	OMNIVORE	FLUID FEEDER	TOTAL
TOTAL	35	36	11	23	105
LEFT BANK	30	31	11	22	
RIGHT BANK	33	24	07	19	

Table 24. Number of insect species and its distribution in the Sardar sarovar & its environs. in Gujarat.

TOTAL ON Rt. BANK	TOTAL ON Lt. BANK	ONLY ON Rt. BANK	ONLY ON Lt. BANK	TOTAL INSECTS
84	95	10	21	105

Table 25. Number of insect species according to its economic importance in Sardar Sarovar & its environs in Gujrat.

ECONOMICALLY IMPORTANT INSECTS			ECONOMICALLY UNIMPORTANT INSECTS	TOTAL INSECTS
PESTS	VECTORS	POLLINATORS		
07	06	17	75	105

VERTEBRATE FAUNA OF NARMADA VALLEY

Y.M. NAIK

The geographical and geological features that delineate the left and right banks as well as those climatic and vegetational characteristics of the two banks of the Narmada river are discussed elsewhere. Suffice to state here that the vertebrate fauna recorded from the Narmada valley also showed differences between left and right banks. With environmental degradation more rampant on the right bank, the vertebrate fauna there is confined to patches here and there, especially near streams. Small streams with trickling water course, interspersed with small pools, sustains a variety of life forms in and around the water system. These water streams have planktonic forms and aquatic forms such as arthropods. Large number of small fishes also populate these streams and pools.

FISH FAUNA

Large number of small fishes found in the streams are not economically important. However, these are collected with the help of fine cloth sieve by the tribals for eating purposes. These fishes are:

Cyprinidae:

- | | |
|----------------------------|-----------------|
| <u>Danio equipinnatus</u> | - Danio - Derai |
| <u>Rasbora eleniconius</u> | - Rasbora |
| <u>Puntices conehonius</u> | - Pencil fish |

Puntices stigma

Barbus thomases

- Barb - Dhebri

Anguillidae:

Anguilla bengalensis

- Eel

Channidae: Ophiocephalidae

Channa punctatus

- Murrel

Mastocembelidae:

Mastocembelus armatus armatus - Spiny eel

AMPHIBIAN FAUNA

The most common amphibians recorded on both the banks are frogs: Rana tigrina and Rana cyanophlectis. Rana limnocharis is collected from Sagai (left bank) area only. The rare anuran, Uperodon globulosum are located in Piplod and Mozda; which also fall under left bank. There may be other species of amphibians. In summer most of the amphibians aestivate or hibernate, buried in deep soil only to come out after monsoon sets in. Thus a complete picture of amphibian fauna will be available only after the onset of monsoon. The breeding season of most of the amphibians also coincide with monsoon. The tadpoles metamorphose into adult condition as the monsoon season ends. By October/November there should not be any tadpoles left. However, in the right bank, the small river (Men Nadi), near Kukarda, there were large number of tadpoles of various metamorphic stages. Most of them were unusually large. These tadpoles were seen in the month of April/May (1990). This prolonged larval stage or arrested metamorphosis is a strange phenomenon not come

across in India. This kind of prolonged metamorphosis - suspended metamorphosis - has been reported in bull frogs Rana catasbeiana and midwife toad Alytes obstetricans in North Canada. This is not a similar adaptive life style adopted by the tadpoles in this area but due to some environmental reason. We suspected iodine deficiency. On enquiring with local people, Acharyas (teachers) of Kukarda Ashram School and the doctors and staff of Hospital at Tanakhia, we gathered that endemic goiter is prevalent in the local inhabitants. In light of this information, we brought large number of the tadpoles of varying stages along with the water samples to the laboratory. The tadpoles of comparable stages were separated and divided into two groups. One group was kept in the water sample brought from the region and served as control. To the water sample in which the other group was kept, iodine was added in the form of potassium iodine (0.68 gms/10 litres to make 0.0068% KI solution). The experimental group of tadpoles immediately began to undergo metamorphosis and the control group remained as such. Further studies are in progress.

The spade frog, Uperodon as reported earlier were seen only in the left bank. Moist soil condition, soil texture and the presence of large number of ground based (terrestrial) insects in the left bank are providing congenial condition for these amphibians to thrive in the left bank. The absence of Uperodon in the right bank also explain the difference in the soil texture of left and right banks.

REPTILIAN FAUNA (Table - 26)

The snakes recorded from the study area are Cobra, Viper, rat snake, krait and Boa. Most of these snakes are found in the right bank. Lizards recorded so far are Calotes, Chameleon, Mabuya and Varanus. Calotes calotes, a rock climbing lizard is mostly seen in the right bank.

MAMMALIAN FAUNA

Amongst mammals, the bats occupy a large niche. Fruit bats, Megachiropterans, are observed in both left and right banks, but the population on the left bank is much more than in the right bank. Many microchiropterans have been observed but a more concerted effort is necessary to collect and identify them. Hare and jackals are commonly seen in both the banks. (Table - 26)

Table - 26

Reptilian and Mammals

PHYLUM - CHORDATA

CLASS - REPTILIA

ORDER - SQUAMATA

SUB-ORDER - LACERTILIA

CHAMAELIONIDAE

Chamaeleon zealanicus.

AGAMIDAE

Calotes versicolor

Calotes calotes.

SCINCIDAE

Mabuya carinata

GECKONIDAE

Hemidaetylus flaviviridis

SUB-ORDER - OPHIDIA

COLUBRIDAE

Ptyas sp.

UROPELTIDAE

Uropeltis ocellatus

ELAPIDAE

Naja naja

VIPERIDAE

Echis carinata

CLASS - MAMMALIA

ORDER - CHIROPTERA

SUB-ORDER - MICROCHIROPTERA

Rhynolopus sp.

SUB-ORDER - MEGACHIROPTERA

Pteropus giganteus

ORDER - RODENTIA

SCIURIDAE

Funambulus pennate

MURIDAE

Mellarda mettada

Mus boodunga

ORDER - LAGOMORPHA

Lepus nigricolis

ORDER - CARNIVORA

Felis pardus*

CANIDAE

Vulpes bengalensis

Canis aureus*

HYAENIDAE

Hyaena hyaena.*

HERPESTIDAE

Herpestes edwardsi

URSIDAE

Melursus ursinus

ORDER - PRIMATES

CYNOMORPHA

Macaca mulata.

* Reported by locals.

**PUBLIC AWARENESS EFFORTS
AND ECO-ENHANCEMENT STUDIES**

G. PRATHAPASENAN

PUBLIC AWARENESS EFFORTS

The team during its visits to the study area always makes it a point to talk to the villagers and learn their reactions to the project. Recently an extensive campaign has been launched to create an awareness among the local populace regarding the positive impacts of the project. This is operated through a number of agencies viz., Principals and teachers of schools run by private trusts (Ashram Shalas), Panchayats and social workers.

The research group had been to Ukai to get a first hand information of people regarding their experience with respect to the pre-and post-construction of the dam. The group met a number of project affected people especially outstees to learn their viewpoints. A cross-section of the society comprising people from Government Departments such as Irrigation, Forest, Fisheries and Social Welfare and heads of selected villages has been interviewed to assess their reactions. The team made its own observations also relating to the environmental status of the areas coming under up-stream and down-stream of the dam. It is worth noting that the commissioning of the Ukai project has significantly enhanced the agricultural production leading to the

Results

yes
but
what
about
order
End.
damage?

establishment of agro-based industries, improved the power situation, and boosted the inland fishery activities to such an extent that fish is transported to far off places like Calcutta and Delhi.

ECO-ENHANCEMENT STUDIES

Eco-enhancement is the ultimate goal towards which the group has been working. It includes, among many other things, catchment area treatment, periphery or slope stabilization methods (particularly biological), the quality of water and the life-span of the dam and the reservoir.

For the maintenance of the full life and efficiency of the reservoir it is essential to reduce the rate of evapo-transpiration and the process of siltation. The infestation of reservoir by obnoxious weeds especially water hyacinth and Pistia can greatly reduce the efficiency of the project by enhancing the rate of evapo-transpiration and this calls for keeping these weeds away by proper management. Investigations on the biocontrol of aquatic weeds especially water hyacinth is to be launched during the monsoon of 1990. All preparations for this work have been completed except the procurement of insects. Neochetina eichorniae and N. bruchi from the Indian Institute of Horticultural Research, Bangalore. The proposed study is aimed at (1) standardising conditions for culturing water hyacinth, (2) assessing the potential of weevil and the mite to control the weed and (3) studying the survival and ability of insects to

Very Very
by 20/10/90
CAT.

multiply under local agroclimatic conditions. The sensitivity of insects to some of the commonly used insecticides will be determined. Similarly the presence of any predator of these insects in the area also will be examined.

The checking of siltation which otherwise would cut short the life span of the reservoir involves stabilization of reservoir periphery of the catchment (water shed) by suitable engineering techniques followed by putting a vegetational cover comprising suitable multipurpose species which are good soil binders as well as soil improvers. This needs very careful and intensive studies on the degree of slope, physical and chemical properties of the soil, rain fall, run off and the type of erosion. The works on these lines are being initiated. Both data generation and data retrieval methods are being employed.

The eco-enhancement of selected areas on the right bank calls for immediate and permanent cessation of the operation of major biotic factors viz man, cattle etc. This is possible only when their needs are met with externally at least during the initial stages. Moreover, a certain amount of additional energy inputs into the area are required for its revival. To assess the energy balance a social survey is already mounted. Grassland cultivation may be encouraged for quick monetary returns and stabilization of soils. Along with grass, species such as bamboo, Laucaena (subabul), Casuarina (saru), cashew-nut, Agave and pine-apple can also be tried to provide fodder, fuelwood, fibre and fruits..

IN BRIEF

During the period Nov. 15, 1989 to June 15, 1990 the group:

- (1) Conducted 18 field trips involving 650 man days, in the study of area.
- (2) Prepared detailed maps of the study area in the scale of 1:50000.
- (3) Divided the study area in 1241 grids of one Sq.Km. each and
- (4) Selected 120 study sites using statistical techniques of stratified random selection.
- (5) Prepared a 8 grade eco-system classification using land use, human interference, and erosion patterns as classifying criteria.
- (6) Visited and graded the entire area according to classification system.
- (7) Conduced biomass studies with trees in 89 sites from 36 randomly selected locations from (4).
- (8) Correlated the forest biomass obtained in (4) with the eco-system grades.
- (9) Made an estimate of the primary production of the various eco-systems of the study area.
- (10) Determined, from available data, the size of human and cattle population that lives in the study area.
- (11) Conducted a survey to assess the socio-economic factors that influence the performance of the eco-system of the right bank.
- (12) Identified one possible route for animal migration.

- (13) Identified an area of 130 Sq.Km., for stabilisation because of erosion dangers.
- (14) Collected 900 plant samples belonging to nearly 300 species for floristic analysis, identification, preservation and phyto-sociological studies.
- (15) During the survey 115 species of birds, 6 of amphibians and 105 of insects were recorded.
- (16) The bird and insects populations were correlated with different eco-system studies.
- (17) The food habits of birds and insects were recorded.
- (18) An area on the right side of Narmada was identified as iodine deficient, the tadpole to frog metamorphosis time requirement was used as indicator.
- (19) The iodine deficiency of tadpole from area (20) was confirmed by laboratory experiments.
- (20) Conducted a workshop, had Several Sessions with the world bank people, met several organisations to propagate the positive aspects of the Dam.

As a result of the work carried out during this period, the group concluded that:

- (1) Ecosystems of the both the left and right bank were subjected to human interference;
- (2) The right bank ecosystems were more severely affected and left bank ecosystems were better off;

(3) Under the influence of this disturbance, the wildlife of the area had greatly diminished. It was almost absent in the submergence area, and on the right bank, but it was present on the left bank.

(4) The exact composition and numbers of animals on the left bank were not known but certain guesses were available.

(5) There were differences of climate, topography and of management between the left and the right bank but the greatest difference was in the size of human and domestic animal populations. These alone can account for ecosystem differences.

(6) The human population of the area, was poor, devoid of modern skills, and mostly living off the earth. It had also poor money management skills;

(7) During their extensive examination of flora and fauna of the area in Gujarat during 1982 and 1990, there was not a single species of plant or animal that could be regarded, in danger of extinction.

(8) Extensive areas of the left and right banks of the river are denuded and need to be protected to prevent erosion and silting of the Sardar Sarovar.

(9) Any attempt to revamp these areas must take resident human population, as well as that of the neighbouring areas into account.

(10) It is possible to analyse the ecosystem well if the data is examined in relation to different ecosystem grades of the classification developed here.

Separation of submergence from bank areas not clear in nest of

health of sustainability? It is not clear that is not

(11) It is possible to detect early human intrusion in a ecosystem using the presence of certain plants as indicators.

(12) The avian fauna is closely linked both the forests and the human factors operating within the ecosystem.

(13) There is a probability that a degree of iodine deficiency exists in native population as evidenced by studies on some amphibians. Other animal systems are also likely to be affected.

The future work of the project will be directed towards:

(1) acquisition of more extensive data on biological diversity of the area, biomass production and preservation of germplasm.

(2) more detailed analysis of the ecosystems.

(3) examination of different alternatives involved in the revamping of ecosystem, keeping human population in focus.

(4) Initiation of work on aquatic weed control.

① What about impact of submergence?
② Migration potential, relocation, other compensatory measures needed?