RESEARCH PAPER

Social and Environmental Impacts of Large Dams in India

Shekhar Singh

RES/DAM-EIA/2003

RaaG

Research, Assessment and Analysis Group

Scripted in 2003, when Shekhar Singh was Director, Centre for Equity Studies, Delhi. This paper is a modified summary of "Environmental and Social Impacts of large Dams in India" by Shekhar Singh, Raman Mehta, Vishaish Uppal, Asmita Kabra, Bansuri Taneja, and Prabhakar Rao, in Shekhar Singh and Pranab Banerji (Ed.), *Large Dams in India: Environmental, Social and Economic Impacts,* IIPA, 2002. This summary has subsequently been edited and published in *The Ecologist*, vol. 11, no. 1, January-March 2003.

The sketch above and on the cover is by Pratibha Pande.

Dams have both intended and unintended impacts which can be positive or negative. However, it is unlikely to find intended negative impacts, though positive impacts can be both intended and unintended. Each of these types of impacts can be inevitable in their entirety, reducible or totally avoidable.

Most adverse social and environmental impacts of large dams were, till recently, ignored. Even now, such impacts are only partly reflected in the project's financial and economic analysis. While a financial analysis might reflect the direct costs of reforestation, catchment area treatment or of relocating and rehabilitating project affected persons (PAPs), many other costs remain unacknowledged.. Also, many of the environmental and social costs do not lend themselves easily to financial quantification.

Social impacts are the overarching impacts, while all economic and environmental impacts also have social impacts. However, whereas economic impacts can all be seen as having essentially social impacts, environmental impacts affect not only the human society but also other elements of nature.

Social Impacts

Beneficial Social Impacts

The major beneficial impacts of large dams are captured in financial and economic terms and, as they are widely known, they are not being discussed here. There are, however, other benefits that are not usually included in an economic analysis of dams. These include:

Beneficial Impacts Upstream of the Dam

One major beneficial impact, upstream of the dam, is the added biomass, enhanced water availability, incomes, and ecological security, and restored micro-climatic conditions, that follow for the local communities from the restoration of degraded

catchments. For almost all the projects approved after 1980, there is a requirement to treat severely degraded catchments.

Beneficial *Impacts at the Dam/Reservoir*

The reservoirs created by large dams often become tourist attractions. As per the data available, there are at least fifty reservoirs that have also been made into national parks or sanctuaries and, consequently, not only contribute to wildlife conservation but also serve as tourist resorts.

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

Beneficial *Impacts Downstream of the Dam*

Dams, by intent or otherwise, sometimes play the role of regulating floods.

In areas that are water deficient, the provision of surface water and the enhancement of ground water, because of the canals, can significantly improve water availability, sanitation and hygiene.

Adverse Social Impacts

Impacts of Displacement[1]

Among the most significant adverse social impacts of dams are those that result from forceful (or involuntary) displacement of human populations from their homes, fields, towns and regions.

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

This has many specific impacts, which are described below. As a part of the case study, the rehabilitation packages and details for 47 dams were studied.

Apart from the displacement because of the dam itself, canals and other dam structures and infrastructure also cause displacement. Often the rehabilitation packages and processes of those affected by canals and other works are even worse than of those affected by the main dam.

Some of the major issues and problems regarding rehabilitation packages and processes are listed below.

- **Eligibility:** Though the family is the unit eligible for compensation and rehabilitation, it is defined differently in different projects. Some (eg Upper Kolab, Orissa) define it as all those living under the same roof or sharing a common kitchen. This is detrimental to joint families, as 20 or 30 people could receive the compensation that is due to one family. Other projects define a family in terms of the eldest surviving male, in whose name the property is. However, in many tribal areas, land and property remains in the name of the eldest male as long as he lives, without being divided among the sons/daughters or grandsons/granddaughters. In the case of the Loktak project, the family unit was considered in terms of all married males, discriminating against women and unmarried sons. This is gender insensitive. Also, the cut-off date to determine adulthood is usually when the first notice is issued, even though rehabilitation may take place years later.

Apart from the definition, there are problems relating to the application of these criteria: the most common complaint being that a large number of eligible people are left out and sometimes ineligible people included.

- **Loss of Common Property Resources:** Rarely are attempts made to compensate for the loss of common property

resources. Most displaced populations rely on free access to water, grasslands, forests, wetlands, riverbed land, fish etc. They derive incomes and subsistence from a host of natural resources, many of which may be unavailable at the rehabilitation site.

- **Loss of Cultural Sites:** Displacement causes cultural and psychological trauma due to the severing of cultural and religious links with ancestral surrounds. With a few projects, some temples were relocated or fresh places of worship were constructed, but in most cases there was either no compensation or only a monetary compensation. (Rs. 500 per temple in Warna, Maharashtra).
- **Loss of Home:** The forced abandonment of one's ancestral home is always traumatic and cannot be fully compensated for by a new house. In only five of the projects studied was it proposed to provide a replacement house. In one, Pipai (Rihand) in Uttar Pradesh, it was proposed to construct houses for all those who lost houses. In the four others, Konar, Maithon, Panchet and Tilayia, some people were to be given houses; others would get land and cash. Of the 47 projects studied, 11 promised land for homes. Another seven promised partly land and partly cash. Another seven offered a choice, while 11 offered only cash. The rate at which a house was compensated for varies but is never the true replacement cost.
- ***Loss of Preferred Livelihoods*:** The forced change of occupation and livelihood resulting from displacement can be a source of significant trauma as people are forced to adopt a profession they are not trained or suited for. To become a shopkeeper or vendor after being a first-class farmer or artisan takes a toll on an individual's self-value.
- **Impacts on Health:** The change in climate, water, food, and sanitary conditions, etc. can affect the health of displaced persons. In the case of the Pong, Bhakra and Pandoh dams,

people living in the hills of Himachal Pradesh were to be relocated to the Rajasthan desert. Similarly, people displaced by the Tehri dam have been shifted from the hills of Garhwal to the hot plains of Uttar Pradesh.

- ***Conflicts with Host Communities*****:** *Rehabilitation sites usually come up near existing settlements, causing tensions and conflicts between the host community and the displaced persons.*

- ***Process of displacement:*** *There are many complaints about lack of information, wrong and misleading information, inadequate warning and notice of impoundment, lack of information about the processes of relocation and rehabilitation, lack of assistance in the process of relocation, and of secrecy, corruption and incompetence.*

- ***Quality and quantity of land:*** *Perhaps the largest number of complaints are about land being uncultivable, non-availability of irrigation, poor soils, and the quantity of land being less than entitlement or scattered.*

- ***Availability and adequacy of other inputs:*** *There are many complaints that cash compensations are delayed, often not given till bribes are handed out, or inadequate. Other facilities are also often reported to be non-existent, delayed, inadequate or of bad quality.*

- **Follow up and grievance redressal:** Another common complaint is that once the initial shifting takes place there is no system of monitoring and correcting problems or of redressing the grievances of the displaced populations.

The high social costs of dam projects can be attributed to the fact that as things stand, the legal framework in India does not require that:

- The social impacts of a project are comprehensively

assessed and the project sanctioned only if socially viable.

- Social costs are adequately computed and included in the cost calculations of the project before its economic viability is assessed.
- All possible measures for preventing social costs have been planned for and implemented (alternative sites, reducing dam height, etc.)
- The compensatory package upholds basic principles of rehabilitation to ensure that people are not worse off after relocation.
- The package ensures that they are not forced to change their way of life or profession and that their traditions and culture are respected.
- The package includes compensation for all losses, not just in cash but also in kind.

This absence of legal and policy directives makes it difficult for affected people to fight for their rights. It also makes it difficult to ensure that compensation packages are uniform across regions and meet basic requirements.

THE NUMBERS GAME

Himanshu Thakkar, in his paper on displacement for the World Commission on Dams, says: *"Displacement due to dams in India has been variously estimated. Fernandes, Das & Rao (1989) claimed a decade ago that Indians displaced by dam projects numbered 21 million. As the authors themselves pointed out, these were very conservative estimates. A recent statement by Shri N.C. Saxena (the then Secretary, Ministry of Rural Development, Government of India) however put the total number of persons displaced due to large dams at 40 million. He said in an open meeting that most have not been resettled. Roy (1999), based on a survey of 54 projects estimated the people displaced by large dams in the last 50 years to be 33 million*

"The compilation of figures in the present study shows a total of 4,387,625 persons displaced by the 140 large and medium dams included in the survey. The average for these 140 dams thus comes to 31,340 persons per dam. "

We have also attempted an estimate on total area submerged. As per our calculation, in the 213 dams for which this information was available, the average area submerged per dam was 8,748 ha. This estimate is extremely conservative, as a study of 11 dams between 1978 and 1988, done by the World Bank, and quoted by the Central Water Commission, records that submersion per dam was 13,000 ha. A CWC study of 54 projects shows a per dam submergence of 24,555 hectares per project!

If one takes the average of the 83 dams for which we have both submergence data and the number of people displaced, the average submergence per dam comes to 16,604 ha. Comparatively, our estimate of 8,748 ha per dam is conservative.

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

The total number of large dams built or under construction, according to the Central Board for Irrigation and Power (CBIP), is 4,291. Therefore, as per our calculations, the total submerged area is 4291x 8748 ha, which is a whopping 37,53,7668 ha (over 375,376 sq. km.). Using the average of 1.51 persons per hectare, the number of people displaced would be an astounding 56,681,879 (approximately 56 million six hundred and eighty thousand). This could be an overestimation, however, given the hesitation of the government to make data available,

it is the best estimate that can be made. In any case, what it does establish is that the displacement figures cannot be anywhere as low as suggested by some official sources. Moreover, these figures do not necessarily include displacement by canals, colonies, resettlement programmes or other infrastructure.

Impacts on Equity

Changes in the equity status can be measured:

- Between human beings of the same generation (Intra-generational Equity), which can, in the case of dams, be primarily between and among those who lose (mainly the upstream populations) and those who gain (mainly the populations in the command and the recipients of electricity).
- Between the beneficiary generation and future generations (Inter-generational equity).
- Between human beings and other species (Inter-species Equity).

- **Intra-generational Equity:** Generally speaking, the upstream population, who are either displaced or otherwise adversely affected, pay most of the costs of dams. Most benefits flow to the downstream populations, especially those who benefit from irrigation and power. Very often the upstream populations, mainly tribals or other forest communities, are resource rich but without high monetary incomes. The downstream populations are relatively resource poor but with higher monetary incomes. The construction of a dam takes away the resources of the resource rich community and impoverishes them, not even giving them high monetary incomes. It, on the other hand, enhances the incomes of the downstream landed class, who are already in a higher income bracket.

Tribals and Scheduled Castes: One indication of this type of inequity is the proportion of tribals and members of scheduled castes displaced by large dams. From the dams for which such data were available, nearly 45% of the population displaced were tribals and members of the scheduled castes. Considering their population nationally is only a little over 24.5%, clearly their representation among those displaced was disproportionately high.

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

Beneficiaries of Power: Dams mainly produce peaking. The main peak demand comes from the urban domestic sector. Consequently, much of the electricity produced by the dam goes into the grid and is then primarily used (or stolen) by the well to do populations in urban areas. Consequently, the dam promotes inequity between them and the poor and disadvantaged, who receive none or little of the benefits but pay much of the price.

Further, according to the Planning Commission, the subsidies to the agricultural and domestic power sector in 1997-98 were a whopping Rs. 22,216 crores. The losses by the state electricity boards (without subsidy) were Rs. 10,684 crores. These subsidies and losses also come mainly out of the pocket of the common man and woman in India, but the benefits go mainly to the rich in the urban and rural areas.

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

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

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

However, traditionally, irrigation planning has been done mainly by men, for men, and the role of women in the irrigation system has been ignored. The fact that in India women very rarely have ownership rights over land does not necessarily mean that they do not work as farmers or users of irrigation.

Unfortunately, in none of the projects studied was there any mention of granting explicit and direct water rights to women, or of differential gender requirements, nor was there any effort to address these. Consequently, the net impact of large dams on women in the command area can be seen as adverse.

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

Landless Labour: An increase in cropping frequency as a result of assured water supply can lead to higher employment generation for the landless labour in the command areas, but a change in cropping pattern in favour of more capital intensive and labour displacing crops can reduce employment opportunities.

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

Another factor that worsens equity between head and tail reaches is the countrywide tendency of spreading of available financial resources among a large number of projects. As a result, for a number of projects, a severe resource crunch affects the extension of irrigation facilities to far-flung areas of the command, and expenditure on Operation and Maintenance (O&M) activities.

Inter-generational Equity

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

The sustainability of dams, in this sense, has not been looked at for any of the projects being surveyed. However, the fact that many of them have significantly adverse environmental impacts means that as they are currently designed and constructed they adversely affect the equity status between the beneficiary generation and future generations.

Inter–species Equity

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

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

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

Conclusions

Interestingly, in India there is no process by which the equity impacts of dams are assessed. This absence by itself highlights the low priority that equity issues are given by the government, as far as dams go. While conducting an economic assessment of dams, there is neither a requirement nor a practice to give weights in order of equity. None of the dams studied had any such assessment, where costs to be borne by the poor were given a higher weight than those borne by the

rich, and the benefits going to the rich were given lower weight than those going to the poor. The cost benefit analysis of all the dams studied equated the costs, whoever paid them, and the benefits, whoever received them. No class-benefit analysis, or an equity impact assessment (EqIA) as Amulya K.N.Reddy calls it, seems to be required while assessing the viability and optimality of a dam.

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

- Project need and optimality must first be assessed and established.
- The "project affected persons" (PAPs) must not, with the project, be worse off, in any tangible terms, than they were prior to it. In fact, they must invariably be better off, so that they are at least partly compensated for all the intangible and non-quantifiable losses.
- Whatever their status prior to the project, they must, in economic terms, be above the poverty line with the project.
- While determining compensation, replacement value at the operative market rates must invariably be the basic principle.
- Also, not only should lost property and assets be compensated for, but lost livelihoods and lost opportunities should also be compensated for.
- However, it is not enough to just pay cash compensation, various other principles must be followed to ensure that social costs are minimised.
- The principle of 'land for land' must be followed scrupulously and each PAP who loses land must be given land of equal size and of at least equal productivity.

- Usually the project authorities must also construct or have constructed appropriate replacement housing for the PAPs.
- The process of selecting rehabilitation sites and lands must involve the PAPs and their preferences must seriously guide the final selection.
- Agricultural land must be consolidated, as far as possible, and communities kept together, after displacement, so that their social and cultural identities are safeguarded.
- As far as possible, displacement should not be forced and people should be made to feel that, despite inevitable losses, they are on the whole going to be better off and therefore should not resist displacement. There is also a growing demand that prior informed consent of the community is taken before any project, including a dam project, is approved.
- Whereas it must be ensured that PAPs are not forced to change their occupations and professions, there must, of course, be the flexibility to allow individual PAPs to choose from among other viable alternatives.
- The PAPs must also have a first right to get employment in the project.
- The PAPs must also have the first right to irrigation waters from irrigation projects and to power from hydro-electric projects, and to both in multi-purpose projects.
- The definition of PAPs who are entitled to receive compensation must include the land-less, those who are tenants, agriculturists, adult unmarried daughters and sons, adult married sons, and widows, divorcees and women abandoned by their families. All those affected by any of the works or activities related to the dam must be treated as PAPs.
- Rehabilitation packages and processes must be gender sensitive.

- The special needs of particularly vulnerable communities, like isolated tribal groups or other marginalised groups, must be catered for.
- The plight of those who have been affected by earlier dam projects must be recognised and they must be properly rehabilitated and compensated on a priority basis before any further dislocation and displacement is effected.
- The provisions of an enlightened rehabilitation and compensation policy, as and when formulated, must have legal backing so that not only the concerned agencies of the government but affected and interested citizens can ensure enforcement and legal intervention.

Environmental Impacts

This assessment is based on a general study and specific assessments of over two hundred dams, of which 67 were studied in greater detail.

Beneficial Environmental Impacts

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

Beneficial Impacts of Catchment Area Treatment

For most recent projects, the environmental clearance conditions include the treatment of the catchment. Where this treatment is adequately undertaken and results in the regeneration of natural forests and other ecosystems in the catchment area, there are significant benefits to the environment.

Beneficial Impacts of the Reservoir

The creation of a reservoir provides a habitat to wetland species, especially water birds. The reservoir can also be a source of water to the animals and plants in the adjoining areas

and, where such areas have become unnaturally dry, this can be a significant environmental benefit. These benefits were not included in the cost benefit analysis for any of the projects studied.

Adverse Environmental Impacts

Impacts of the dam on the Catchment

The construction of a dam can itself contribute to the degradation of its catchments. For example, extraction of cooking fuel by the labour force and improved access to the forests, both during and after dam construction, degrades ctachment forests. The construction of roads and other infrastructure and the enhanced activities in the area also put an additional pressure on the forests. This results in greater silt flows into the reservoir, thereby reducing the life of the dam and also posing a threat to the safety of the dam and to the equipment and machinery installed in the dam. Degraded catchments also result in erratic water flows resulting not only in dry season shortages but also a serious threat of surplussing during heavy rainfall and cloudbursts, again threatening the safety of the dam. The degradation of the catchments also adversely affects the biodiversity value of the forests upstream and their other ecological functions.

After construction, where forests are submerged under the reservoir, the pressures on the remaining forests, mostly in the catchments, go up significantly. Also, where catchments get degraded, the local community's access to biomass is adversely affected. This often results in further degradation.

One common prescription to avoid the negative impacts of dams on the catchment and of degraded catchments on dams is the carrying out of catchment area treatment (CAT).

However, there are many problems with the current system of CAT.

- **Inappropriate treatment:** The major activity under CAT ought to be the extensive plantation and regeneration of vegetative cover. In order to ensure that trees survive and regeneration takes place, the factors that have led to the degradation of the catchment in the first place need to be minimised. For this to be successful, local communities have to be involved. However, this almost never happens. Consequently, even where treated, the catchments rapidly deteriorate to their earlier levels.
- **Delayed treatment:** To be effective, treatment of catchments must be completed prior to impoundment. Unfortunately, this does not happen and the considerable amount of silt thrown up by the treatment process itself along with that emanating from yet untreated catchments, gets deposited in the reservoir.
- **Treatment of inadequate area:** Recently, there is an increasing tendency of treating only the "directly draining" reservoir, a scientifically absurd concept, as against the entire catchment that is 'highly degraded'.
- **Problems of ownership:** Much of the catchment requiring treatment can be private land, where treatment can only work if the owners cooperate. However, most schemes do not cater for this.

Impacts of mining/quarrying for construction materials

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

Impacts of Backwater Build up

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

Impacts on Aquatic Ecosystems and Biodiversity

Construction activities, including the diversion of the river through a tunnel, have major adverse impacts on the aquatic ecosystem. In many cases, vulnerable species, with either limited distribution or low tolerance, become extinct even before the dam is completed.

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

Impact on Terrestrial Fauna and Flora

The disturbance caused by the construction activities, including the noise and movement, the building of roads, extraction of stone and soil, construction of buildings, etc. also negatively impact on the fauna and flora at the dam site. As impoundment starts, the reservoir invariably submerges large tracts of forests and other ecosystems, including grasslands and wetlands.

SUBMERGENCE OF FORESTS

Data were available regarding forest submergence for 60 dams. On the basis of these, the average forest area submerged per dam works out to approximately 4879 ha. Therefore, the 1877 dams built between 1980 and 2000 would have submerged 9,157,883 ha (roughly 9.1 million ha) of forests. The CWC has stated that, according to a study they did of 116 projects (details not available) the average forest submergence per project was 2,400 ha. Even if we take this to be the correct figure, the total submergence between 1980 and 2000 would be 4,504,800 ha.(roughly four and a half million hectares).

The most common mitigative measure prescribed is compensatory afforestation. However, available evidence indicates that "compensatory" afforestation is difficult to implement, and in some cases was not complete many years after completion of the project. According to the MoEF, the performance of state governments in raising compensatory afforestation has not been very satisfactory. Till 1997, only 46% of the area stipulated to be afforested had even been taken up.

Also, it is impossible to replace a natural forest by a plantation. Therefore, even if there is formal 'compensation' for the forests lost, in terms of forest area, the actual ecological and biodiversity losses that the destruction of natural forests imply cannot be so compensated.

Apart from forests, the reservoir and the dam also affect other ecosystems and various fauna and flora species. Unfortunately, till recently, there was little effort to assess the impact on flora and fauna and on non forest ecosystems. Even where studies were conducted, there was a tendency to consider only large mammals as 'wildlife'.

MITIGATING LOSS OF WILDLIFE?

Recommended mitigation included creation of bridges for the movement of elephants (Dalma - Subernarekha Project) and the creation of sanctuaries (Sardar Sarovar). In some cases it was suggested that there would be no impact on wildlife as they would migrate to neighbouring forests. For example, a study done on the impact of the Indira (Narmada) Sagar project on wildlife, by EPCO in Madhya Pradesh, suggested that the wildlife would either voluntarily migrate into neighbouring forests when impoundment took place or be driven there by squads of specially trained staff. Similarly, studies done in relation to the Tehri Project maintained that the fish would migrate and establish themselves upstream of the dam. For Rajghat Project, it is suggested that "The National Park at Shivpuri is also not far off. It is thus felt that there is ample scope for migration of the wild life to the adjoining forests and there would be no difficulty on this account". The CWC also states that "wild life could be shifted and rehabilitated. Birds will migrate on their own".

But do the animals and birds know this? And the areas where these animals would hopefully move into are not 'vacant habitats' available for occupation by displaced animals. They have their own complement of wildlife. Besides, wild animals are rightly wary of leaving their own territory, and panic-stricken when waters flood in. Some animals are nocturnal, others roam around during the day, others live underground or on trees and in caves. And wild life includes plants and insects and reptiles and micro-organisms. What of them?

Impacts on Cultivated Biodiversity

Reservoirs also submerge productive agricultural land in the valley. This not only has a social and economic cost but also adversely affects cultivated biodiversity and a host of birds, insects, mammals and reptiles that have adapted to agricultural

ecosystems. In many cases, traditional crop varieties and methods of cultivation disappear because of dams.

Impacts on Human Health

For reservoirs in the tropical regions of the world, especially those that are below 1000 m elevation, there is a significant threat of vector breeding. Mosquitoes, which are carriers of malaria, filaria, dengue and other such diseases breed in small pools of water created on the edges of the reservoir due to the lowering and raising of the water level of the reservoir. In some areas snails, which are carriers of schistosomiasis, are also found to proliferate because of dams. The correlation between the spread of vector borne diseases like malaria and irrigation projects has been well studied and established. In various projects, for example Sriramsagar and Ukai, the incidence of malaria reportedly increased after impoundment. Raichur district in Karnataka became highly endemic for malaria after construction of Tungabhadra dam and its canal network. In the Sirhind Feeder Canal Command Area, there is a "menacing increase in mosquitoes". Further, fluorosis was also noticed in Nagarjunasagar. *Genu valgum,* a crippling bone disease associated with skeletal fluorosis, developed in young people, especially males.

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

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

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

Impacts of Reservoir Induced Seismicity

The weight of the reservoir, by itself or in conjunction with other reservoirs in the region, can create the sorts of pressures that result in an earthquake. The weight of the reservoir can also force water down cracks and faults till it catalyses an earthquake. The occurrence of reservoir induced seismicity is now a well accepted fact. RIS has occurred in various dams across the world. It is interesting to note that 17 of the 75 cases of RIS reported world-wide have been reported from India.

Water Logging and Salinity

Canals themselves can directly contribute to water logging. If not properly lined, or maintained, significant amounts of water can seep out of canals and inundate the lands around. Also, when subsidiary canals are not well maintained, when the releases of water are not properly monitored, or when drainage is not assured, water logging results.

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

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

Impacts of Canals on Natural Drainage

Canals also interfere with natural drainage across a slope and thereby lead to water logging on the up slope side of the canal, where the water collects, and aridity on the down slope side.

Impacts of Power Lines

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

In Uri Project, for example, 98.54 ha. of forest land was given clearance for transmission lines in J&K. In the ongoing Tehri project, power lines are not only resulting in the felling of a large number of trees in the Himalayas but are also passing through the Rajai National Park.

Power lines, especially high-tension lines, are also known to produce high levels of radiation, affecting ecosystems and human beings. High-tension power-lines can also be sources of fire hazards and hazardous to birds and other animals.

Impacts on aquatic ecosystem and biodiversity downstream

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

Heavy rainy season flow also acts as a flush for the riverbed and mouth, clearing them of accumulated silt, garbage and stale water. The absence of such a flow creates significant

problems down stream and decreases the capacity of the riverbed to accommodate peak flows, leading to larger floods in the case of cloudbursts or sudden releases of water.

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

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

The inability of certain species of fish to travel up stream, which they must do in order to breed, has already been mentioned earlier. The recent tendency to, therefore, set up breeding centres for such fish might ensure the availability of these fish downstream but does not compensate for the ecological roles these fish species played in the riverine ecosystem upstream of the dam. Post construction effects can also have a negative impact on coastal and sea fish and ecosystems, especially as the depletion of nutrients result in an insufficiency of food for various marine species. In other cases, reduced flows can lead to the erosion of estuaries and coasts.

Impacts of rehabilitation activities

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

force the project affected people to earn their living by extracting fire wood and fodder at an unsustainable rate.

Many examples of this are available. In Nagarjuna Sagar, 14,000 ha. of reserved forest was denotified for rehabilitation. In case of Sriram Sagar, compensatory afforestation was reported to be less than what was diverted for rehabilitation. Forest land was also diverted for rehabilitating PAPs of the Sardar Sarovar Project.

Impacts of water flow variation downstream

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

- **Pollution:** Reduction and variation in the flow of the river also results in the increased concentration of pollutants downstream, during dry seasons.
- **Salt-water ingress:** Where the quantity and force of water reaching the river mouth and flowing, through it, to the sea, is reduced, there is a danger of salt-water ingress. Such ingress can not only destroy the riverine and terrestrial ecosystems but can also contaminate ground water resources.

Impacts of sudden release of water or of dam failure

Degraded catchments, excessive rainfall or over-filling of reservoirs, may make it necessary to suddenly releases large quantities of water from the reservoir in order to protect the dam structure. Such sudden releases can be disastrous for the people living downstream, for their crops and for the downstream ecosystems. Reportedly, such releases occurred twice from the famous Bhakra Dam, in the late 1970s and again in 1988. A recent case was that of the Rihand Dam. In 1997, huge amounts of water were suddenly released and flooded 175 villages in Rewa district of Madhya Pradesh as well as Rewa town, killing 14 people and causing an estimated damage of Rs 200 crores.

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

According to the World Bank, in the case of the Manchu Dam – II. "The initial design flood capacity of the spillway was 200 ,000 cusecs based on an estimated PMF of 191,000 cusecs. However in August 1979 the dam was overtopped by a flood of 460,000 cusecs. As a result of this a complete review of the hydrology lead to a revised PMF estimated at around 739,000 cusecs, which was nearly four times the original design flood. Even as this revised design was about to be built a still greater flood occurred which required the PMF to be raised still

further to around 933,000 cusecs. This is a five fold increase on the original design flood in just 20 years."

Similar fears are being widely expressed about the Tehri Dam. According to a presentation done by the MoEF for the Prime Minister of India, if the Tehri Dam burst, in less than an hour and a half the water would hit Rishikesh and Hardwar and wipe out these two cities.

Decommissioning of Dams

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

Conclusions

It would be clear from the findings presented above that all is not well with large dams. If the cost of preventing and mitigating those environmental impacts that can be prevented or mitigated, along with the cost of what cannot be prevented or mitigated, are internalised, perhaps very few of the dams made or under construction would still be economically viable. However, by just looking at the findings, it is not obvious why such a state of affairs exists. What does emerge clearly is that:

- That the process of assessing proposed large dams, for their environmental and social impacts and their consequent viability and optimality, must be far more comprehensive, rigorous, participatory and transparent.

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

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