DISCUSSION NOTE

Environment and Sustainable Development

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This note, written in 1999, discusses the seeming conflicts between “development” and “conservation”, and considers strategies to reconcile these conflicts and work towards sustainable development.

The illustration on the cover is by Uma Bordoloi

1 INTRODUCTION

"*Development*" is a major objective of governments and societies across the world. Countries and societies have, for many years, been classified in terms of their state of development: as underdeveloped and developed, and then as developing and developed. More recently, the terms "south" and "north" are being used to categorise "developing" and "developed" countries respectively. Nevertheless, whatever the language, the primary preoccupation is with the status of development.

The term development actually refers to a process rather than a state of reality, and even the term developed is misleading for it suggests that the countries so described have reached a stage such that no further development is required. However, this is not true and all societies and nations, however developed, can develop further and are only developed in comparison to those less developed than them.

The notion of development has had an interesting history. When it first began being used to describe countries, it referred almost exclusively to the levels of economic development or growth that had been achieved. Therefore, countries were considered developed in direct proportion to how rich they were in economic terms. European countries, with many colonies and, consequently, with large revenues, were described as more developed than those which did not have colonies and, consequently, were economically poorer.

However, at the turn of the century and especially after the First World War (1914-1918), many people began to question this understanding of 'development'. It was felt that economic growth alone could not be considered development unless it promoted equity. Consequently, a country that had as a part of its 'empire', colonies that were impoverished, could not be considered developed. Similarly, if within a country the wealthy were few and the many poor, then again such a country could not be considered developed, even if its wealth was very great.

In recent times such thinking has been translated into what are known as *social or human development indicators*, which include education, health, sanitation, access to drinking water, nutritional levels, and civil rights. The United Nations Development Programme (UNDP) now brings out a Human Development Report that ranks countries in terms of their development status with regard to these various social and human indicators.

In the 1960s, another type of concern started being expressed about the definition of development. With the growing realisation of what we were doing to our natural resources, people started questioning whether a country could

be considered developed if its economic growth was based on the destruction of nature and natural resources. Considering natural resources are the most fundamental of resources, even more fundamental than financial resources, any process of growth which destroyed these resources is bound to fail in the medium to long run. Such a development strategy is not likely to be sustainable. Out of such realisations has grown the notion of *sustainable development*.

Development therefore was redefined to mean only that economic and social growth that was equitable and that could be sustained over time. The term "sustainable development" began to be used to distinguish between the old idea of development and the new, sustainable, one.

Sustainable development has been described as development which:

> *"...meets the needs of the present without compromising the ability of future generations to meet their own needs."* (Our Common Future 1987)

2 CARRYING CAPACITY

To fully understand what sustainable development means, we must first understand the notion of *carrying capacity*. The carrying capacity of an organism or a system is its ability to meet demands and withstand pressures without doing permanent damage to itself or compromising its ability to meet future demands and withstand future pressures.

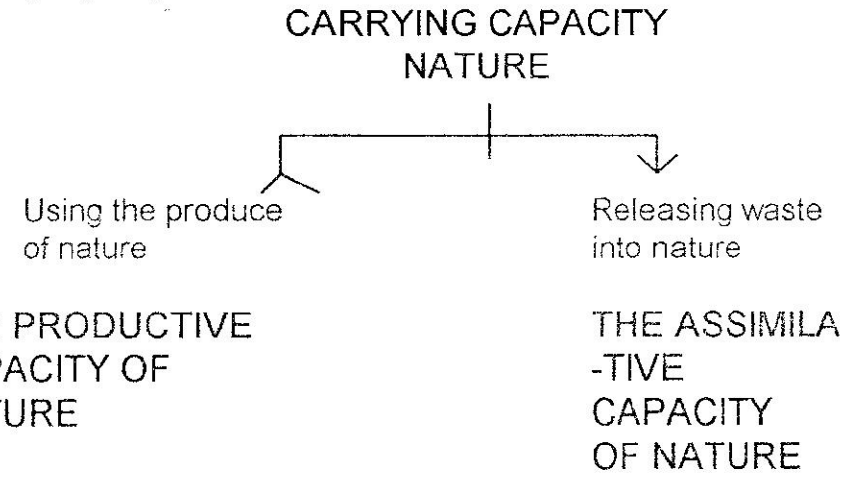
For an ecosystem, this could mean its ability to tolerate extraction (its productive capacity) and withstand pollution (its assimilative capacity) without getting degraded.

To understand this better, consider that even human beings have a carrying capacity. We can donate only those amounts of blood safely that our body can replace in a short time. Similarly, we can assimilate a certain amount of caffeine or other pollutants, without they permanently damaging our health. However, if our body was drained of blood or if we were exposed to the type and quantity of pollutants that were beyond our ability to assimilate, then we would not only seriously injure ourselves, but in extreme cases also die. In any case, our ability to produce and function would be impaired.

A similar thing happens in nature. For example, take a river. The river has an ability to function without permanent damage even if a certain amount of water is withdrawn from it and taken for human consumption. However, if we drain the river of most or all of its water, then the river, as an ecosystem, dies or gets permanently damaged. Also, a river has the ability to assimilate some pollutants and to *biodegrade* them so that they do not damage the ecosystem. However, if we dump the types or quantities of pollutants that are

beyond the assimilative ability of the river, then the river gets seriously damaged and even dies.

The diagram below shows how we interact with nature and excercise its carrying capacity:

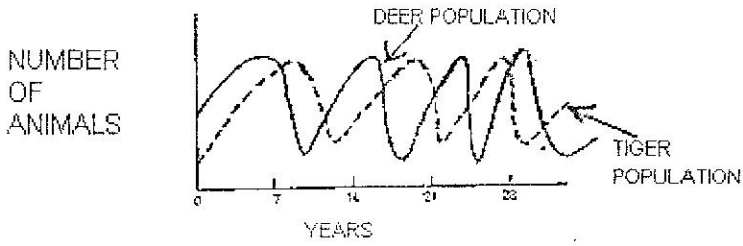


Therefore, one way of ensuring sustainable development is to ensure that the process of economic growth does not take from nature more than it is able to regenerate, and does not pollute nature beyond its ability to assimilate.

The carrying capacity of a resource is not finite. Through better management and technology, the carrying capacities of various natural ecosystems can be enhanced. For example, through the application of genetic engineering, mainly in the form of better seeds and faster growing strains of crops, the productivity of cultivated plants and of the land on which they grow can be increased. The application of fertilisers and irrigation can also enhance the productivity of land. Similarly, the assimilative abilities of an ecosystem can also be enhanced. Recently there have been successful experiments with earthworms - called *wormiculture* - where the introduction of earthworms in compost pits can significantly enhance the ability of the ecosystem to break down the waste matter and assimilate the biodegradable substances, consequently enhancing the quality of the soil.

Human beings are perhaps the only living creatures on Earth that have the ability to exceeded the carrying capacities of ecosystems to a point where these ecosystems get degraded or destroyed. In the rest of nature there are in built checks and balances to prevent the over utilisation of natural resources. The consumption of resources by animals is determined by the availability of such resources.

So, for example, if the number of deer in a particular area increase to a point where they start consuming more grass then can be regenerated, then the availability of grass goes down and this, in turn, adversely affects the population of deer. Similarly, if the number of tigers in an area increase to a point where they eat up the other *prey* animals faster than these animals can reproduce then, very soon there is not enough food for these tigers and their population begins to decline. Their population rapidly reaches a point where the balance between their populations and the population of the prey animal is restored without any permanent damage being done. This cycle is endlessly repeated. The diagram below explains this relationship.



Also, in nature, nothing is waste. The 'waste' of one creature is the food of another and is finally an input to one part or another of the ecosystem. Therefore, a whole host of insects and *microorganisms* live in and off the excrement of various animals. These insects and microorganisms break down (biodegrade) this excrement to a point where it becomes nourishment for the soil. Similarly, dead plants and trees and even the carcasses of animals, become homes and food for other creatures who, in the process, help them to be assimilated by the ecosystem.

Only human beings, because of the rate at which they consume, the technologies that they have developed for facilitating consumption, and the nature and quantum of the waste they throw out, have a tendency of exceeding the carrying capacity of the ecosystems they depend on. The problem is aggravated by the fact that human beings have the ability to immunise themselves from the consequences of degrading their immediate environment by transferring their attentions to other, remote, ecosystems, once their immediate ones are destroyed. Therefore, it is important to devise ways and means by which the interaction of human beings with the rest of nature is kept at sustainable levels.

3 SUSTAINABLE DEVELOPMENT

Sustainable development is not something that can be achieved overnight. The path to sustainability is through ensuring that every project, every activity, every scheme and every policy is progressively made environmentally friendly till it itself becomes sustainable and promotes over all sustainability. Given below are some of the issues, listed sector wise, that need to be focussed on in our search for sustainable development

3.1 Forestry

Sustainable development within and through the forestry sector means that we should harvest from forests only that much of timber and non timber produce that it can regenerate. So, for example, if a forest grows at the rate of 2 % a year, our harvest should never be greater than the *increment*. This is similar to the principle of judicious financial management where people are expected to not eat into the capital of their savings but live off its interest.

Take not from the capital of nature, but only from its interest.

What we take and how we take is also important. For example, if we harvest the young and growing trees, then in the long term the forest will die. Similarly, if we concentrate our harvesting on only one part of the forest, then even though overall we might not have extracted more than what is regenerated, the area from which we have over harvested might become barren.

10.3.2 Biodiversity

Biodiversity or biological diversity is defined as the variability of ecosystems, species and genes. It is now recognised that the maintenance of biodiversity is critical for human wellbeing and survival.

There are many types of ecosystems on earth. For example, there are the seas and oceans, rivers and lakes, forests, deserts, grasslands, islands, and mountains. Within these categories, there are sub-categories. In India, for example, there are sixteen major types of forests and hundreds of subtypes. Similarly there are tropical oceans and temperate oceans; there are cold and hot deserts and various types of mountain ranges and grasslands. Biodiversity at the ecosystem level means the variability of ecosystems.

Within each ecosystem, there are various species. Human beings are one such species, but there are others like tigers, lions, elephants, *peepal* trees, *deodar* trees, *gulmohar* and *neem* trees, peacocks, crows, bees, flies, etc. etc. Biodiversity at the species level means the variability of species.

Within each species, each individual is different. Among human beings, for example, though we are all of one species, each one of us is physically and mentally different from the other: genetically variable. There are similar variations among individual members of all species. Biodiversity at the genetic level means the variability of individuals of the same species.

Conservation of biodiversity implies ensuring that the variability among ecosystems, species and genes does not become less than what is natural and that, in any case, no ecosystem or species becomes extinct.

There are many reasons why it is important to conserve biodiversity. Some of the major ones are described below.

Medicine: a large proportion of the medicines that are used in the world, especially the non-allopathic ones, are derived from plants and animals. Yet, we have only investigated about one percent of the known species for their medicinal and other values. And of the species likely to exist on earth, perhaps only twenty percent have so far been discovered and identified. If a species that has either not yet even been identified, or whose medicinal and other uses have not yet been investigated, becomes extinct, then the cure to some of the diseases that are currently plaguing the world, like AIDS and cancer, might be lost for ever.

Even if a species that we have already investigated and found to be of no use, becomes extinct, there are grave dangers. For, though this species might be of no use in curing the ailments we know about today, what is the guarantee that some new diseases might not appear in the future, just as AIDS did some years back. And then we might discover that its cure died with the extinction of the species that we thought was valueless. Therefore, in order to ensure that our options are not foreclosed, we need to ensure that each and every species is conserved. This is the *option value* of biodiversity.

Agriculture: All the plants we cultivate or the animals we domesticate, are derived from wild species. In order to keep open the option of developing new strains for cultivation and domestication, we have to ensure that wild species are conserved. Also, if cultivated or domestic strains have to be immunised against pests or diseases, then most often wild species have to be used to create such immune strains.

Biotechnology: This is a new area which perhaps offers the greatest promise, among all technologies, to provide answers to some of the major problems facing the world: those of poverty, hunger and disease. However, the 'raw materials' of biotechnology are wild plants and animals. It is from the various plants and animals that genes can be found which, through genetic engineering, give new hope of solving many of the old problems. For example, the green revolution in India was a result of genetic engineering and, whatever might be the problems with it, has certainly raised the productivity of food grains in India. However, if species in the wild became extinct, then this 'raw material' of genetic engineering would no longer be available. We, therefore, must keep this option open also.

Web of life: All life is interconnected like the web of a spider. Each species is directly or indirectly dependent on all others. Therefore, if one species becomes extinct, then this affects all the species. The effect might not be felt immediately, but eventually the chain reaction starts.

For these and other reasons, it is important that biodiversity is conserved if development has to be sustained.

3.3 Agriculture

The soil and water resources, that are a basis for agriculture, also need to be sustainably used. Soils are susceptible to wind and water erosion and to degradation. When the vegetative cover on soils is destroyed, the binding that such a cover provides to the soil is removed. These exposed soils become prone to erosion. Further, with the removal of vegetative cover, the soils get exposed to the direct rays of the sun and dry up quickly. This also lowers their productivity and makes them susceptible to erosion. The leaf and vegetative litter that is generated by the green cover enriches the soil and provides it with humus. When the vegetative cover disappears, the soils also degrade.

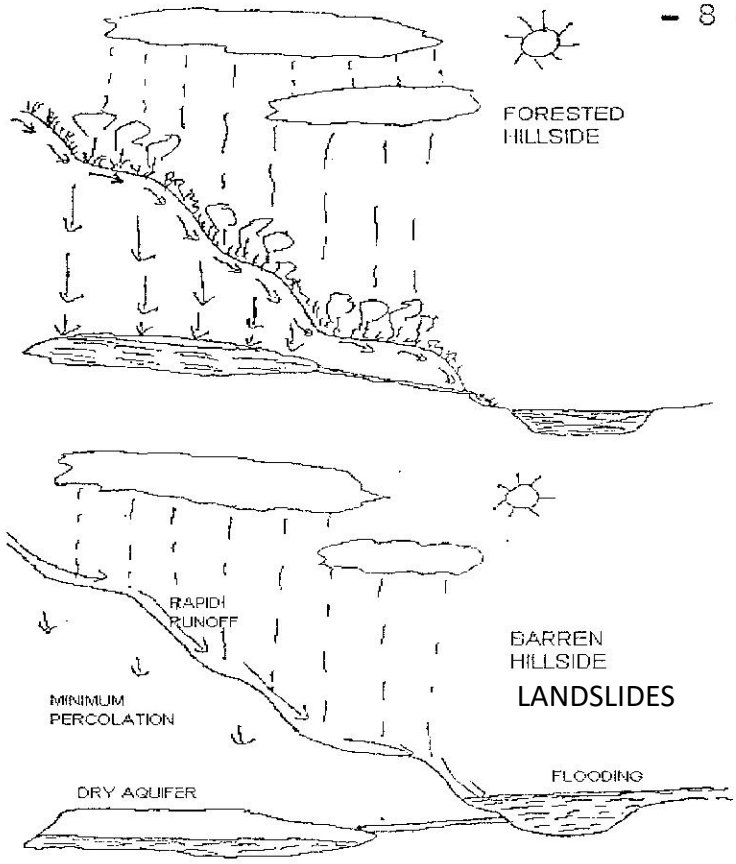
Cultivation and ploughing on slopes, without adequate measures to prevent soil erosion, also aggravates the loss of soils. Another factor that degrades soil is unsuitable cropping patterns. If the soils are not allowed to rest adequately between crops, they loose their productivity. Also, if the nutrients of the soil are not replenished through natural fertilisers, the soil degrades.

Though chemical fertilisers can, for a short time, enhance the productivity of soils, over a long period they are not able to replenish all the trace elements in a soil and therefore cannot sustain long-term productivity. Eventually, more and more chemical fertilisers have to be applied to support a declining productivity. This not only reduces productivity but also significantly raises the financial costs of cultivation.

The over use of chemical pesticides, or the use of inappropriate pesticides, also degrades the soil. Such pesticides, apart from killing crop pests, also kill the various insects, birds and *microorganisms* needed for regenerating the soils. The residues of such pesticides find their way into the water and the atmosphere, significantly degrading the environment and adversely affecting human health. If applied carelessly, they also contaminate the crops and become an additional health hazard.

Water logging is another threat to soils. Whereas this problem would be discussed in detail in the section on irrigation, suffice it to say here that large tracts of productive lands have become fallow because of *salts and alkali* contamination caused by rising ground water tables.

Deforestation in the *catchment* areas also results in floods and droughts, further compromising the productivity of our soils. Where catchments are denuded of their forest and other vegetative cover, the soils become susceptible to wind and water erosion. The summer sun dries them and when the rains come they all flow down with the water. The lack of vegetative cover on the slopes also results in very rapid water *runoff* resulting in inadequate recharging of the underground *aquifers*. This means that where catchments are degraded there is much greater water in the streams and rivers in the rainy season then there was when the catchments were vegetated. In addition, the topsoil and other debris, which was stabilised on the hillsides by



the vegetation also now flows off the barren landscape. The resulting volume of water and silt is too much for the riverbeds to contain and so there are floods.

Also, as this silt reaches the plains and the river slows down, the silt sinks to the bed of the river, silting it up. This results in the capacity of the riverbed becoming less so that even normal flows of water cannot be contained and there are again floods.

Conversely, in the dry season, as the aquifers have not been properly recharged, there is little water in the streams and a drought occurs. Initially floods might enhance the quality of land in the flood plains, as they bring down the topsoil from the catchments. However, in a few years, all the topsoil has been eroded and only rubble is deposited. This significantly lowers the productivity of soils (see figure above)

Another threat to sustainable agriculture is the destruction of wild *biodiversity*. All the plants we cultivate today are derived from the wild. In the case of hybrid varieties, like the green revolution varieties, the cultivated strains are derived from the genes of wild plants. In order to ensure food security and to keep open the options of developing new strains of cultivable plants, we need to ensure that wild plant varieties are conserved. We also need the wild varieties to meet threats to our existing cultivable varieties (for details see section on biodiversity).

3.4 Water resources

Water is, after air, perhaps the most critical human resource. The location of human settlements, throughout history, has more often been determined by the location of water sources than by any other single factor. And historically many societies and cultures have perished because they could not manage their water resources properly.

Water is essentially a renewable resource, much of it subject to yearly or half yearly cycles. The water (or hydrological) cycle moves water from one place to another and changes some of it from one form to another. The monsoon winds pick up moisture from the Indian Ocean and distribute it, as precipitation, throughout the country. In this process, they also convert salt water into fresh water. There is also the melting of snows and glaciers, in the Himalayas, which feed many of our rivers.

To ensure that water is sustainably used it has to be ensure that the hydrological cycle does not go awry. This involves, to start with, ensuring that rainfall patterns do not get disrupted. Though the relationship between deforestation and macro climatic changes is not yet well understood, there is good evidence to believe that deforestation can cause serious disruption in micro rainfall patterns.

But, more important, the degradation of vegetative cover in the catchments seriously disrupts, as already described, the water cycle and causes floods and droughts. Deforestation and degradation of the upper reaches of the Himalayas also causes micro climatic changes which affect the ice and snow melt regimes, thereby disrupting the hydrological cycle.

So, the first task is to ensure that water is available where required, in the right quantity and at the right time. The second task is to ensure that this water is clean and wholesome. Ordinarily, the water that comes down as rain or through ice or snow melt is pure and not polluted. However, certain types of air pollutants can contaminate rainwater even before it reaches the ground. A common result of such pollution is called 'acid rain'. Acid rain occurs when the atmosphere is polluted with sulphur dioxide and nitrogen oxides which mix with rainwater to form sulphuric acid and nitric acid. Such rain, instead of nourishing the soil and vegetation, destroys them. Thousands of hectares of forests in Europe and North America have been 'burnt' by acid rain. The soil there has become acidic and lost much of its productivity and the lakes and rivers have been polluted, resulting in extensive fish kills.

Apart from atmospheric pollution, water is also subjected to pollution on the ground. Silt, domestic wastes, agricultural run off and industrial wastes pollute our lakes, streams, rivers and even the ocean. Such polluted waters become unfit for most human uses. Due to rampant water pollution in India, most of the surface water is unfit for human consumption. Much of it is also unfit for bathing and some of it even for agricultural use. When polluted water is fed into industries, there is a danger that it would damage the machinery or otherwise adversely affect the industrial process. Polluted water also

degrades the environment, particularly affecting the fauna and flora that either live in that water or partake of it.

Water is stored or conveyed on the surface of the earth in or through various water bodies. These natural bodies have an ecological process of their own and include lakes, ponds, seas, oceans, springs, streams and rivers. These are not mere receptacles or passages of water but also habitats for hundreds of living creatures: fish, insects, plants, snakes, reptiles and crustaceans. These water bodies also energise the water, just as they are energised by it. Water, as it rests in or passes through them, is oxygenated, cleaned and mineralised. If there are pollutants in the water, the ecological processes act to biodegrade them and to clean up the water again. Rocks and rapids in the streams and rivers help mix oxygen in the water, which the fish and other creatures living in the water then breathe for their survival.

When the water is polluted beyond its capacity to assimilate the pollutants, then these various functions of the *aquatic* and *marine* ecosystems get compromised. Similarly, if large quantities of water are extracted from such water bodies, then again the ecosystem gets affected and cannot perform normally. Where excessive pollution or extraction continues over time, the ecosystem gets irretrievably damaged, sometimes becoming incapable of supporting even the most basic life forms. Apart from the loss of fish and other life forms, this means that the water body is no longer able to cleanse the water and the water either becomes useless for human use. It has to be subjected to an expensive process of artificial cleansing before it can again be used.

Polluted water also poses a threat to its users. The threat to the environment has already been explained. It also threatens human health and it is estimated that 10,000 children die every day in India due to water related diseases. Also, water that contains large quantities of silt does damage to human made structures, silting up dams and tanks and damaging hydroelectric turbines.

Given the growing human population and the consequent increase in the demand for water, controlling the use and wastage of water, especially 'treated' water, is a high priority. What is required is 'demand side management' of water. The current patterns of water use are not only inequitable but also wasteful and unsustainable. While the well to do in a city throw away 12 to 16 litres of 'treated' water every time they flush their cistern, the poor in the same city have to line up for hours to get even one bucket of water. Our houses and industries are not designed to be water efficient and millions of litres of water are wasted because of leaking taps or outdated industrial processes.

3.5 Industry

Industrial growth is seen as central to economic development. However, in order for industry to be environmentally sustainable and for it to contribute to overall sustainable development, it must be environmentally friendly, or

'green', from 'cradle to grave'. This means that right from the setting up of the industry and the extraction of raw material and the generation of energy, through its production process and the nature of the produce, to the decommissioning of each plant and the final disposal of each product, the sector must be green.

If the Industrial sector is not environmentally friendly, it puts unsustainable pressures on the environment, both by using more natural resources than can be replaced and discharging more waste than can be assimilated. By using natural resources inefficiently and by polluting needlessly, an industry takes away the opportunity for additional production out of the same natural resources and the consequent additional discharge of pollutants. So, industries that are green not only negatively affect the environment but also take away the opportunity for additional industrial production.

In India, both water and electricity are subsidised, in the sense that their true cost, especially if you include the environmental costs, are not recovered from the consumers. Water and electricity are also two of the resources that are most often wastefully used. It is therefore imperative to conduct environmental audits of industries and of the industrial sector. To make such audits meaningful, standards must be prescribed for the quantity of water and electricity to be used in the production of various types of goods and the provision of various services.

It is preferable to prevent pollution, rather than to try and control it once it has happened. In order to prevent pollution, it is important that production technologies must also be green. The use of green technologies is not only good for the environment but also economically beneficial. Environmentally friendly technologies consume less water and electricity per unit of production and produce less waste. The costs of raw materials and of waste disposal are also, therefore, minimised, along with the expenditure on electricity and water. Besides, many green processes link up production processes in a way that the wastes of one process become the raw materials of another. Therefore, industries can be located and designed in ways such that the quantity of waste is minimised and the cost of purchasing raw materials is cut down

Another area of concern is that of packaging. Again, because garbage collection and disposal is done at public cost, not chargeable to the industry, many industries pack their products in an environmentally unfriendly manner. The use of plastics and other toxic or non-biodegradable materials as packaging material, needs to be controlled. The products themselves must be such that they or the materials they are made of could be recycled once their life was over. This would not only save on raw materials but also lessen the problem of garbage control.

3.6 Energy

Power projects have historically had significant social and environmental costs associated with them. The two most common types of such projects in India are hydro and thermal power projects.

Hydroelectric projects: Hydroelectric projects, especially those involving large dams, usually have the more significant environmental and social impacts. Some of the main impacts are listed below:

Upstream of the dam

1. Degradation of the catchment. This can be due to the project, partly because of project activities and partly because of increased pressures on the remaining catchment, once a part has been submerged under the reservoir. Apart from the adverse impacts this has on the biodiversity of the region, it also often has critical implications on the livelihood needs of the local people.
2. Of course, degraded catchments, whatever be the cause of degradation, can also have significant impacts on the dam project itself by, among other things
   - Increasing the silt load
   - Causing erratic water runoffs
   - Posing a possible threat of surplussing due to sudden increase in water flow
3. There is the threat of backwater build-ups and consequent floods and destruction
4. There is also the threat of reduced water availability upstream, as the water is required to fill the reservoir

At the reservoir and project site:

5. Dust Pollution
6. The threat to rim stability
7. The potential for breeding vectors
8. Adverse impact on the aquatic ecosystem and biodiversity
9. Possible adverse Impact on fisheries
10. Impact on the water quality including potential for mineral contamination of water
11. Submergence and destruction of flora and fauna
12. Submergence of agricultural land
13. Submergence of grazing land
14. Submergence of sources of local fuel wood and other non timber forest produce
15. Reservoir induced seismicity
16. Adverse micro climatic changes
17. Human Displacement

Downstream

18. Adverse impacts on aquatic ecosystem and biodiversity downstream
19. Adverse impact on fisheries downstream
20. Adverse impact on water availability downstream
21. Adverse impact on water pollution levels downstream, especially due to reduced river flow
22. Possible salt water ingress
23. Threat from sudden releases of water
24. Threat from dam failure

Command Area (in multipurpose projects)

25. Threat of water logging and salinity
26. Threat of vector breeding

Unfortunately, there are many projects in India and in other parts of the world, which manifest one or more of these adverse impacts.

Hydroelectric projects in India are often not investigated properly for their environmental and social impacts. Their environmental and social viability is, therefore, not clearly established. Besides, the measures to mitigate the social and environmental impacts are often inadequate. Also, activities related to the assessment and mitigation of environmental and social costs are often started very late and then hurried along so as not to delay project implementation.

There has been an unfortunate tendency, in recent years, to grant hydroelectric projects "conditional clearance", with the stipulation that environmental assessment and the mitigation of adverse impacts be carried on *pari passu*. Some prominent beneficiaries of such clearances are the Sardar Sarovar Project in Gujarat, the Indira Sagar Narmada Project in Madhya Pradesh, and the Tehri Project in Uttar Pradesh.

What such conditional clearances imply is that the project is given a go ahead before its environmental impacts have been assessed and, consequently, its viability established. It also usually means that the assessment is never properly done, and mitigative measures are delayed to a point where they become ineffective.

Rehabilitation: Hydroelectric projects also take a heavy toll of the human beings living in the submergence areas, who are made homeless in the thousands. Till recently, there were very inhumane rehabilitation policies, where by and large the "oustees" were handed a small amount of money in lieu of their homes, livelihood and heritage, and asked to fend for themselves. Recently, there has been a serious effort to change all this. Some of the

newer projects, notably the Sardar Sarovar Project in Gujarat, offer land for land and other facilities to the "project affected people".

Despite this, the cost paid by the project affected people, mostly poor villagers and tribals, is horrific. And the benefits of the electricity generated goes mostly to the rural rich and to the urban populations.

Coal Based Thermal Power Projects: Though the adverse environmental and social impacts of thermal power projects are not as dramatic as that of dams, they are still significant. This is especially so if one assesses the impacts from "cradle to grave", i.e., including the impact of mining the coal and of its transportation to the power plant.

The major environmental and social impacts of thermal power stations are listed below.

Construction phase

1. Displacement of people
2. Dust pollution
3. Local level disturbance
4. Destruction of fauna and flora

Operational phase

5. Air pollution
6. Water pollution
7. Withdrawal of water
8. Land pollution, mainly through fly ash
9. Noise pollution
10. Micro climatic changes

Unfortunately, thermal power plants are often not properly assessed for their environmental and social impacts, and alternative sites and technologies are rarely explored.

Perhaps the three most critical issues concerning thermal power stations, in terms of their social and environmental impacts are:

1. The location of the plant. Inappropriate locations imply heavy environmental and social costs and an inability to adequately mitigate these costs without making the project economically nonviable.
2. The use and discharge of water. As water is a scarce commodity in most parts of the country, the use of water by power stations results in greater, sometimes critical, deprivations for the local populations.
3. The dumping of fly ash. Fly ash is perhaps the single greatest hazard to the environment, to land and to human health.

Many examples of thermal power plants, which were posed for environmental clearance without a proper appreciation of the environmental issues, are available. Some of the notable examples are described below.

The Dholpur Thermal Power Project, Rajasthan

This power project is to be located on the banks of the Chambal River, adjacent and, in part, within the National Chambal Sanctuary. The efforts of the Environmental Appraisal Committee to get the state government to shift this power station even a few kilometres, so that the impact on the sanctuary could be minimised, were unsuccessful. Consequently, the project was not accorded clearance for many years and has only recently managed to get cleared, in its initial location, but with very stringent environmental conditions. The loss of time and the additional costs of environmental safeguards could all have been prevented if the project had initially been shifted to a more suitable site.

Kayamkullam Power Project, Kerala

This project is to be located adjacent to a fragile system of *Kayals* (backwaters) in the state of Kerala. The project envisages dredging the *Kayals* in order to get earth fill material for the project site. Such dredging would destroy the *kayal* as an ecosystem and have significant adverse impact on the fisheries in the region. Again, efforts to have the site shifted by a few kilometres were not successful. The project was, therefore, not recommended for clearance. Later, the Ministry of Environment and Forests cleared the project, over ruling the recommendations of its own appraisal committee. However, if the project does come up it will have unacceptable environmental costs.

3.7 Transport

The contribution to air pollution levels, especially urban air pollution levels, of the transport sector is significant. This is primarily because of the concentration of vehicles in urban areas, the technology prevalent, the poor state of maintenance of vehicles, the poor quality of fuel and, sometimes, local climatic conditions.

Air pollution levels in most of our cities are much above the prescribed limits, especially for *suspended particulate matter* (SPM). Some recent statistics are given below.

Average Annual SPM in ug/m3

WHO Recommended Standard 75 ug/m3

Agra	451.93	Patna	230.91
Mumbai	226.00	Pune	226.07
Delhi	543.00	Calcutta	394.00
Dhanbad	364.64	Surat	283.81
Ludhiana	380.17	Varanasi	489.23

Source: Reports of the National Environmental Engineering Research Institute and of the Central Pollution Control Board

In the last few years, the government has taken some important steps in tackling this problem. They have notified motor vehicle emission standards and introduced a system by which motor vehicles need to have pollution checks regularly. They have banned the sale of cars, which are not fitted with *catalytic converters*, in the metropolitan cities. They have introduced lead free petrol. Efforts are also on to improve the quality of fuel being supplied, to upgrade motor vehicle technology, to ban the sale of loose oil at petrol pumps and to phase out of Delhi, for example, public vehicles which are over fifteen years old.

However, as long as the number of vehicles on the road keep increasing, the problem will only get worse. The only sustainable answer lies in improved public transport, which makes the use of private vehicles, or of individual public transport like taxis and three wheelers, less popular. Along with these, the other options like better and different fuels, and greener technologies, must be pursued.

For travel and transportation between towns and cities and across the country, some of the greenest options are no longer available. River transportation, if properly managed, can be a very environmentally friendly method of travel. Unfortunately, many of our rivers have now become too silted to be able to allow this option. However, if the earlier discussed methods of catchment area treatment and afforestation are implemented, then it might again become viable to desilt our rivers and other water ways and make them navigable for transporting people and goods.

Rail transport is also preferable to road transport. However, in the last few decades there has been a much greater focus in developing the roadways sector rather than the railways. This strategy also needs to be reconsidered.

4 STRATEGIES FOR SUSTAINABLE DEVELOPMENT

The strategy for making the development process greener and environmentally sustainable involves ensuring that each sector and, within a sector, each project, scheme or activity, is environmentally friendly and contributes to a development process which is sustainable.

There are various methods and instruments available to assess the environmental impact of such projects and activities and to ensure that they are environmentally viable. Two of these are **environmental impact assessments** and **natural resource budgeting and accounting**.

4.1 Environmental Impact Assessment (EIA)

Conducting an EIA of a project or an activity involves developing an environmental impact statement and then assessing the expected impacts of the project or activity.

An environmental impact statement (EIS) usually contains a list of the activities and processes that might have an adverse impact on the environment. These are then described in terms of the nature and severity of impact on the various elements of the environment. So, for example, an EIS of a proposed power station may look something like this:

ENVIRONMENTAL PARAMETERS

Activities	Air quality	Water availability	Water quality	Land	Soil	Ground water	Local inhabitants
Clearing of site	L	L	L	H	H	L	H
Land filling	L	L	M	H	H	L	M
Transportation of building materials	H						M
Construction of buildings	H			M	M		
Withdrawl of water		H	H			H	H
Discharge of water		M	H			M	H
Discharge of flyash	H	H	H	H	H	H	H
Discharge of SO2	H		M		M		H
Transportation of coal	H			H	H		H

H = high impact, M = medium, L = low, Blank = no impact

An assessment of the impacts, as laid out in the statement, is based on various factors. The purpose is to determine whether the proposed activity or project is environmentally viable and, as such, deserves environmental clearance. To decide this, various questions are considered. These include whether it is possible to prevent or mitigate the anticipated adverse impacts? How severe are the final impacts? How valuable or unique is the affected ecosystem? And whether the benefits from the proposed activity or project justify such impacts?

4.2 Natural Resource Accounting and Budgeting:

Till recently, environmental costs were rarely taken into consideration in the national planning exercises. This is because financial and economic experts do the planning and they do it in primarily a financial and economic context.

However, natural resources are the most fundamental of human resources, certainly more fundamental than financial and economic resources.

Given the rapid environmental degradation, the world over, in the last few decades, many countries have begun to realise that unless environmental costs are incorporated into their national accounting system, a true picture of the health of their economy would not emerge. Perhaps motivated by this, the Government of India, in its policy statement on sustainable development, has undertaken to present before Parliament, each year, a natural resources budget.

Also, the Government of India has also prepared a National Environmental Action Programme (NEAP) and is a party to Agenda 21. Both these documents further reiterate the commitment of the government to move towards a model of sustainable development.

In countries of the North, environmental economics is now a popular and fast growing discipline. Unfortunately, the models developed in these countries are not always appropriate to India. Despite this, there has been a concerted effort by various countries of the North and many international agencies to persuade India and other countries to accept their model of natural resources accounting.

The imperative for natural resource accounting seems, on the face of it, to flow from an urge to integrate natural resource parameters into the national accounting systems. This means that the GNP calculations of a country would reflect, each year, the use and accrual of natural resources. For specific projects and activities, a system of natural resource accounting would mean that the financial and economic costs of natural resources will be reflected in the cost benefit analysis carried out to assess the viability of the project.

Unfortunately, the methods currently being used by many countries of the North for generating natural resource accounts, have many problems. Some of them are outlined below:

Classification of Nature: The first problem relates to classification of nature into that which has economic value or, as economists sometimes describe it, has alternate uses, and that which has no economic value for it has no alternate use. The belief that some elements of nature have no alternate use and therefore no economic or financial value seems misplaced. Perhaps, if one takes a very narrow definition of "value" and "use", then one could argue this. However, it is well established that each individual living organism represents a unique element of biodiversity. Therefore, it is difficult to imagine even a single plant or creature that has no use.

Attaching Value: Even more difficult is the method by which economic and financial value is attached to elements of nature. Unfortunately, economics as a science can only put a replacement value to those goods and services,

which are inputs into, or outputs of, an economic process. Much of nature, critical as it is to human survival, is not an input or an output of an economic process. Therefore, for economists, it is either invaluable or valueless. As economics cannot handle the notion of invaluable, it tends to consider much of nature as valueless.

As an example, how can economics ascribe a realistic financial or economic value to the last surviving pair of a species of a bird, which currently might have no known economic function? Given the present methodology, such a pair would ordinarily be considered without economic value. Yet, this very species might, if it survives, become of very great economic value in the future. Nevertheless, as there is no way of predicting with any certainty whether this would happen or not, ascribing value becomes an impossible task.

The North-South Divide: Though the difficulties in ascribing economic value to elements of nature are common all over the world, their implications are far greater for countries of the South. Whereas in countries of the North most people have enough surpluses after meeting their immediate basic needs, to be willing to pay for recreation and long term needs like environmental conservation, this is not so in countries of the South. Therefore, if the economic value of the environment was to be determined through market forces, as is envisaged in many of the prevailing methodologies, it is unlikely that in countries like India the poor people would be in a position to choose long term needs over their immediate ones. Market forces would, consequently, make it difficult to conserve and protect anything.

Also, given the vast differences in the buying power of different segments of society in countries of the South, and between the North and the South, it is difficult to ensure socially just utilisation of natural resources. This is especially so if decisions were to be made solely or primarily on an economic basis.

Undervaluing Nature: There is also a tendency of governments, dominated by imperatives for economic growth, to systematically undervalue the contributions of natural ecosystems to the economy and to human welfare in general. For example, a forest can be contrasted with a human made industry. Whereas the human made industry requires inputs of capital, energy, raw materials, maintenance, replacement, and a labour force to make it productive, the forest, as an industry, produces goods and services critical to humanity without requiring any of these. It generates its own energy, produces its own raw materials, maintains and replaces itself, and goes on for eternity without needing any human input. However, the economic value attributed to forests never reflects this miracle of productivity and renewability.

The Solution: But what is the solution? Perhaps one way out is to adopt a dual approach of both budgeting and accounting. The elements of this approach are described below.

First, a natural resource, say water, needs to be budgeted in physical terms and allocations made to meet the basic ecological and social requirements. This means that, in a river, the minimum flows required for maintaining the ecological balance of the river and consequently its ability to cleanse itself and support life, must be assured.

Once this is done, then the surplus water must next be allocated for meeting the basic needs of the human populations dependent on the river. This includes their drinking water requirements and other basic needs. If any 'surplus' remains, this can then be subjected to market forces and its use determined based on the paying capacity of the various contenders.

In such a model, where there is industrial demand for water, then the industrial sector must pay for enhancing lean season flows by, for example, regenerating catchments, in order to produce larger surpluses. There is also, then, an economic incentive to invest in water saving technology, as the real cost of water is being charged.

5 SOME USEFUL BOOKS AND DOCUMENTS

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