*DISCUSSION NOTE*

# Conserving Water and the Environment

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This note was discussed in an international meeting organised in Kunming, China, in December 1997. It had, as participants, representatives of most of the countries in Asia. It focusses on the strategies and issues that need to be adopted by India, Bangladesh, Nepal and China in order to better manage the water resources and the environment of the region.

The illustration on the cover is by Uma Bordoloi

# CONSERVING WATER AND THE ENVIRONMENT

## Multi-country Cooperation for Environmental Conservation

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Projects aimed at managing water resources often have adverse impacts on the environment. The severity and geographical extent of such impacts is normally dependent on the scale of the project. In the event of large projects, the adverse impacts can be felt in more than one country.

Projects and activities, especially in the catchments of watercourses (like rivers and streams) and water bodies (like lakes and ponds) can also have an impact on the quality and quantity of water. Consequently, for properly managing the water resources of the region, it is essential to look at not only the adverse impacts of managed water on the environment, but also at the impact of various projects and activities on the quality and quantity of water.

In this region, the rivers from Nepal feed those in northern India, and in turn the rivers from north and north-east India feed the rivers of Bangladesh. Consequently, projects and activities in one country could have impacts on other countries.

For these various reasons, it is appropriate that there is interest and commitment in Bangladesh, India and Nepal to look at such issues collectively. Perhaps at some later date China can also be brought into this dialogue.

## A. USES OF WATER

Water can be seen to have atleast three distinct, though possibly overlapping, functions.

- As a human resource
- As an ecosystem, especially as a habitat for flora, fauna and micro-organisms.
- As an element of the larger ecosystem.

The effort in this paper is to identify the major environmental issues related to all these three different functions of water.

### 1. Water as a Human Resource:

Broadly speaking, water is used by human beings for at least the following five purposes:

i) For Domestic and Municipal Use

This includes drinking, cooking and washing, watering of lawns and gardens, and for other sanitation purposes. The major environmental concerns regarding this form of water use relate to:

a) Maintenance of sustained supply for human use, appropriately spread over seasons and populations.

b) Maintenance of water quality to within acceptable levels both at the input and output stages.

ii) For Industrial Use

This involves the use of water for industries, including power projects, either as raw material or more often as input into the industrial process. Such use of water also involves the same two environmental issues, namely sustainable supply and maintenance of water quality.

iii) For Agricultural Use

Water as an agricultural resource involves the storage, extraction or diversion of water to support agricultural activities. For such use, apart from the earlier two issues of sustainable supply and water quality, there is an additional issue regarding the impact of water management or storage projects on the rest of the environment, and on elements of the human society. Certain water storage projects, like multipurpose dams, are the means of managing water not just for agricultural use but also for domestic, municipal and industrial use.

iv) For Recreational Use

Water bodies like rivers, lakes and artificial reservoirs are important centers of tourism and recreation. The important environmental issues associated with such use include sustainable supplies, water quality and, additionally, the ability to maintain these water bodies as holistic ecosystems, which are aesthetic.

v) For Inland Water Transport

This involves using rivers and other large water bodies for transportation of goods or people. The major environmental issues related to such use are sustained availability of water flows in rivers, and the maintenance of water quality.

2. **Water as an Ecosystem**

Water in itself is a habitat for aquatic flora, fauna and microorganisms. These are not only important as a socio-economic resource, but their maintenance is in itself important to maintain water quality and to keep water bodies and courses healthy and functional. This function of water can be adversely affected by poor water quality, fluctuations in flows or levels, and by other disturbances.

3. **Water as an Element of the Larger Ecosystem**

Apart from water being a habitat itself, it is essential for the maintenance of other habitats, including terrestrial and marine habitats. Some of the fish and other fauna and flora that exist in watercourses and bodies are food for terrestrial creatures, and a part of the web of nature. Similarly, influx of fresh water is essential for maintenance of coastal ecosystems and for the prevention of salt water ingress. Fresh water is also essential to maintain the brackish water ecosystems in the coastal regions. Pollution and erratic flows and levels are issues here also.

## B. MAJOR ISSUES

Of the issues listed above some, like the maintenance of water quality, are being dealt with in other papers. Consequently, there will only be a passing reference to them here. However, there are three other issues that are discussed in detail here.

- The maintenance of water levels and flows, spread appropriately over seasons and areas.
- Prevention and mitigation of the impacts of water management projects on biological diversity.
- Prevention and mitigation of other environmental impacts.

### 1. Maintenance of water flows and levels

Natural ecosystems, if any such remain, have in-built regulatory mechanisms to maintain water levels (in water storage bodies) and flows (in waterways like rivers and streams) to an optimum level. It has been established that careless or uncontrolled intervention into the processes of nature can have serious adverse impacts on human societies, both directly and indirectly.

Studies have shown that dams and other projects that alter flows and levels have at least the following impacts on aquatic ecosystems:

"1. HYDROLOGY: Altered – temperatures, water chemistry and nutrients, sediment transport and deposition, and the big one reduced flow patterns (hydrographs) – substitutes daily and hourly fluctuations for seasonal ones;

2. AQUATIC BIOLOGY: Altered – habitats (reduced), species composition (favours introduced species at the expense of native ones and reduces species composition and diversity and dried up spawning areas;

3. AQUATIC ECOLOGY: altered-primary production and nutrient cycling, reduced species diversity and simplified food chain and reduced primary production in the long term

4. TERRESTRIAL HABITAT AND SPECIES: altered – riparian habitat, generally reduced species diversity or replacement by non-natives; the old riparian community is left high and dry and replaced by a new one at a lower elevation due to "reduced flows and lack of seasonal flood flows"; terrestrial species that were dependent on the habitat and food sources associated with the old flows (pre-DAM) are generally adversely effected and reduced in population and habitat distribution or replaced by non-native species. "

[Source: Phillip Harrison, Chief Ecologist, Ecological Information System]

Consequently, it is important to carefully understand the limits to the manipulation of water levels and flows, without triggering off, sometimes irrevocably, undesirable consequences.

1.1 Manipulating water flows

Essentially there are at least three ways in which human beings can manipulate water flows and levels.

a) At the source

The source could be snow and ice melt, underground aquifers, or rainfall. Both directly and indirectly, human actions can

change the nature of the first two sources, namely snow and ice melts, and aquifers. Such areas are found mostly within India and Nepal, and form an important source for much of the water that flows through these countries and into Bangladesh. Estimates suggest that between 40% to 60% of the waters in the Himalayan rivers are derived from glaciers. According to one estimate, the ice volume of Himalayan glaciers is approximately 1400 cu. km. of ice, or 175 frozen dams of the size of Bhakra.

However, glaciers and snow bound regions have, in recent years, been threatened by various human activities, especially by the construction of roads. As these areas are also usually along the international borders of these two countries, especially along the border with China, there are understandable security compulsions. However, the manner in which road networks are being built needs to be changed so that the source of some of the major rivers are not unduly disturbed. Deforestation and the consequent changes in microclimate have also taken their toll of glaciers. Current trends at global warming would also adversely affect glaciers.

Human action can also interfere with rainfall patterns, though to perhaps a lesser extent.

b) <u>By diverting or otherwise modifying water run offs</u>

Where the patterns of rain fall, snow melt or aquifer recharge remain the same, the degradation of catchments and the independent or consequent modification of river beds and streams, can affect the patterns of run off from the catchments into major rivers and other water bodies. This can have at least two results:

- A seasonal change in water flows where, though the annual run off remains the same, the run off in some seasons go up and in other seasons go down. Where the seasonality matches human requirements, for example by enhancing dry season availability at the cost of wet season availability then,

as long as it does not have adverse ecological impacts, it can be considered a desirable outcome. However, very often degradation of the catchments and other unplanned modifications of natural ecosystems leads to the opposite, with heavy human and environmental costs.

- An absolute change in water flows where the amount of water flowing down the river system decreases (or increases), in absolute terms. In such cases the desirability of the change would depend on the impact it has on the environment and whether it better meets the social requirements. However, to properly assess the impact of such a change, the environmental impact of enhancing or reducing the water must be comprehensively looked at. For example, if water is withdrawn from a watershed and diverted to another, or allowed to evaporate, then the impact on the receiving watershed, or on microclimate, must also be assessed.

Road building activities, quarrying, mining, other construction activities and deforestation are also affecting the watercourses that criss-cross the Himalayas and feed the great rivers of the plains. Most significantly, the silt and debris coming down these watercourses are increasingly leading to destruction of the aquatic ecosystem.

Another threat to water flows is diversion. Such diversion might not involve the transfer of water to some other ecosystem but only its 'interception' for human use, putting it back into the same ecosystem, after use. Such interception' often results in fluctuating flows and ieveis, and also in an adverse change in water quality. In some cases, like in diversion tunnels for `run-of-the-river' projects, it can mean the drying up of whole stretches of the riverbed.

Apart from water flows, changes in run-off patterns also mean changes in the silt and nutrient loads of a stream or a river. The consequences of this also need to be studied.

c) By artificial storage

For many years now, human societies have endeavored to optimize water flows by building artificial storage structures like dams. In their design they are supposed to optimize water flows to suit human requirements. The storage is also used to generate electricity and divert water through channels for irrigation and other purposes. Where such projects are well planned and executed, they can contribute to an optimization of water use by humans, through often with adverse environmental impacts. However, where they are inappropriate, their impact on the human society and on the environment can be disastrous.

## 2. Conservation of Biodiversity

As river valley projects and some other water management projects take a significant toll of biodiversity resources, both upstream because of the impoundment and other project related activities, and downstream because of changes in water flows, it is important to mitigate such adverse impacts.

### 2.1 Assessing Impacts on Biodiversity

The impact of river valley and other water management projects on biodiversity needs to be assessed at the following three levels:

a) At the level of **genes**. This means assessing the impact on the variability of genes within species, in terms of each population being large enough to be genetically viable. It also involves assessing what would be the impact of the project on populations of various species of flora and fauna, and consequently its impact on the genetic viability of each species.

b) At the **species** level. This means assessing the impact on the variability of species: assessing what would be the impact of the project on the existence of each of the species in the area, and consequently its impact upon the diversity of species.

c) At the **ecosystem** level. This means assessing the impact on the variability of ecosystem types : assessing what would be the impact of the project on the existence and viability of various ecosystem types in the region, and consequently its impact upon the variability of ecosystems.

Where the species and ecosystems affected are not endemic to the region, or otherwise threatened or endangered, the impacts might be restricted to the specific region. However, if any of the species or ecosystem types are either endemic or generally threatened or endangered, the impact of the project would be felt nationally, regionally and possibly globally.

In assessing the impacts on populations, species and ecosystem types, it is not only the primary impact that is important but equally important is the secondary impact. When any one species or ecosystem is affected, it has an impact on other species and ecosystems which are interlinked or dependent on it. Consequently, no impact assessment is complete unless it is a holistic one.

2.2 Importance of conserving biodiversity:

The importance of conserving biodiversity is well recognised today. First, biodiversity needs to be conserved to protect the possible options available to humanity for improving its lot and for solving some of the major problems that it faces. Most significantly, the maintenance of wild biodiversity is especially crucial for food security, as all domesticated plants and animals that human beings use come originally from the wild. Added to this, the current "green revolution" technology, with its inherent component of plant breeding, also requires access to wild species for constructing new and improved varieties of crops and for ensuring genetic renewal of currently cultivated strains.

Access to wild genetic stock is also required to ensure that pests and diseases of domestic and cultivated species can be effectively neutralised through genetic engineering.

Given the ongoing changes in the environment and potential threats from global warming and the depletion of the ozone layer, humanity has to secure itself against changes in the biogeographic and agro-climatic regimes.

It needs continued access to wild genetic resources in order to replace those cultivated and domestic species that might become nonviable due to these changes.

Also, as a base for new medicines and for other gains from bio-technology, wild biological resources are critical if humanity is to progress.

Species and ecosystems are dependent on each other. If one species becomes locally or globally extinct, its impact is invariably felt by other species, setting off a chain reaction which can sometime prove disastrous for ecosystems and for agricultural activities.

As the extent of wilderness areas in the country shrinks, it becomes progressively more important for each of the remaining wilderness areas to be properly evaluated and assessed in terms of their biodiversity.

2.3 Measures for Prevention Mitigation

Biological resources, especially after the signing of the Convention on Biological Diversity, have also become a significant economic resource. Given the fact that this region is among the richest in the world, in terms of biodiversity, it would be to each country's advantage of its biodiversity was catalogued and conserved.

Some of the biodiversity resources in the region would be endemic to the region but perhaps common to more than one country in the region. It is critical for these countries to safeguard their economic and financial interests by combining together and for forming a biodiversity cartel. Given the fact that biotechnology, promises to be the technology of the future, conservation and joint action for marketing biodiversity resources could be of significant economic benefit to the countries of the region

## 3. Preventing and Mitigating other Environmental Impacts

Dams, especially large dams, are examples of water management project with the maximum adverse impacts on the environment. These include:

Upstream of the dam

1. Degradation of the catchment.
2. There is also the threat of backwater build-ups and consequent floods and destruction

3. 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:

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

Downstream

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

Command Area

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

Over the years such storage projects have begun to be seen as one of the great threats to sustainable environmental management. This is primarily because there has been inadequate planning, poor investments in preventing

and mitigating environmental impacts, and indifferent implementation. This has led to growing public opposition to dams, especially from the upstream population who get displaced because of the dam, and from those who are going to suffer the adverse environmental impacts of such projects. People concerned about sustainable development and about social justice have also protested against such projects, usually because such projects are either not assessed properly and their viability is questionable, or because there is a lack of concern for environmental and social issues.

Though the debate on dams, especially large dams, is too well known to need repetition here, it would be in place to mention some of the major issues.

3.1 Protection and regeneration of catchments

Deforestation in the catchments is perhaps the one single greatest threat to the water systems of north and north eastern India, Nepal and Bangladesh. Such degradation adversely affects seasonal water flows, allowing much greater run offs during the rainy season and a consequent shortage of water during the dry season. Degradation of catchments also means much greater silt flows in the streams and rivers, thereby lowering the life of reservoirs, threatening hydro electric turbines, silting-up river beds and contributing to the incidence and extent of floods. In many catchments the top soils have been washed away and what is coming down the streams is rubble and silt. This is adversely affecting the prospects of agriculture in the flood plains of the rivers.

The forests and the catchments are not only affecting the life and well being of irrigation and hydroelectric projects, but are also being adversely affected by them. When river valley projects submerge fertile land and, usually the best, forests, in the valleys, the economic and biotic pressures that these lands and forests supported get transferred to the surrounding areas. Such transfer pressures, along with growth in population and in economic activities, that river valley projects usually bring to an area, lead to a rapid degradation of the remaining forests in the catchments.

This degradation of catchments adversely affects the lives of the local communities dependent on these catchments who, in turn, adapt more and

more sustainable ways of meeting their basic needs, that being the only survival option left to them.

Also, during the construction of the project itself, and subsequently because of heightened economic activities in the area, greater pressure is put on the catchments. The construction of roads and buildings, the significant increase in dust pollution levels, blasting and noise pollution, changes in the micro climate, increased population pressures because of construction, and other disturbances related to the project, all take their toll of the catchment.

Therefore, the protection and regeneration of catchments must be a very important part of any water management strategy and, given the implication of degraded catchments for all the countries involved, it could well be an area of joint concern and action.

3.2 Cost Sharing

Considering the benefits of such catchment treatment that the countries down stream would share, especially the favorable water availability and flows, it is only fair that the costs of such treatment also be shared on a proportionate basis.

Attracting donor and multilateral funding for such projects, especially under some of the new funding mechanisms created for the environment, would be much easier if it is seen to be a collaborative exercise between two or more countries of the region. Though this might raise certain difficulties relating to sovereignty and a nation's right to self determination, it is possible to sort out such difficulties and still have a workable model for regional cooperation.

3.3 Looking at options

Considering the inevitable environmental and social impacts of such projects, it is desirable that these projects be taken up only where no other strategy is possible. Unfortunately, there has been a tendency to look at dams as the first option and in fact to try and dam every river, as long as it is technically feasible. The proper strategy would be to look at the needs that are sought to be met by constructing a dam, and to first investigate whether there are alternate methods available to meet these needs. Where no better,

alternative methods are available, then a dam must be considered but only if it realistically offers substantially greater benefits than the various costs.

3.4 Cost Benefit Analysis

Historically, even where a cost benefit analysis has been carried out, it has focussed almost exclusively on financial and economic costs. It is important for social and environmental costs to be realistically measured and included as a part of the over all cost benefit analysis. Besides, as our region is a region of significant social inequities, another dimension that must be evaluated when such projects are planned is whether the project would promote equity. If the costs of the project are to be borne mainly by the poor, as often happens, and the benefits are to go primarily to the relatively rich, then the project is clearly not promoting equity. What is perhaps needed is a 'class benefit analysis' which assesses projects in terms of the class of people who lose and gain. So, projects where the costs are being paid by the poor and the benefits go to the rich, however attractive it might be in simple financial and economical terms, must be discouraged.

It is also not desirable to do an assessment of the project from the either/or stand point. That is to say, the assessment should not be on the basis of the costs and the benefits of either having the project, or not having anything. Any meaningful cost benefit analysis must determine the optimality of the strategy from among multiple strategies. Even where building a dam has been established to be the best option, multiple designs, locations and sizes of possible dams must be compared.

3.5 Viability

Notwithstanding all this, even if a dam is the best alternative, it should only be built when its environmental and social costs are found to be acceptable. Nonviable projects, even if they are the best alternatives, do not promote national and regional interests.

Given the difficulties in realistically calculating, especially in economic terms, environmental and other social costs, a project must built into its financial costs the resources required to do all that is necessary to prevent and mitigate environmental and social costs.

A primarily economic approach to the assessment of such projects is not an acceptable approach. In such an approach, by allocating financial and economic values to elements of the environment and to aspects of social costs, it is argued that it is "cheaper" to let the environmental and social costs occur, than to prevent or mitigate them. However, as already mentioned, the ability to properly capture environmental and social costs in financial and economic terms is severely limited. Consequently, such an approach invariably leads to an undervaluing of the real costs of a project.

3.6 Sectoral Approach

Perhaps the real reason why river valley projects have rarely been designed and implemented in a manner such that their costs are minimal and their benefits optimum, is the sectoral approach that prevails in our countries. The power or water resources departments whose main, sometimes only, interest is to produce as much power as possible and to irrigate as much land as possible usually implement river valley projects. However, both the costs and benefits of such projects go beyond the power and irrigation sectors. The correct approach would be to consider a dam as a multi-sectoral project which has costs and benefits relating to at least the following areas:

i) Power
ii) Irrigation
iii) Drinking water supply
iv) Domestic and municipal water supply
v) Industrial water supply
vi) Flood control
vii) Forest and environment
viii) Health
ix) Social and tribal welfare
x) Agriculture
xi) Tourism
xii) Water transport

A project must be designed in a manner where the benefits for all these sectors are optimized and the costs shared between them. Therefore, for example, it might often be in national and regional interest to curtail the

benefits of power or irrigation in order to enhance some of the other benefits or minimize some of the other costs. The process of optimization must not be only a financial or economic one for, as already mentioned, the costs and benefits of some of these sectors are more effectively captured in financial and economic terms than of others.

3.7 Regional Approach

As both the costs and benefits of such projects affect the whole region, a regional approach is desirable. For example, if there is excessive submergence of forests in the upper catchments and the consequent or parallel degradation of catchments, the impact is felt not only in that specific country but also in downstream countries. Similarly, loss of biodiversity in the region not only impoverishes all the countries of the region, but also the world. Even dislocation and impoverishment of tribal and rural populations in one country can pose significant economic and social pressures on neighboring countries.

3.8 Public Perception

Also, if after following all the required steps, the optimum strategy for handling the water resources of the region involves the construction of some dams, it is likely that there would be significant social protests against such a strategy. In order to meet with the genuine concerns of such protestors, it is important that advance planning and implementation be taken up in the region. This could involve, for example, identification of potential sites where the dams could be built and advance action for assessing the social and environmental impacts and for regenerating and protecting the catchments of these sites.

It is important, if public confidence is to be built, that the planning, assessment and implementation of such projects be done in a transparent manner.

## C. FUTURE DIRECTIONS

### 1. Environmental Impact Assessment

As already mentioned, the assessment of specific water management projects must be comprehensive, especially in terms of their environmental and social impacts. In fact, with the mounting pressure on countries to move towards an environmentally sustainable model of development, it has now become essential to do an environmental and social impact assessment not only of specific projects but of the strategies and policies that these projects represent.

Just as the optimality and viability of specific projects must be established, so also must the optimality and viability of policies and strategies. The need for dams, especially large dams, in an optimal and sustainable strategy for the management of water resources, is questionable.

The major constraints to such an assessment of our water management strategies are perhaps five:

1.1 Technological mindset

A highly trained cadre of technical experts whose focus is on a particular strategy and who are not equipped and sometimes not willing to consider and adopt alternate strategies.

This is especially true of some civil engineers who have been trained to make dams and believe that bigger the dam, greater the technological achievement. It is difficult for them to seriously consider alternate ways of managing our water resources.

The problem is exacerbated by the bureaucratic and technocratic tendency to work within the narrow confines of specific disciplines and sectors, without allowing a cross-fertilisation of ideas and approaches. Modern science has also taught some of us to be dismissive of traditional and local community knowledge, which is often categorised as unscientific and superstitious.

Clearly, there are answers to the problems of the society in both modern sciences and technology, and in traditional and local wisdom. Bureaucrats and technocrats must be made sensitive and open to this fact.

1.2 Prior investments

Unfortunately, even if a country decides to alter its strategy for the management of water resources, another inhibiting factor is that at any given time there are a large number of unfinished river valley and other water management projects of the unsustainable variety. Any decision to make the strategy more sustainable would mean abandoning these unfinished projects. This would mean both financial losses and lost opportunities. Even where national governments have recognised the need to change their strategies, they have not usually found the political will to cut their losses and write off these costs as bad investments.

Perhaps what is required is a phased conversion from current, unsustainable strategies to new, sustainable, ones. For one, there should be a moratorium on the setting up of any new projects which, either themselves or in the strategies they represent, are unsustainable. Of the unfinished projects, an assessment must be made to determine which ones should be abandoned and which ones finished. It might be better to complete those projects where the social and environmental costs have already been incurred. For the rest, they must be written of as bad investments and the nation must cut its losses.

1.3 Technological constraints

A popular argument against alternative strategies for the management of water resources is that either alternate technologies are not available, or that those that are available have even greater social and environmental impacts.

It is perhaps correct that alternate technologies like small dams, catchment development, riverbed turbines, aquifer control and management, efficient recycling of water, etc. are not as widely tried and tested as the current large dam technologies. However, it must be recognised that technologies do not develop in a social vacuum. Technological development is motivated and fuelled by social

sensibilities and demands. As long as those who have been brought up to believe in the desirability of big dams are allowed to impose such dams on the society, there is little incentive for developing and perfecting other ways of managing our water resources.

However, if the resistance to big dams adequately changes social and environmental perceptions, then a situation might be created where talented young people will see their future in developing alternate technologies. Funding and other support for such research and development would also then become available. Therefore, the perpetuation of the big dam philosophy is in itself the single most powerful factor inhibiting the growth of alternate strategies and technologies.

As already mentioned, the governments of the world and this region should set a time limit by which this technology would be abandoned in favour of newer and better methods for meeting the water needs of a country. If such governments are seen to be sincere and serious about this moratarium, then many other viable alternatives will certainly become available.

An interesting parallel can be seen in the decision of the global governments to phase-out the use of ozone depleting substances like CFCs. Whereas initially it was feared that any effort to phase out CFCs would result in disastrous consequences to various sectors of the industry, the inevitability of the phase-out has resulted in new and less harmful alternatives being developed.

The argument that alternatives, like micro dams, collectively cause more environmental damage than big dams, is clearly misplaced. It might be true, given today's technological levels and the technological biases in favour of large dams, that to generate the same amount of power or to irrigate the same amount of land the area that needs to be submerged through micro dams might collectively be more than what is submerged by a big dam. However, the fact that in micro dams the submergence is not in one continuous area, concentrated in one region, but distributed in small patches, significantly minimises

their impact. For example, even though the areas of land submerged collectively through such micro projects might be greater, it almost never results in the dislocation of many villages. Even if some houses or the whole village has to be shifted, at best it just shifts a few hundred yard without any significant social trauma. Similarly, even where a portion of forest is submerged under such micro projects, it is usually such a small part of the existing forest that the impact on biodiversity and on the general ecosystem is almost negligible. This is in contrast to big dams.

To take an example, if a thousand motor vehicles are spread out over a thousand sq. kms., they would have a much less impact on human health and the environment than if you have five hundred motor vehicles in one sq. km. Admittedly, given the present state of alternate technology, the financial returns on investments might be greater in large dams than in small ones. However, with improvements in alternate technology, this can change. Also, big dams might today represent greater financial returns but they also represent huge social and environmental costs.

1.4 Short-term versus long term benefits

The so-called developing countries, in their haste to catch up with the "developed world", feel that time is passing them by. They persuade themselves to believe that they do not have the option to look at medium and long-term strategies but only to fight fires that are currently raging. Whereas in a few extreme situations fire fighting is clearly a priority, for much of the time the interests of the country and the people would be far better served if medium and long term strategies were developed and adopted. The fact that countries in the region have followed unsustainable short-term approaches for the last many years without solving any of their fundamental problems, should be proof enough of this.

Instead of thinking about how they can get the maximum in the next year, or the year after, without worrying about whether such a process of maximisation compromises future options, they should

focus their sights on what they would want to be like, 50 years from now. They should then work their way backwards to see what inputs would be required this year, and the next, and the year after, if in 50 years the country is to stabilise in social and economic terms. This would not only ensure that the minimum basic needs are met, but would also energise the nation. The people would see a hope for a better future and thereby be more willing to put up with some of the shortages and deprivations that are in any case a part of their destiny. Clearly, any vision for the medium or long term could not accommodate unsustainable projects.

## 2. Economics and the Environment

Till recently, environmental costs were never taken into consideration in the national planning exercises. This is because planning is done primarily in a financial and economic context by financial and economic experts. However, natural resources are the most fundamental of human resources, certainly more fundamental than economic resources.

Given the rapid environmental degradation of the last two decades, many countries began to realise that unless they reflected the state of the environment as a part of their assessment of the nation's growth and economy, they would presenting a false picture, or at best an incomplete one. In fact, motivated by such an understanding, the Govt. of India in its policy statement on sustainable development, undertook to present before Parliament, each year, a natural resources budget.

At the behest of the World Bank, the Govt. of India and other governments in the region prepared a National Environmental Action Plan (NEAP) and were signatories to Agenda 21. Both these documents further reiterate the commitment of these governments to move towards a model of sustainable development. But, there is little action on the ground.

In countries of the North, environmental economics is now a popular and fast growing discipline. Unfortunately, the models developed in these countries are not appropriate for this region. Despite this, there has been a concerted effort by various countries of the North and international agencies

to pursuade 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.

The current process of developing natural resource accounts has many problems. Some of them are outlined below:

a) 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.

b) 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 an input into, or an output of, an economic process. Much of nature, critical as it is to human survival, is not an input into 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.

c) 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, those very species might, if they survive, 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.

d) Though this is a handicap all over the world, its implications are far more critical for countries of the South, than for the North. Whereas in the Northern countries there is already a high value attached to natural resources even for those functions, like recreation, which can to some extent be measured in economic terms, this is not so in countries of the South. Therefore, if decisions regarding the use and destruction of nature and natural resources in the South are to be made on the basis of the financial value attributed to such resources, it would be very difficult to conserve and protect anything.

e) 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 economic basis.

f) There is also a tendency in governments dominated by imperatives for economic growth, to systematically undervalue the role of natural ecosystems. 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 inputs. However, the economic value attributed to forests never reflects this miracle of productivity and renewability.

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 to maintain 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 on the basis of 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.

## D. CONCLUSIONS

To manage the water resources of the region in an optimal and environmentally sustainable manner, the countries of the region should collaboratively:

1. Protect and regenerate the water sources and catchments.
2. Comprehensively assess the environmental and social impacts of water management strategies and projects.
3. Decisively abandon short term, unsustainable, strategies and projects.
4. Develop an appropriate method of natural resource budget and accounts, which can help to determine the real water management priorities.
5. Treat the region as a holistic ecosystem where environmental costs and benefits transcend national boundaries and need, therefore, to be looked at accordingly.
6. Recognise that in the proper management of the environment, especially biodiversity, lies great economic possibilities for the region.