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EXECUTIVE SUMMARY

Content of the report

This report constitutes the draft final output of the study on "Valuation of the Socio-Economic and Environmental Costs and Benefits of Hydro Power Projects in India: Case Study of Two Selected Projects" being conducted by TERI for NHPC.

The report attempts to (a) articulate the inadequacies in the present definition and measurement of forest lands in India; (b) provide a rational basis for the classification of forest lands in India into different categories and identify these categories; (c) identify and define the parameters (scientific, bio-metric and social) on the basis of which the value of each category of forest land should be estimated; and (d) present detailed case studies of the Bhakra-Nangal Project and the Uri Project, including credible numbers on the value of each of the benefits and costs resulting from these projects, on the value of the forest lands diverted for these projects, and on the NPV of the forest lands diverted for these projects.

Definition of forestland

In the absence of an appropriate definition of forests, any land that is recorded as forest under the Indian Forest Act 1927 would attract a charge under the Forest Conservation Act 1980, irrespective of the type of vegetation or ecological attributes of the land. In other words, collection of the determined payment from a user agency is based on a notional premise under the Indian Forest Act 1927 (that notified certain areas as forest) rather than an ecologically sound and socially acceptable definition. As a consequence, this penalty is currently charged (at the rate specified for forest land) on land that is part of a river bed, a desert or a non-vegetated hill slope as long as the land is notified as a forest.

Functional classification of forests

Recognising the distortions created by the above approach, a threefold classification of forests based on functional attributes – Conservation Forests, Production Forests and Restoration Forests – is suggested here. Conservation forests are forests that are managed and valued primarily for ecological functions. Production forests are maintained and managed for focussed production of timber, fuelwood, NTFPs and leaf fodder, although these forests too could provide a limited set of ecological functions. These forests are characterised by relatively high productivity, but low species diversity. Restoration Forests are open and scrub forests which could be potentially converted/restored to production forests. Parameters determining value would vary according to the type of forestland being affected.

Parameters affecting value of forestland

The factors/parameters that determine the value of a forest could be classified into biotic (vegetation, biodiversity), ecosystem attributes (watershed functions, nutrient cycling, carbon sequestration etc), topographic and socio-economic (subsistence and livelihoods, recreation, religious and cultural values). The report provides a matrix depicting the relative importance of these parameters for each of the three suggested forest categories.

Case studies of two selected projects (Bhakra-Nangal and Uri)

The case-studies provide the following values [1](NPV: t=100 yrs, r=8%, current prices), for benefits and costs of the two projects (all values in Rs crore):

Bhakra-Nangal

Benefit	Value (Rs crore)
Irrigation	5,800
Electricity contribution to GDP	250,817
Drinking water	16,190
Fisheries	7
Employment during construction	560
GHG emissions avoided	5,400
Flood control	1,431
Groundwater	24
Tourism	8
TOTAL	280,237

[1] We define NPV of a project as the Present Value of the discounted streams of the net benefits. The figures can be adjusted to account for the costs. (We have estimated a present value of cost for the two projects by taking into account annual expenditures and costs of construction. The 2004-05 wholesale price index is used to convert costs into constant year prices. The present values work out to be Rs. 4,745 crore for the Bhakra project and Rs. 8,874 crore for Uri HEP; clearly these do not significantly impact the order of magnitude of the benefits). Moreover the benefit/ cost figures for the two projects are not comparable in an absolute sense; since they have been discounted at a uniform rate with start of project as the base year. This is not a problem since the same effect will be felt on both benefits and costs in case of each project when taken separately.

Uri

Benefits	Value (Rs. crore)
Electricity contribution to GDP	204,636
Employment during construction	32
GHG emissions avoided	2,744
TOTAL	207,412

The values (NPV) of forestland diverted (for tangibles) in the two cases are Rs 65 crore and Rs 10 lakh respectively. In case of Bhakra, there was no provision for Compensatory Afforestatation (CA) or Catchment Area Treatment, since the project was implemented much before enactment of FCA 1980. In case of Uri, CA and CAT has been implemented as per provisions of FCA 1980. The project represents a good case of compliance with legal provisions. It is to be noted that the benefits of CA/CAT would largely be on account of prevention of soil erosion or reduction of silt load, rather than due to commercial harvest of the plantation. In this scenario, the loss of forestland could well be more than compensated by gains due to these functions.

The report argues that using existing data, it is not possible to assign a value to the services lost in these two cases. Available case studies on watershed values report too wide a range of values to have site-specific validity. We suggest the development of suitable measurement/ monitoring systems for site-specific estimations.

Likewise, all case-studies on tourism/ recreational values relate to Protected Areas (which are of significant conservation value); hence these are also not applicable to the two case-studies taken up by us. In this scenario, the approach we suggest is based on 'indicators' where we identify specific characteristics of each case-study site and assign those values to sites which fit these characteristics.

Payment regime for diversion of forest land

The implications for the payments regime can be summarised as follows:

- The relevant land-use category should be 'ecologically defined forests' rather than 'historically notified' forests. Thus, areas that do not have any vegetation cover, but are treated as forests as per IFA 1927 should not attract the provisions of FCA for the purpose of payments for diversion. (A comprehensive 'ecological' definition, used by FAO, has been provided in Chapter 1)

In case of conservation forests, the services provided are irreplaceable and therefore of infinite value. Hence, diversion of such land should not normally be done, unless there is an overriding national interest. In any case, this will then be a public policy decision based on careful evaluation of competing national interests, rather than comparison of monetary values of benefits. In case of other forests, reasonable replacement of the goods lost is possible. In either case (conservation forests and production/ restoration forests), **existing arrangements for paying for CA and CAT should continue.** However, the institutional mechanism for implementing these should be strengthened so that these measures achieve the intended result. In case of diversion of forestland, the user agency needs to set up appropriate implementation systems, and the Forest Department can play a monitoring role.

- At times, social costs from such projects are very high and need to be taken care of, even if they cannot be monetised. While planning such projects it needs to be borne in mind that there are practical limits to quantification: everything cannot be quantified and there are genuinely intangible socio-cultural variables of importance. This needs to be acknowledged and the appraisal methodology needs to give due weightage to the same in the decision making processes in the project planning phase. In addition, **if social costs are too high, then the very decision to go ahead with the project would again be a public policy decision, much like diversion of conservation forests, rather than one based on monetary valuation**. In addition, when such projects are planned, then care should be taken that R&R measures are made as per the accepted norms and do not lead to further marginalisation of the PAPs. [The World Commission on Dams (WCD)2 provides a framework for addressing the socio-economic and environmental issues surrounding large dams. The commission addresses a rights and risk approach (WCD 2000).]
- **NPV based on value of forest land diverted should not be the basis of payments. What is relevant is a comparison of the NPV of the project and NPV of forest land diverted. The study shows that the former is higher than the latter by orders of magnitude. Hence, there is no basis for charging of NPV based on value of forest land diverted alone.**

[2] The WCD was an independent, international, multi-stakeholder process, which has addressed various controversial issues associated with large dams.

CHAPTER 1 Rationale for the present consultancy study

The need for developing hydroelectric power and achieving a proper balance between hydroelectric power and thermal power is well recognized. However, for various reasons speedy development of the hydroelectric power has been hampered, one of these being the issue of the NPV (Net Present Value) charged on forest lands diverted for the use of hydroelectric power projects. The NPV changes the relative prices of hydroelectric power using forest lands and of electric power not using forest lands. This may hamper the achievement of a proper balance between hydroelectric power and thermal power. This study therefore attempts to critique the present system of paying for forestland diverted, and provides numerical estimates of typical benefits associated with hydro power projects.

The specific objectives of the study are the following:

- To articulate the inadequacies in the present definition and measurement of forest lands in India;
- To provide a rational basis for the classification of forest lands in India into different categories and identify these categories;
- To identify and define the parameters (scientific, bio-metric and social) on the basis of which the value of each category of forest land should be estimated; and
- To present detailed case studies of the Bhakra Nangal Project and the Uri Project, including credible numbers on the value of each of the benefits and costs resulting from these projects, on the value of the forest lands diverted for these projects, and on the NPV of the forest lands diverted for these projects.

The interim report of the study has covered the first three objectives. This report is the draft final output of the study, largely presenting the two case-studies along with the material already presented in the interim report. The two projects being studied represents two hydropower generation possibilities – a multi-purpose reservoir type project (Bhakra) and a run-of-the-river project (Uri). From the viewpoint of our case-studies, the first represents a situation where a project is associated with a range of non-electricity benefits, and the second represents a situation where the primary (and usually sole) benefit is electricity generation. In either case, there is a loss of forestland although the magnitudes of loss are vastly different. The report attempts to put a value (NPV) on the forestland lost as well as the economic gains from the alternative use.

India’s water economy

A review document prepared by the World Bank (Briscoe, 2005) lucidly outlines the challenges in water development and its management and suggests a few steps to be taken in order to meet these requirements. The steps include an improvement of the efficacy with which water institutions are run, by making them more participatory in nature and ensuring regulatory and financial freedom to them. A very grim scenario is projected here in that the demand for water far exceeds its supply, and that short term measures, such as groundwater abstractions, are not sustainable. Thus it calls for massive increases in water infrastructure and also a pathway that will ensure that the water supply potential is optimally utilized in India. A specific case for furthering surface water investments is made since India currently only stores only 30 days of its intermittent rainfall compared to an average of 900 days in developed countries. Similarly with regards to hydropower infrastructure, India only utilizes 20 percent of its potential, as compared to an average of 80 percent in the developed countries. Briscoe’s (2005) recommendations, while well-meaning, are however not novel. Ideas such as making processes more participatory have been highlighted in India’s National Water Policy of 2002. The good news that is highlighted is that the World Bank plans to increase funding for water projects in India. These funds, if effectively utilized, can only do good for India. This implies that there be a supportive policy regime that does not impose undue financial byrden on the hydro sector. The present study generates estimates of benefits of hydroprojects to build a case for a suitable payments regime for diversion of forestland.

CHAPTER 2 Definition of forests in the Indian Context

Why define forests?

Forest definitions are helpful in providing a clear picture of the functions that a particular forest is providing and its utility value. These definitions could also inform us on the ease with which one is able to place a monetary value on the forest. Thus, conservation forests that provide the most complex ecological services and also serve as a repository for bio-diversity would be the most difficult to value and would be subject to the largest levels of uncertainty in the value placed on them. Additionally, the very small extent of knowledge/documentation of the bio-diversity contained in natural forests could lead a valuation exercise to place the value on such forests that would tend towards infinity. It is often argued by ecological economists that conservation forests are invaluable. Production forests on the other hand have a clearly defined primary objective of meeting the demand for some products. Ecological functions provided by these forests could be treated as ancillary benefits. As such, in relative terms, it would be much simpler to place a monetary value on such forests.

The Indian context

Diversion of forest land for non-forest purposes represents a major challenge for public policy in India. On the one hand, the Indian Forest Policy (1988) mandates increase of forest cover of the country to 33% (currently just above 20%), while on the other hand, it may be necessary to divert forest land for socially desirable projects in many cases. The Forest Conservation Act 1980 makes such diversion subject to clearance from the Ministry of Environment and Forests (MoEF), and also makes it necessary for the user (the entity that diverts the land) for pay for *Compensatory Afforestation*[3] in a physically different location. In addition, the user is now required to pay for the value of the forest land being diverted at a rate that tallies with its Net Present Value (NPV). In principle, this means that the user pays more than fully (compensates) for the complete range of goods and services that is lost due to diversion.

[3] Compensatory afforestation is afforestation done on equivalent non forestland or on degraded forestland twice in extent, by the State Forest Dept in lieu of the forest area diverted for a developmental project. The user agency pays the cost of such afforestation to the state forest department and even the cost of land, if non forestland is identified for afforestation.

However, this NPV is charged on any land that is notified as forest s even when such land forms a part of river bed, desert, cold desert, non-vegetated slopes on hills without a single tree or blade of grass since these areas have been *notified as forests* under the provisions of Indian Forest Act , 1927**.** Therefore, it is clear that NPV collection from the user agencies is based on notional premise under an Act (IFA 1927) rather than on a ecologically sound (scientific) and socially accepted definition of forests. The next section of this report attempts to point out such inadequacies in the definition(s) of forests in the Indian context and suggests broader categories of forests, which are in vogue internationally and are well accepted by the scientific community and development agencies.

Critique of the present definition (or lack of it)

When most people look at a forest, they see a large number of trees close together. But forests are much more than that. They are interconnected communities of diverse organisms -- bacteria and fungi, gigantic trees, birds, shrubs, ants and beetles, fish, and mammals. Forests cover about 30% of the earth's land mass, and forests can be viewed from a range of perspectives from the microscopic to a global. At a microscopic level, a forest is characterised by species diversity, microclimate, soil profile etc whereas at the global level, a forest is classified in terms of biomes (corresponding to climatic regions of the earth, predominant vegetation type and adaptation characteristics of animals) such as boreal, alpine, temperate, subtropical and tropical.

In India, to estimate the extent and state of forests, the Forest Survey of India (FSI) has defined forest cover as all land more than 1 ha in area with a canopy density of more than 10% irrespective of land-use and ownership. FSI has recognized three broad categories: very dense, moderately dense and open (corresponding to canopy cover >70%, 40-70% and 10-40% respectively).

The Indian Forest Act, 1927, on the other hand, *does not* define forests, and the legal extent of forests depends upon the process of notifications under relevant sections of this Act.

Consequently, a large chunk of Thar desert in Rajasthan, rocky slopes of Himalayas, and many such other unproductive lands, which do not support even a blade of grass have been classified as forests in the revenue records and Working Plans of the state forest departments. Out of a total of 77.47 m ha of notified forest area in India, forest cover is about 67.38 m ha (FSI 2005). Therefore, the difference – 10.09 m ha – would have a crown density of < 10%, implying that while this land attracts provisions of FCA 1980, they are not forests in an ecological sense. It is however possible that the actual extent of such land is more than 10.44 m ha since some part of the land under forest cover (67.38 m ha) may be privately owned plantations that are not under the control of the Forest Department.

An ecological definition of forests is therefore imperative. FAO provides such a definition in the following terms:

Forests may include natural forests and forest plantations. The term 'forest cover' is used to refer to land with a tree canopy cover of more than 10 percent and area of more than 0.5 ha. Forests are classified both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 m (metres). Young stands that have not yet reached, but are expected to reach, a crown density of 10 percent and tree height of 5 m are included under forests, and categorized as temporarily un-stocked areas. The term includes forests used for purposes of production, protection, multiple use or conservation (i.e., forest in national parks, biosphere reserves and other protected areas), as well as forest stands on agricultural lands (for example, windbreaks and shelterbelts of trees with a width of more than 20 m) and rubberwood plantations and cork oak stands. The term specifically excludes stands of trees established primarily for agricultural production, for example fruit tree plantations. It also excludes trees planted in agro forestry systems (FAO, 2001).

This definition, at once, characterises forests in a quantitative and qualitative sense while also addressing end-uses (production, protection etc). In line with current international thinking, it does not view forests as a ecosystem that is managed to maximise timber yield alone (or more generally biomass in the stems of a few preferred species). Rather, it recognises multiple end-uses including conservation in protected areas.

We would argue that while a quantitative definition of forests (based on minimum land area and minimum canopy density) is useful in delineating land to be treated as forest, determination of values is best done based on end-uses, which determine the utility of forests to mankind and the world at large. In the next chapter, we provide a rationale for classifying forests into three categories – conservation, production and restoration based on end-uses.

Box : The long hand of forest law

In the state of Tamil Nadu, a large area of notified forest land (under IFA 1927) has been converted into monoculture plantations of commercial timber species and non-timber species such as Rubber, Cardamom, Tea and Coffee. Moreover, the area is being managed in a profit oriented industrial manner. Although these ventures are not land use changes in a strict sense, rubber, cardamom and tea plantations cannot be termed as a forest in the ecological sense. What is interesting is that these plantations *do not* attract the provisions of Forest Conservation Act though they may result in the loss of significant ecological services.

Similarly, a large land area belonging to community (Panchayats) and even individuals has been declared closed under PLPA 1900 (Punjab Land Preservation Act) in the states of Haryana and Punjab. Premise of closure of such areas under PLPA stem from the location of these lands in fragile ecological zones such as Shivaliks and Aravalis. There is a long list of do(s) and don't(s) for such areas under the PLPA. For example, even tilling of soil for agriculture is not permissible. Further, removal of stones and grasses for bona fide use is prohibited. Such lands have been regulated by State Forest Departments traditionally since 1900, when PLPA was enacted. The Supreme Court has considered such areas as forests for the purpose of FCA and their diversion for non-forest purposes also attracts mandatory clearance from the State Forest Departments and MoEF.

Suggested categories of forests

An overview of the global forestry sector suggests that forests can be classified into three major groups (Allan and Lanly 1991). While the natural forests are being projected as reservoirs of biodiversity and their conservation for ecological security of the world has been envisaged, the major production of timber is coming from production forests, which occupy fertile lands. Such production forests are mainly plantations of superior genotype and are being raised as monocultures by intensive operations such as mechanised soil working, irrigation, chemical weed control and harvesting. The plantations of clonal Eucalyptus in Brazil, Radiata pines in New Zealand, hoop pines (Arucaria sp.) and its hybrids in Australia, and tropical pines in many tropical countries are some such examples (Evans 1992). The third main form of forestry is restoration forestry. This forestry aims at ecological restoration of landmasses degraded due to anthropogenic activities such as irrigation, application of fertilizer and pesticides, mining etc. and natural calamities such as floods, erosions and drought (Singh 1982). Afforestation of deserts, alkaline and saline lands, waterlogged areas and mine spoils are some examples of this category of forestry.

The forestry scenario in India is no exception. Firstly, the national forest policy envisages that good natural forests are to be conserved for bio-diversity, and as source of clean air, water and for conservation of soils. Secondly, the trees outside forests in various models of agroforestry, farm forestry and social forestry are contributing a major portion of pulp and small timber, particularly subsequent to imposition of moratorium on green felling by Supreme Court of India (FSI 1999). Finally, there have been efforts to restore a large chunk of degraded lands (National Forest Policy 1988 and National Forestry Action Plan 1999). Consequently, a large area of degraded lands such as alkaline saline lands, shifting and stabilized sand dunes, mine spoils, and waterlogged areas have been planted with tree species throughout the country under various programmes of Wasteland Development Board and Eco-development Board in the recent past (National Forestry Action Plan 1999).

Conservation Forests

A dense or closed forest, as it is known in scientific terms, is characteristic of a specific biogeographical area and set of climatic conditions. Therefore, when a natural forest is felled, the ecological system is lost, including rare species of flora and fauna. What replaces it is generally a monoculture plantation of fast-growing species. Therefore, the first category of forests is conservation forests, which is primarily valued and managed for its ecological functions (non tangible values) such as water, air, fertile soil and as a repository of valuable floral and faunal diversity encompassed in the site-specific ecosystem. It has been opined in the latest forest policy (1988) that revenue generation is subordinate to the ecological value of such forests. Moreover, maintenance and management of such forests primarily for conservation is obligatory as India is signatory to many international instruments such as CBD, UNCCD, UNFCCC etc. It has been further opined that such forests may not provide livelihood, and at the most can fulfill the subsistence needs of the tribal population and other rural poor living in the vicinity of these forests.

Production Forests

The national annual requirement for fuel wood, timber and fodder is 201 million metric tones, 64 million cubic meters and 1337 million metric tones respectively. Forest degradation due to expansion of agriculture, indiscriminate wood extraction and other anthropogenic pressures has resulted in a net deficit of 21 million cubic meters for timber, 365 and 86 million tones of fodder and fuel wood respectively (NFAP, 1999). The policy emphasis on restricted extraction from conservation forests and the moratorium on green felling from forests (National Parks, Sanctuaries, Biosphere Reserves and areas above 1000 m MSL) imposed by the e Supreme Court of India has further aggravated this situation. Consequently, it has been opined that a special category of forests "production forests" should be maintained and managed for focused production of timber, fuel wood and leaf fodder. It has been emphasized that such forests have a higher Mean Annual Increment (MAI) than the national average of 0.7 cubic meters. To achieve this, one would require trees of known genetic potential growing on soils of high fertility, moisture content and rich nutrient status. Furthermore, these areas are mostly monoculture plantations of economically important species and in some cases, mixed forests dominated by a few economically important species. Moreover, all man made plantations, which are conspicuous by artificial regeneration, irrespective of their high or low productivity can be classified as production forests. The classification (notion) is based on premise that such forests, by virtue of their location in fertile and erosion less areas and being characterised by lesser species diversity, are managed primarily for production of wood and noon wood forest products. Furthermore, plantations of rubber wood, teak, poplars, and biomass energy plantations may also be included in this category of forests.

Restoration Forests

A large area (187.54 million hectare) of land of the country suffers from varying degrees of degradation. Maintaining tree cover in this area is essential for restoration of optimal productivity. Forests created in this area mainly to arrest the process of land degradation can be categorised as Restoration Forests. These are open and scrub forests, which have <0 .4 canopy density and are least productive. Further, in terms of species diversity these are generally less diverse. Consequently, MoEF has supported many schemes, which aimed at restoration of these forests to productive forests. Moreover, large tracks in arid parts, Aravalli hills, degraded slopes in Himalayas, waterlogged areas and coastal lands, have been afforested by the respective forest departments under externally aided projects for restoration. It is emphasized that main function of forest management in such forests is ecological restoration. Neither production nor conservation can be the mainstay of forest management in these lands.

Implications on realization of NPV under FCA 1980

The discussion in the previous sections clearly indicates that these three different categories of forest lands are valued for very different purposes. For example, the diversion of conservation forests may result in irreversible losses such as habitat loss or fragmentation leading to species extinction. It can be safely said that no amount of monetary resource can compensate this loss. The conversion of conservation forests therefore may be permitted only in exceptional cases where the alternative land use leads to another public good, and in no case, for the creation of forest goods. On the other hand, using production forest-land for other purposes will mean primarily tangible loss in terms of lower production of timber. A restoration forest on the other hand will have little effect on biodiversity, may result in erosion and would have little value in terms of timber losses. In the case of production or restoration forests, the expected utility is more clearly defined and it may be possible to replicate this utility value elsewhere.

It is therefore, argued that the factors determining the calculation of NPV in these three categories of forest-lands will also vary. In the following chapter, an attempt has been made to identify the parameters that should be taken into consideration while calculating NPV.

A somewhat similar classification has been adopted in the National Forestry Action Plan, and Table 1 below provides a break-up in terms of area under each category.

Table 1. A functional classification of forests (National Forestry Action Plan, 1999)

Forest type	Area (mha)
Protection Forests (for biological stability)	10
Production Forests (for meeting timber requirements)	15
Social Forests (for needs of local communities)	25
Protected Area Network	14
Total	64[4]

As per our proposed classification, protection forests and area under the Protected Area Network would correspond to conservation forests. Likewise, production (timber) and social forests would roughly correspond to production forests in our terminology. These two categories add up to 64 m ha. Since the recorded forest area of the country is 77 mha, the remaining 13 mha is either restoration forest or barren land.

[4] Based on 1997 forest cover assessment (FSI 1997)

CHAPTER 3 Parameters for estimating value of forests

NPV of forest land can be defined as the discounted value of benefits from the forest land net of the management costs. This chapter provides an overview of factors/parameters that are to be taken into account while assessing NPV of forests.

The relative importance of these factors will vary based on the type of forest being considered. We first define and describe these parameters, and then provide a matrix depicting their applicability/relevance for specific categories of forests. The parameters are broadly categorised as biotic, scientific (ecosystem attributes) and socio-economic. Additionally, topographical and soil characteristics would affect the nature of forest values.

Biotic factors

Vegetation

A forest typically consists of trees, understorey vegetation along with associated fauna. As per the State of Forest Report 2003, forest cover comprises all lands more than 1 ha in area with a tree canopy density of more than 10% (irrespective of land use and ownership). Tree growth in a forest can be assessed based on its canopy density, stocking, stand density and growing stock . However, in India canopy density and growing stock are the most commonly used parameters. Forest Survey of India categorizes forests (that is forest cover, as defined above) into 3 categories based on its canopy density. These categories are given in Table 2.

Table 2 Categories of forests based on canopy density (Forest Survey of India)

Category	Canopy density
Very dense forests	> 70 %
Moderately Dense Forests	40-70 %
Open forests	10-40%

Any land below 10 % canopy density is considered as scrub forests.

The growing stock is measure of volume of clean bole/timber that could be extracted from a forest. However, this does not take into consideration the biomass that is accumulated in the branches, which is important, as it constitutes an important source of fuel for the rural population. Hence, for NPV calculations, total biomass would be better parameter than the growing stock. The growing stock estimates gives only volume (in cu.m) of stem wood component and does not take into account non-coommecial components such as branches, twigs, foliage etc. Total above ground biomass per hectare (in tonnes) can be estimated by multiplying the growing stock (in cu.m) by mean dry wood density (in Mg/m^3 or gm/cm^3) and biomass expansion factor.The biomass expansion factors and mean dry wood density has been idenfied for various forest strata by Haripriya (2000).

Faunal and floral biodiversity

Forests are rich repositories of flora and fauna. The richness of the flora and fauna forms an important parameter, while calculating the NPV of forests. The richness in case of both flora and fauna are expressed in terms of indices. The common index used in quantifying biodiversity is used are Shannon-Weiner index . The index is measure of the average degree of uncertainty in predicting to what species an individual chosen at random from a collection of S species and N individuals will belong. The average uncertainty increases as the number of species increases and as the distribution of individuals among the species becomes even. A high value of this index would generally imply high relatively conservation importance. This could imply that the NPV is relatively high (depending on the degree to which loss of services is not replaceable).

Another parameter that should be considered is whether the forests under consideration contain any threatened species of flora and fauna.

Ecosystem attributes (scientific parameters)

The ecological services provided by forest are given below

Watershed functions

Forests play an important role in watershed regulation. The watershed services provided by the forest include:

- Water flow regulation: maintenance of dry season flows and flood control
- Water quality maintenance including nutrient load control
- Erosion and sedimentation control
- Water table regulation/land salinisation reduction, and increase in water yield

However, available studies show that the link between forests and hydrological services are area specific and are highly variable, and thus cannot be extrapolated for large areas. For instance, Wiersum (1984) conducted a review of 80 studies to understand the link between land use change and soil erosion.

His results were that groundcover, rather than canopy extent, was the chief determinant of erosion. The study found that erosion rates were low in natural forests, but they were equally low in tree gardens, in the fallow phase of slash and burn cultivation, and in plantations; which shows that dense forest has no apparent advantage in controlling soil erosion (as against grassland). The other important findings were:

Deforestation has *not* been shown to be associated with large-scale flooding.

Tropical deforestation is generally associated with higher, not lower, dry season flows.

The link between deforestation and downstream sediment damage is sensitive to the basic topography and geology. Where sediment transport is slow - as in large, low-gradient basins - downstream impacts may manifest themselves in the distant future, so that the net present value of damage would be small.

Hence, one needs to be careful in ascribing hydrological benefits on a per hectare basis to forests. One needs to carefully explore local hydrological relationships before 'prescribing' values on this count.

Nutrient cycling

Forests play an important role in nutrient cycling. Nutrient cycle refers to the transformation of chemical elements from non-living inorganic form in the environment to living organic form in organisms and, via decomposition, back to non-living inorganic form, e.g. the Oxygen cycle, Carbon Cycle and Nitrogen Cycle. As a thumb rule, while in the temperate forests most of the nutrients are stored in the soil, in case of tropical forests most of the carbon and essential nutrients are locked up in the living vegetation, dead wood, and decaying leaves.

The nutrient cycling phenomenon is particularly well-developed in a tropical rain forest. Because the heavy rainfall tends to carry away nutrients, tropical rainforests have only been able to develop with the "invention" of very efficient nutrient cycling. The warm, moist conditions in the forest are ideal for the decomposers breaking down the remains of dead organisms. This quick decay returns the carbon and oxygen in the decomposing material to the air, and returns nitrogen, phosphorous, calcium, and other minerals to the soil. In the soil, the minerals are almost immediately taken up by a thick mat of plant roots and rootlike fungi. The fungi are known as mycorrhizae (literally "fungus-roots"); many of them form symbiotic relationships with plant roots. The mycorrhizae supply the plant with minerals and water; the plant returns

sugars to the fungus.
(http://www.marietta.edu/~biol/102/rainfor.html#nutrient)

When a forest is harvested or when plant products are harvested or when a forest is burned, nutrients will be lost from the ecosystem and would be unavailable for further use.

Carbon storage and carbon sequestration

Forests are significant reservoirs or sinks of carbon. While a growing forest sequesters carbon from the atmosphere, it is however, worthwhile to mention that the net carbon sequestration rate decreases as the forest matures and becomes negative when the rate of respiration becomes more than photosynthesis. In case of forest conversion, the storage and sequestration values will be lost.

Air quality

Forests play an important role in maintaining /ameliorating air quality by replenishing the oxygen supply and by trapping particulate air matter, thereby having a positive impact on human health.

Socio-economic parameters

Subsistence and livelihoods

Forests in India provide subsistence and livelihoods to large number of people living in and around forests. About 200 million are partially or wholly dependent on forest resources for their livelihoods (Khare *et al* 2000), especially for timber, fuel wood, fodder and NTFPs. There are also estimates that about 100 million people living in and around forests in India derive their livelihood support from collection and marketing of NTFPs (Saxena 2003).

In this context, the values of timber, fuelwood, fodder and NTFPs forms an important component in determining the NPV of forests.

We however need to provide two caveats in this context:
What is captured here is the local livelihoods/subsistence functions of forests as distinguished from commercial timber production functions. The degree to which local communities depend on forests (in terms of small timber, NTFPs etc) needs to be considered while defining the dominant parameters for NPV estimates.
It is possible (and most often the case) that the same stock provides local benefits (subsistence/livelihoods) and other relatively non-local benefits (such as recreation). When both are captured separately, we essentially do at least a partial double-

counting. This is however a methodological issue that is to be decided based on the range of socio-economic parameters relevant locally. At this stage, we flag the importance of subsistence/livelihood functions as a socio-economic parameter.

Recreation

Tourism values are relevant for any area that is accessible by road or river (CBD 2001) Forest tourism is an important category of ecotourism. The International Ecotourism Society defines ecotourism as: 'responsible travel to natural areas that conserves the environment and sustains the well-being of local people'. Ecotourism is now not a small niche in the wider tourism market, but a major part of it. According to the International Ecotourism Society, as much as 40%--60% of the 528 million tourists in 1998 were enjoying nature-based tourism (Landell-Mills and Porras 2002).

Religious and cultural values

Forests are often associated with religious and cultural values either of the local community, or people in general. Several parts of India have traditions of keeping aside a forest patch as 'sacred grove' dedicated to a deity or some element of nature. India has around 20,000 such recorded sacred groves, although the area covered by such groves is not certain. Presence of such patches within a forest area may result in significant religious or cultural values. It is often the case that such areas host ecologically significant or keystone species although the conservation ethic is couched in religious traditions rather than in scientific management practices.

Topography, soil and geology

A biotic factors such as soil type, slope and nature of rock and geology would also determine the nature of forests. A temperate forest growing on a steep slope will have a larger protective role (prevention of soil and water erosion) than a similar forest (with similar species composition) growing in a flatter terrain. Similarly, growing trees on alkaline, saline soils and arid soils will have restoration function at least in the initial years of growth, which may extend up to one complete rotation. On the other hand a forest growing in tropical climate, which is characterized by nutrient poor soils due to a very fast turnover rate can be a forest of very high productivity. The process of soil formation depends upon the type of rocks, which form the substratum. Therefore, rock types and geology will also be very important attribute for categorization of forests.

Table 3 Categories of forests and dominant values

Category of Forests	Biotic				Ecosystem attributes				Socio-economic			Topography/soil
	Stand density/ canopy density	Growing Stock	Faunal/floral diversity	Presence of Threatened/ Keystone species	Watershed/ Hydrological	Nutrient Cycling	Carbon Storage	Air quality	Subsis-tencece and livelihoods	Recreational	Religious and Cultural	
Conservation Forests	VR	VR	HR	HR	HR	HR	VR	HR	NR	HR	VR	HR
Production Forests	HR	HR	R	R	R	HR	HR	R	HR	R	R	R
Restoration Forests	R	R	R	NR	R	HR	R	NR	R	NR	NR	HR

HR-Highly Relevant
VR-Very Relevant
R-Relevant
NR-Not Relevant

CHAPTER 4 Review of literature on value of forestland

Why value forests

Forests are potentially a renewable source of a country's, as yet incompletely discovered, wealth which, if used sustainably, could generate a perpetual stream of income. As such, the key reason for valuing forests is to enable the integration of this resource into a country's system of national accounts so as to appropriately reflect both its potential wealth as well as its contribution to the flow of income. An appreciation of this value, in terms best understood by policy makers of a country and the common (wo)man, it is felt would result in policies/legislation that would ensure the sustainable exploitation of this resource.

The valuation of forests could also be used to facilitate decision making on conversion of land under forests to alternative uses by comparing the benefit streams across various applications.

However, it needs to be recognized that the values assigned to forests are largely notional and fraught with uncertainties. As such, the use of such values to recover the opportunity cost of diversion of land should be treated very cautiously. Particularly in the context of conservation forests, it could safely be said that any such estimate is probably a very conservative estimate and no amount of monetary resources could replicate the creation of the resources embodied in conservation forests over several lifetimes. In this case, the government of any country needs to have a clear policy on the preservation of such forests at any cost. As mentioned earlier, diversion of such forest should only be done in exceptional cases where the alternative land use will generate public goods of national importance. In the case of production or restoration forests, however, the expected utility is more clearly defined and it may be possible to replicate this utility value elsewhere.

Having said that, and recognizing the public good value of conservation forests in particular, there needs to be a clear guideline indicating the circumstances in which a portion (limits to be defined) of conservation forests can be diverted to other land uses with their benefits. Any policy/guideline to consider diversion of land under such forests should consciously weigh the benefits of the alternative end-use and trade-off the uncertainties of future benefit streams from this portion of land for the benefits expected from the proposed alternative land use. This would necessarily have to be a subjective, judgemental exercise.

In short, forests need to be valued for two primary reasons – (i) to reflect their (potential) contribution to a country's economy and therefore define policies/strategies to manage forests and (ii) to determine the monetary amounts that alternative users would have to pay to compensate for the diversion of forest land.

It is interesting to note that the monetary amounts (penalties) to be paid by alternative users could be different to the contribution of forests to the economy. Placing a value on the contribution of forests to the economy, through the development of natural resource accounts, would ensure a proper appreciation of the role of these natural resources in the GDP of a country and, hence, provide an impetus for their conservation. However, the issue of determining the monetary amounts to be paid by alternative users has to be viewed in the context of the types of forests, services provided as well as the objective for which the penalties are being levied – is it for compensatory afforestation, is it for providing a deterrence for diversion, is it for generating resources for the forest department or is it all the above? Arriving at monetary estimates would therefore first require an appreciation of the value of a forest which would need to be tempered to arrive at the charge to be levied for the purpose identified.

The concept of Net Present Value (NPV)

The NPV of an investment is conventionally defined as the present value of the investment's future net cash flows minus the initial investment. [5] By extension, the (NPV) of *forest land* can be defined as the discounted value of benefits from the forest land net of the management costs.

The Supreme Court has defined NPV as the present value of *net cash flow* from a project discounted by the cost of capital. (CASE NO.:Writ Petition (civil) 202 of 1995; date of judgement: 26-9-05[6]). Forestry is viewed as a public project which leads to a flow of benefits over an extended time horizon.

The benefits of forests include both goods and services only some of which can be valued directly. For example, while timber, fuelwood, non-timber forest products can be valued directly at market prices, there are many services that either do

[5] www.investorwords.com/3257/Net_Present_Value.html
[6] Internet document without page number (http://judis.nic.in/supremecourt/qrydisp.asp?tfnm=27201)

not have a market, or have a heavily distorted market. The management costs include costs of protection, silvicultural operations, and various kinds of transaction costs.

Clearly, cash flow needs to be interpreted as not just flows from marketed goods, but as total flows from both marketed and non-marketed goods and services (as calculated through an appropriate valuation method).

NPV is formally captured by the following expression:

$$\sum_{t=1}^{T} \frac{B_t - C_t}{(1 + r)^{\wedge} t}$$

where B_t and C_t refer to Benefits and Costs respectively in period t, and r is the discount rate.

In this expression above, the discount rate is independent of time. However, it is theoretically possible to have an alternative formulation (at least in the context of forests) when discount rate is a decreasing function of time, so that benefits that accrue over long time horizons receive an upward weight. But, all NPV studies we have reviewed are based on the assumption of a constant (invariant with time) discount rate.

NPV is a widely used criterion for project evaluation. A positive NPV implies that a project is financially viable under the relevant time horizon and discount rate. (An alternative criterion is the Internal Rate of Return which should give the same result in most cases – in terms of project decision-making – when benefit and cost curves are 'well-behaved', that is when they have expected shapes.) NPV gives us a snapshot estimate of the value of the relevant entity. This entity, in the classical sense, is defined as 'capital' - that leads to a stream of benefits over a well-defined time (definite or indefinite). Natural resources such as forests are of the nature of capital, since they provide benefits over an extended period of time. However, unlike conventional capital, such as equipment or infrastructure, they are not 'produced' – they are result of accumulation of value over a relatively long time period. Moreover, much of the benefits of natural resources are in the nature of services which do not have a well-established market. Besides, natural capital, unlike physical capital, can potentially replenish itself; thus a forest when sustainably harvested, can provide returns on an infinite time-scale.

The calculation of NPV for natural resources therefore is a much more complex and challenging problem as compared to similar calculations for physical capital. However, of late, these calculations have gained in significance due to increased recognition of environmental services that are provided by natural resource systems. Forests are prime examples of natural resource systems. They constitute not just an ecosystem, but form part of a complex social system involving a very wide range of stakeholders. The range of goods and services emanating from forests does not reach each category of stakeholder uniformly. Moreover, each group of stakeholders would value the goods and services differently based on their relationship with the forest ecosystem.

Given these complexities, economists have tried to place values on goods and services provided by forests. These estimates have been based on the following motivation (analogous to the two purposes of valuation mentioned earlier):

Value of (benefits from) forest land is generally underestimated worldwide due to the large component of indirect values. For example, in Norway, forestry (wood), pulp and paper, and sawn wood and wood-based industries account for 1.1% of the GDP. In Finland, agriculture, forestry, fishing and hunting account for 3.5% of the GDP. In India, forests (timber, fuelwood and NTFPs) contribute about 1.5% to the country's GDP, though India has a fifth (over 20%) of its geographical area under forest cover. These percentages are low because conventional accounting systems ignore the large contribution of ecosystem services provided by forests. Even among goods, they include only recorded extractions, while a large amount of fuelwood, small timber, NTFPs etc are locally consumed and hence unrecorded, or extracted illegally and hence not reported. This often results in a disproportionately low importance attached to the forestry sector in national planning processes. (Forest land also provides significant subsistence and livelihood benefits which need to estimated for local level planning exercises. For example, development of plans for local-level forest management (for example, Joint Forest Management) or watershed management needs an assessment of the nature and quantity of livelihood benefits.)

Forest land diversion could be socially desirable in many cases. These include conversion into another public good (such as a school, hospital or a hydropower plant). When forest land is diverted for non-forestry purposes, the corresponding losses and gains in values need to be computed in order to maximize social welfare.

Recent importance of NPV in the context of forests

The issue of loss of ecosystem values due to diversion of forest land has gained critical importance in recent years due to the Supreme Court order which requires agencies that divert forest land to pay the NPV of the diverted land over and above the money spent for compensatory afforestation (CA). Thus while CA attempts to recreate the forest land diverted in a physically different location, NPV payments account for 'compensation' for the total economic value of the forest land lost.

However, it is being argued that projects that divert forest land could create a set of environmental and social benefits that could more that offset the loss of value due to diversion of forest land.

At the same time, application of NPV rates decided at a national level to local-level project sites is questionable, since forest lands vary widely in terms of physical and social characteristics, as mentioned in the previous chapter, and nature of project banefits and costs also vary widely. We are thus faced by a twofold challenge:

Determination of a basis for site-specific NPV based on a (more) rational classification of forest land (addressed in this report), and building a rationale for the use of the NPV criterion in context of different kinds of forests, and different types of alternative uses

Determination of net economic, social and environmental benefits of the alternative land-use (in this case, a hydro power project, whether reservoir type or run-of-the-river type).

Typology of forest values

Forests are essential to the survival of humankind. They provide an entire range of goods and services as listed out in Table 5. This table follows a taxonomy that lays out three broad types of environmental values.

Direst use values which looks at forest resources as a benefit in terms of either consumption goods (as subsistence for rural dwellers dependent on forests) or as an input to production activity (for commercial timber extraction).

Indirect use value which account for the ecological functions of forests. These functions either support or protect other economic activities- for e.g. micro-climatic functions of forests can enhance the productivity of crop cultivation in neighbouring areas.

Non-use values refer to the intangible benefits of the existence of forests. This includes *existence* values and *bequest* values. The former is a value that people may place on just knowing that a certain forest or resource exists and need not necessarily derive any direct benefit from it or actually use the resource- for e.g. one may place a value on the existence of the Amazon basin even though one may never visit it. The latter is a value placed on conservation or preservation of a resource for the sake of future generations so that they too can enjoy the benefits of a natural resource.

Some economists place an additional category under *use* values (i.e. as part of the first two listed above), called *option* value. These are potential direct and indirect use values that could be realized in the future. For instance certain forest areas may be unexplored or unexploited, but may have a high value in future since it may contain vast stores of genetic information or may even be important for commercial and educational purposes.

Table 4 Use and non-use values of forests

Use Values			Non-Use Values
Direct Use	*Indirect Use*	*Option*	*Existence*
Timber, fuelwood, woodchips, charcoal Fisheries Forest resources: food, medicine, construction materials, tools, dyes, wildlife Agricultural resources Water supply Water transport Genetic resources Tourism and recreation Amenity value Human habitat Educational, historic and scientific information	Watershed services Groundwater recharge and discharge Carbon sequestration Biodiversity maintenance Migration habitat provision Nursery and breeding grounds for fish Nutrient retention Coral reef maintenance and protection Saline water intrusion prevention	Future direct and indirect uses	Cultural and aesthetic Spiritual and religious

Source: Adapted from Bann, C. 1997

Valuation methods

Direct use values generally get reflected in market prices; indirect use values get reflected in the prices of goods and services that depend on an underlying environmental benefit; and non-use values are not reflected in market prices. An absence of a value placed on a certain service may cause it not to enter into the decision-making ambit of the agent using the service. Using forests to produce tradable commodities may reduce the availability of non-timber goods and services, which results in non-marketed environmental benefits being lost. In theory, markets work efficiently when the marginal cost of producing a good equals the marginal benefit of consuming it and this leads to an equilibrium price at which the demand and supply for the good in question are equated. With this the consumer purchasing this good attains a property right over it and thereby has exclusive benefits from it. But this is not the case for a *public good* where no one can be effectively excluded from consuming it, and the consumption of the public good by one does not reduce the consumption by another. For example, carbon sequestration services of forests are there for all, as we cannot exclude any one person from its benefits. A related concept is that of *externalities* that refer to uncompensated costs or benefits of economic activity. For instance timber extraction activity leads to a decline in the availability of non-timber produce. Unless the timber industry pays the users of non-timber produce for this loss, the complete economic value of timber extraction will not have been paid for. Thus if price of timber does not reflect this additional cost, it will lead to an over extraction of timber. Thus it is important that such costs and benefits that have the nature of public goods and externalities are internalized in decision-making. We now move on to the techniques available for valuing forest benefits and costs.

These techniques attempt to quantify utility or welfare derived from non-marketed goods and services. What underlies this is the concept of *willingness to pay* of the consumer, or *willingness to accept* compensation for loss of the same, where a monetary value for non-marketed benefits is arrived at. These techniques are divided into five groups:

Market price valuation
Surrogate market approaches
Production function approaches
Stated preference approaches
Cost-based approaches

Table 6 lists the major approaches, the forest benefits they are best suited for, and their strengths and weak points.

Table 5. Methods for valuing forests

Valuation method	Relevant forest benefits	Strengths and weaknesses
Market prices: Use data from surveys of producers and consumers, adjusted if necessary to account for seasonal variation, value-added processing and/or public policy distortions.	Price-based valuation is commonly applied to non-timber forest products which are partly or informally traded, in order to estimate subsistence and/or unrecorded consumption.	Market prices clearly reflect consumer preferences, but often need adjustment to account for public policy distortions or market failures. Aggregation or extrapolation of values based on potential production is not valid unless account is taken of likely price effects (elasticity of demand).
Surrogate markets: Travel cost - use survey data on direct costs (e.g. fares, accommodation) and, in some cases, opportunity costs of time spent traveling to and from a site, evaluated at some fraction of the average wage rate. Hedonic pricing - use statistical methods to correlate variation in the price of a marketed good to changes in the level of a related, non-marketed environmental amenity. Substitute goods - use market prices of substitutes for non-marketed benefits.	Travel cost is often used to estimate demand for forest recreation at specific locations. Related methods used mainly in developing countries estimate the value of non-marketed, non-timber forest products in terms of the opportunity cost of time spent collecting and/or processing them. Hedonic pricing is used to estimate the impact of proximity to forested land and/or logging on the prices of residential and commercial property. Substitute goods approaches may be used wherever close market substitutes for non-timber benefits exist.	Provided the relation between the benefit being valued and the surrogate market is correctly specified, and prices in the surrogate market are not very distorted (e.g. by policy intervention), such methods are generally reliable. Travel cost estimates may need to account for various objectives (benefits) in a single trip. Hedonic pricing requires large data sets, in order to isolate the influence of a non-market benefit on market price, relative to other factors.
Production function: Change in production method - uses data on the physical relation between level (or quality) of a non-market benefit and level (or quality) of output of a marketed	Change in production (or “input-output” or “dose-response”) methods are used to estimate both on- and off-site impacts of land use change, e.g. the effect of logging on hunting,	Change in production methods require good data on biophysical relationships (dose-response).

Valuation method	Relevant forest benefits	Strengths and weaknesses
good/service.	downstream water users, fisheries, climate.	
Stated preference Contingent valuation method - use consumer surveys to elicit hypothetical individual willingness-to-pay for a benefit, or willingness-to-accept compensation for the loss of that benefit. Contingent ranking / focus groups – use participatory techniques in group setting to elicit preferences for non-market benefits, either in relative terms (ranking) or in monetary terms.	Recreational values are often estimated using contingent valuation. Stated preference methods such as CVM are the only generally accepted way to estimate non-use values, e.g. landscape or biodiversity values, for which price data do not exist and/or links to marketed goods cannot easily be established. Contingent ranking may be used where target groups are unfamiliar with cash valuation.	Contingent valuation estimates are generally considered reliable if strict procedural rules are followed. Participatory techniques are more experimental and not widely used to estimate non-market forest benefits. They are good at eliciting qualitative or "contextual" information, but there are doubts about their reliability for estimating willingness to pay.
Cost-based approaches: Uses data on the costs of measures taken to secure, maintain and/or replace forest goods and services.	Cost-based approaches include replacement/relocation cost, defensive expenditure and opportunity cost analysis; may be used (with caution) to value any type of forest benefit.	Cost-based approaches are usually considered less reliable than other methods. One test of validity is evidence that people are prepared to incur costs to secure relevant benefits

Source: Bishop, J.T. (1999)

Review of forest valuation studies

In this section we discuss valuation exercises carried out in various countries. It is divided into the different categories of values as mentioned earlier. We would like to note that most (more than twenty) of the studies reviewed compute annual flows, and a few (seven) compute NPV. However, the underlying valuation logic (method/ technique) could be equally applied to annual flow and NPV calculations.

The NPV estimates however crucial depend on choice of discount rate (r) and the time horizon (t). The discount rate reflects the relative preference of (benefits in) the future as compared the present, as in conventional economic analysis.

However, in case of forests, a case is often made to gradually decrease r at t increases. This is because of the fact that some benefits (like impact on climate change) accrue over very long periods of time. These benefits are socially important, and a way to 'weight' these is to increase the future preference values of these benefits by adjusting the discount rate in the downward direction as time increases. The discount rate used for NPV calculations is often the market discount rate, but it is essentially a parameter that is chosen consciously by the decision-maker.

The time period (t) refers to the appropriate rotation period, that is the age at which even-aged crops are (planned) to be harvested. The most commonly used rotation period is the one that maximises volume of timber production. When a forest is managed for multiple uses (NTFPs for example), one could use a time horizon different from the one that maximises timber yield. Increasingly, alternative concepts of rotation based on ecological services are gaining in importance. Ecological 'rotation', for example, refers to the time period required for a site to reach ('bounce back') to its pre-disturbance stage. While calculating NPV for multiple-use forest systems, use of the classical economic rotation period as time horizon thus may not always be appropriate.

Forests in different regions will also have varying physical and social conditions, and forest benefits are typically location-specific. This is specially true of forest services for the following reasons:

Limitation of scientific knowledge: The links between forest land and the service being provided are complex. For example, it is difficult to have a uniform relation between a particular type of forest and corresponding downstream hydrological services due to a range of confounding factors such as topography and land-type.

Valuation of a service also depends on the nature of importance place on the service by public authorities. Valuation of endemic or endangered species, for example, can be done based on the amount of money spent by the government for maintaining a sanctuary for the species. If the government places a higher priority on a specific species either due to scientific or political reasons, its value in its natural habitat will correspondingly increase.

The value of goods may also widely vary because of market distortions. NTFP prices at the local level, for example, are heavily distorted in large parts of India due to the monopoly power of local traders and middlemen. The prices that NTFPs fetch locally are very often the equivalent of the local subsistence wage, rather than a reflection of its market value.

It may therefore be argued that assigning a uniform value (or a relatively small value range) to a forest good or service (or aggregating these values) for an entire country may not be appropriate. The approach should be classifying forest land through a functional approach (as attempted in this report), identifying dominant values for each class/category, and quantifying these either through primary studies or secondary studies in an area with similar physical and social conditions. At this stage, the pool of case-studies is not large enough to attempt this comprehensively.

In the next section we discuss valuation exercises carried out in various countries. The studies are classified as per the different categories of values as mentioned earlier. We would like to note that most of these studies compute annual flows, and some compute NPV. We begin though with a look at studies that explicitly address the NPV issue.

NPV estimates

We first review the most well-known studies that estimate forest product values in terms of NPV. The studies are summarised in Table 7 below.

Table 6 NPV studies on forest goods and services

Source	Country	Forest type	Forest good/ service	Methodology	Value (Rs.)
Kumari, 1996	Malaysia	Peat forests	Timber, bamboo, NTFPs, carbon stock	Comparing unsustainable with sustainable forestry	28,786/ ha incremental benefit [7]
Kramer et al, 1997	Madagascar	Tropical forests	Flood alleviation benefits of watersheds	Loss in producer surplus in moving from with to without forest	56.18 lakhs incremental benefit [8]
Pearce and Moran, 1994	Uses benefits transfer from other country studies	Value of representative hectare of forest land	Biodiversity- medicinal plants	Benefits transfer	18,623/ ha
Haripriya, 2005	India	Various forests in India	Non Timber Forest Products	Net price method [9]	10,763/ ha

[7] Incremental benefit of moving from the least to the most sustainable forest management option.
[8] Damage cost of flooding saved by having the forest.
[9] This is amount of product multiplied by market value per unit net of per unit cost. Cost includes marginal cost of extraction, development and exploration, and a normal return to capital.

Source	Country	Forest type	Forest good/ service	Methodology	Value (Rs.)
Houghton and Mendelsohn, 1996	Nepal	Sal/ Chir/ Oak forests	Fuelwood	Net revenues converted to NPV	54,236/ ha
Peters et al, 1989	Brazil	Tropical rainforest	Timber	Net revenues converted to NPV	1,41,178/ ha
Manoharan, 2000	India	Various types	Various products	Not mentioned	Wide range

In a study of peat forests in Malaysia, the total economic value was estimated for a range of management options (Kumari, 1996). The forest goods and services considered are- timber, domestic water and hydrology, endangered species, carbon stock, bamboo, rattan, recreation and fish. The study provides an environmental and economic audit of extractive timber harvesting on the one hand, and compares it with a more careful harvest of timber- referred to as sustainable forest management. The results show that there are incremental benefits of moving from the former to the latter management option for the Malaysian forests. Three sustainable forest management options, in increasing order of sustainability, were compared with the conventional extractive timber harvesting option. The projections were done for period of 100 years approximating an infinite time horizon to estimate physical impacts in the long run. A discount rate of 8 percent was used. Questions can be raised on the choice of this rate, as usually lower rates are chosen for longer time horizons. The benefits (total economic value) from the more sustainable options are Rs. 177.36 crore more than the unsustainable options, i.e. the latter two options compared with the first two options. It is not the absolute values that need to be looked at, but the incremental benefits that are important- net positive increment of moving from the least to the most sustainable option is Rs. 28,786 per hectare. But looking only at *timber* and *bamboo*, there is a net *decrement* of Rs. 12,344 and Rs. 355 per hectare respectively of moving extractive harvesting to sustainable forest management. But the overall total economic value shows a positive increment because of high carbon stock values. The net loss in timber is because of lower stumpage value as logging costs increase under sustainable forest management. The net loss for bamboo is attributed to the fact that it thrives better under more ecologically disturbed conditions. There are a few concerns about the methodology of benefits-transfer adopted in this paper for valuing biodiversity, recreation and hydrological benefits. Benefits-transfer requires the use of estimates from other studies and other areas and this would require quite a few restrictive assumptions (Pearce and Moran, 1994). The author of the paper acknowledges that biological, ecological and economic uncertainties abound in forest management as the dynamics are yet well understood, which makes such studies more speculative.

Pearce and Pearce (2001) review studies which show that conventional logging can be more profitable than sustainable forestry management, under certain conditions. Profit in this context refers to only timber returns and other values of the forest are excluded. The choice of discount rates will also play a role since higher discount rates, as chosen by a policy planner, will place lower weight on future returns. The more timber is harvested now, the more returns will get generated in the near future, which will make it more profitable than sustainable forest management. If we ignore other values from the forest, then sustainable forest management is also associated with higher costs of protection i.e. management costs in preventing damage to non-commercial trees. But if we were to consider other values of the forests, then conventional logging will be associated with losses such as, biological diversity and carbon sequestration. And on the other hand, with sustainable forest management, biological diversity will be preserved and carbon storage capacity can increase. If we were to account for such values, then sustainable forest management will generate greater returns. Sustainable forest management is also associated with lower discount rates and longer time horizons as more weight is placed on the returns in the future.

Another study attempts an estimation of flood damage alleviation benefits of watershed protection in Mantadia National Park, Madagascar (Kramer et al 1997). This study focuses only on the flood alleviation benefits of watersheds and ignores the others. There is relatively little empirical work in tropical forests to support the belief that deforestation leads to an increase in the frequency and severity of floods. The study estimates the economic and ecological benefits of reduced flooding that can be attributed to the national park set up in Madagascar. A productivity analysis is used which measures the benefits of reduced flooding to farmers in the studied river watershed region. A three-stage model examines the relationship between economic value and physical and biological aspects of the watershed. In stage 1, the authors look at the functional relationship between deforestation and changes in flooding patters. In stage 2 they look at how these changes in flooding patterns affect agricultural production (paddy). In the third stage, they look at how producer surplus- a measure of welfare- of farmers is affected. The authors calculate the NPV of agricultural yield losses over a period of 46 years using a discount rate of 10 percent. A period of 46 years was selected because other estimates used in the study suggest that in the 'without park' scenario, the protected area would lose its forest cover in 46 years. The incremental benefit of establishing the national park, in terms of flood damage cost saved, runs to the tune of Rs. 56.18 lakhs NPV. This works out to Rs. 10.21 per hectare in NPV terms. The authors acknowledge that due to data limitations, such as percentage of downstream flow of the river, their study may be viewed as more of an exploratory one.

Pearce and Moran (1994) discuss studies carried out for the economic valuation of biodiversity. They look at the potential returns from 'blockbuster' drugs. There is a probability attached to the discovery of such drugs and the assessment of likelihood of such returns is speculative. Traditional medicines may not have a market and this may lead to their under-valuation. But the local willingness to pay could be substantial. Given the difficulties in accurately measuring the returns to local NTFPs, this study of theirs focuses only on the economic valuation of commercial drugs based on plants. They use estimates of the economic value of plant-based drugs to model the value of a "representative" hectare of land as a biodiversity support. The authors do acknowledge that their approach is fraught with difficulties because of large data gaps. The estimates on the value of land as a support for biodiversity or for medicinal plants range from nil to Rs. 931 per hectare. Converting this value into NPV (5% and long time horizon), it becomes Rs. 18,623 per hectare.

A recent Indian study (Haripriya, 2005), tries to capture unaccounted aspects of forests resources and incorporate them into the national accounts. This paper provides perhaps the most recent estimate of per hectare values for NTFPs and fodder across Indian states. It estimates the NPV of NTFPs at Rs 10763/ ha and the NPV of fodder at Rs 189.50/ha as national averages. There is significant variation across states for both these products. The NPV of NTFPs for the state of Himachal Pradesh is lower than in Punjab or Haryana or even Bihar. This runs contrary to the Chopra et al (2001) results that shows the per hectare annual NTFP values are higher for the mountainous regions with fir, spruce and pine tree species, as opposed to the more plain regions with sal and teak forests.

Another study measures the economic value of fuelwood, timber and fodder in villages in the middle hills in Nepal (Houghton and Mendelsohn, 1996). Farm-gate prices were used for calculating the revenues from fuelwood and fodder. 85 percent of bole (tree trunk) growth is used for fuelwood. Harvesting costs were deducted from revenues. Forests in the ecological zone included Sal (seedling and old growth), Chir pine, Oak Chir pine and Rianj oak. The authors evaluate the NPV for all products using an infinite time horizon and a discount rate of 5 percent. (The paper does not make very clear the reason for choosing an infinite time horizon.) The NPV of fuelwood stands at Rs. 2,75,726 and Rs. 54,236 per hectare from boles and branches respectively. Other forest goods and services have not been considered in this study despite the fact that they (bamboo, charcoal, fruits and medicines) are traded in the studied villages. Other non-marketed good and services are also not included in this study. The study does not make clear the claim it makes that managing forests to optimise output of fodder, fuelwood and timber is a better option than strict fodder or timber management programs.

NPV of a fast growing deciduous tree plantation in Brazil - using a discount rate of 5% - is estimated at Rs 1,41,178). (Peters et al, 1989). This paper argues that a tropical rainforest could be more valuable if sustainably harvested than if converted to pasture lands after clear cutting. The authors also estimate the net annual returns to fruit and latex in Peru. This stood at Rs. 15,519 per hectare. But others (Simpson, 1999) have argued that poor nations lack the incentive to preserve biological resources - local markets are limited, and international markets cannot absorb NTFPs on a large enough scale to finance conservation efforts for these products.

Manoharan (2000) assigns a range of values for the *dominant benefit* for a range of forests. Unlike Verma (2000), this study does not attempt to arrive at a per hectare value for all benefits together. Moreover, it reports a range of values rather than a specific value.

Direct use values

Timber and NTFPs

These commodities are usually traded in the market and hence their valuation is straightforward. Timber can be used for commercial (industry) and non-commercial (poles for village houses) reasons. Different studies approach valuation in different ways, i.e. some studies use gross market values, while others account for input costs. Forests in different regions will also have varying physical and social conditions, and forest benefits are very location-specific. Wide ranges of values are therefore observed. Nevertheless, some findings are reported here which can give us an idea on the range of values arrived at.

The Kumari (1996) study referred to above observed that conventional logging in Malaysia gives an NPV (at 8% discount rate) of Rs. 61,189 per hectare as opposed to an NPV of Rs. 22,613 per hectare from sustainable forest management.

In the Peters et al (1989) study on Brazil referred to earlier, estimates of NPV from timber harvests amount to Rs. 1,41,178 per hectare (NPV of a fast growing deciduous tree plantation-using a discount rate of 5%). This paper argues that a tropical rainforest could be more valuable if sustainably harvested than if converted to pasture lands after clear cutting.

NTFPs are extractive products that include latex, honey, gums, nuts, fruits, flowers, spices and rattan amongst others. Several studies have focused on specific or few products, which makes comparison meaningless.

The net annual returns to fruit and latex in Peru stood at Rs. 15,519 per hectare (Peters et al, 1989). But as shown earlier, others have argued that poor nations lack the incentive to preserve biological resources.

In India, NTFP values (Chopra et al, 2001) are estimated at an annual range of Rs. 2000 per hectare (for sal and teak forests) to Rs. 7509 per hectare (for pine, deodar, fir and spruce forests). This is a study on the estimation of the contribution of the forestry sector in GDP. We can see that forests in the higher altitude zones produce NTFPs of greater value. One must therefore take into account the physical and geographical conditions when comparing studies.

In the Pacific Northwest, USA, total market value of mushrooms, floral greens, medicinal plants and edible plant and wildlife species was estimated at Rs. 1,330 crore annually (Krieger, 2001). The definition of NTFPs for this region must also be kept in mind- edible plant and wildlife species are also considered which are native to the region. In other parts- Alaska- NTFPs include salmon fish and venison also. Other countries do not consider edible animals from forests to be part of NTFPs.

Typical problems encountered in valuation studies include the following:

Different prices would be observed at different points in the supply chain, i.e. farm gate prices might be far lower than retail prices in the international market.

The areas surveyed for may not be representative of the entire forest area, specially when they are sharp local differences (Pearce and Pearce, 2001)

Stocks and flows may be difficult to distinguish in some cases. Recreation values may be a function of the ‘stock’ of forest resources, rather than annual flows. This then cannot be logically added with timber or NTFP flows.

Some authors have pointed out several reasons as to why estimates of NTFP values are overly optimistic (Chomitz and Kumari, 1996). These include a failure to (or difficulty in) accounting for extraction costs; and no allowance being made for spatial variation in product density and extraction rates of NTFPs.

Fuelwood

Fuelwood is only locally traded and hence farmgate prices can be used for its valuation. What must also be kept in mind is that a large proportion is extracted illegally and thus some reported figures represent an underestimation.

In India fuelwood extraction is scaled up by a factor of 10 to account for the unrecorded extraction (Chopra et al, 2001). This study arrives at an annual estimate of Rs. 14,272 crore for the country as a whole. Per hectare this figure works out to be Rs. 2,130 after accounting for 67 million hectares of forest area in India[10].

Another study referred to earlier measures the economic value of fuelwood, timber and fodder in villages in the middle hills in Nepal (Houghton and Mendelsohn, 1996). The study has shown that has shown that value of fuelwood stands between 39% and 67% of household annual income in the middle hills of Nepal.

A study in Zimbabwe estimates the value of fuelwood by using a site choice model of fuelwood collection (MacDonald et al, 1999). Here the decision to collect fuelwood is a discrete choice problem on whether or not to do so at a particular site if there is no sale of fuelwood. A travel cost approach is used to model this site choice problem, wherein calories are used to measure the value of fuelwood- if a site is closed, then calories spent in going further to another site increases, and a monetary value can be placed on this increase in calories, which measures the opportunity cost of collecting fuelwood. The results suggest that closing a site will increase calorie intake from 165 to 200 per trip. But values from such a study are very site specific as geographical and socio-economic conditions are unique to it.

Tourism and recreation

Travel cost and contingent valuation studies have been used to determine willingness to pay for recreation services of forests. Estimates can be expressed as price per visit or marginal willingness to pay to visit a national park or forested area. Forest recreational values are controversial because of conflicts between recreation and local forest usage, which is worsened by

[10] <http://www.fsiorg.net/forestcovermap.htm> accessed on 20th February 2006

a clash of interests between the urban higher income groups (who advocate recreation) and rural forest dwellers (who rely on forests for subsistence) (Bishop, 1999). Some tourist sites get large numbers of visitors and this would increase per hectare values considerably. Comparisons again become difficult because different locations have different characteristics.
A study in Italy measures the economic value of open access recreation in the Linguria forest (Bellu and Cistulli, 1997). The use of the travel cost method and the contingent valuation method was made for this purpose. Surveys were carried out and monetary values placed on a hypothetical change of the forest's recreational services. The average travel cost range worked out to be Rs. 49-428 per visit for the 7 different forest sites studied. One obstacle in the travel cost method is to account for multiple destination trips, which can lead to an overestimation of the consumer surplus or willingness to pay. The results of this study are consistent with economic theory in that the total willingness to pay from the contingent valuation method should be at least as high as the same obtained from the travel cost method. This is because the former method captures other values such as option and existence values, while the latter does not. The average total willingness to pay worked out to Rs. 567 and Rs. 426 for the contingent valuation and travel cost methods respectively. Only users of the forest services are considered, whereas potential visitors are not. The authors acknowledge that the seemingly small difference in willingness to pay estimates between the two methods could be attributable to this. The respondents may not have had much perception about the non-use values from the site.

In another study (Shultz et al, 1998) tourism values for two national parks in Costa Rica were determined using the contingent valuation method. The two parks chosen were quite different in the characteristics as the authors wanted to ascertain how much the willingness to pay would differ between them. The questionnaires focussed on hypothetical improvements in infrastructure and services. These were administered for both national and international visitors to the parks. For the national visitors, the mean willingness to pay was Rs. 488 and Rs. 576 per trip for the two sites respectively. For the international visitors, the corresponding values were Rs. 1,020 and Rs. 621 per trip. These figures are notably higher than the park fees that were being charged to visitors. For the national visitors, the mean willingness to pay was a much higher multiple of the park fees as compared to the same for the international visitors. This fact, the authors attribute to national pride. But the conclusion drawn is the same for both sets of visitors- that is that they are being undercharged and there is scope to increase revenue collection from the parks. The authors acknowledge that are a few caveats in their study. These include the need to choose a wider sample from both actual and potential visitors, their sample size selected was too small, and respondents were not responding truthfully to willingness to pay questions. The authors say that further research is needed to fine tune the application of theories in such studies especially in the developing world.

Later studies have focused on choices between sites, factoring in qualities of different sites and different costs of travelling to sites. For recreational trips that last more than a day, simply looking at the choice between sites becomes too simplistic. For recreational trips lasting a few days, type of accommodation chosen and duration of stay also need to be factored in. These are equally important as site qualities and length of journeys in determining the costs and benefits of the trip. Earlier studies worked on the assumption that wage rates could be used to value travel time, and also, the value of time spent on site was ignored. A study in South Africa tries to improve upon these previous studies with a more comprehensive treatment of costs (Day, 2000). It takes into account the cost of travel to site, the cost of accommodation at site, the time cost of travel to site, and the cost of time spent on site. This paper distinguishes three aspects of choice characterising recreational trips lasting more than a day- duration of stay, choice of recreational site, and choice of accommodation type. Average per-trip estimates of the consumer surplus of visitors range from Rs. 665 for one reserve to Rs. 2,217 for another.

Amenity values

Forested landscapes are valued for the joy of viewing their beauty and this can be estimated using travel cost, contingent valuation or hedonic pricing models. Available studies relate to temperate forests (Pearce and Pearce, 2001). In hedonic pricing the total benefits for residents can be captured in property values since the price of a house can be a reflection of the willingness to pay to live near an environmental resource such as a forest.

A study in United Kingdom (Garrod and Willis, 1992) estimated amenity benefits for temperate woodland and mature coniferous forests. The hedonic pricing model was used in this study. A value of Rs. 2,73,49,032 was arrived at for the aggregate amenity benefit that forest estates provide to nearby households.

Another study in Finland (Tyrvainen and Miettinen, 2000) estimated that houses with a view of forests cost 4.9% more than those houses without any view of forests.

Indirect use values

These are more difficult to value than the direct uses. Indirect benefits that have received the most attention are watershed protection, carbon storage and biodiversity.

Watershed protection

Watersheds are important for soil conservation, water flow regulation and water quality regulation. There are several conceptual studies in this area, but there is a lack of empirical work (Kramer et al 1997).
An example of studies that link upstream intervention with downstream (off-site) impacts is one on estimation of flooding alleviation benefits of watershed protection in Mantadia National Park, Madagascar (Kramer et al 1997). The park prohibits any land conversion activity and the benefits of watershed protection are valued in terms of averted flood damage. A productivity analysis approach is used to evaluate flood damage in terms of lost producer surplus. The NPV of watershed protection benefits worked out to be Rs. 56.2 lakhs, or Rs. 210 per hectare of park area.

Evidence of watershed protection values however shows a mixed picture (Bishop, 1999). Some studies suggest that hydrological impacts of forest land conversion are negative. Other studies have produced results that go against conventional wisdom, which holds that the conversion of forest lands leads to a rapid loss of soil fertility, a rise in the sedimentation of waterways and reservoirs, an increase in flooding and a decrease in dry season water supply. In the well-known study on the Arenal watershed in Costa Rica (Aylward et al, 1999; Aylward and Tognetti, 2002), the impacts of forest conversion have been seen to be positive on hydroelectric power production; although increased sedimentation caused by forest conversion reduces the capacity of a reservoir to hold water for electric power generation, the study finds that the benefits of increased water run off, in terms of additional electric power generating capacity, is more significant. Reforestation is estimated to lead to losses in power generation to the tune of Rs. 11,085 to Rs. 48,774 per hectare. The results from these studies suggest that encouraging large-scale reforestation of the watershed or purchasing land for protection is not justified in several cases. Instead what should be looked at is to maximize complementary returns from livestock and water production.

Carbon sequestration

The benefits of trees storing carbon are felt globally because this helps mitigate climate change, and the benefit does not depend on the type of forest or where it is located. Hence any estimate of the value of carbon storage can be used anywhere (Bishop, 1999). The benefit of carbon storage is defined in terms of damage (i.e. damage caused by releasing carbon dioxide into the atmosphere) costs saved.

The critical role of forests in sequestering carbon is being increasingly realized, specially due to the imminent threats of global warming as a result of GHG (Greenhouse Gas) emissions. (Carbon dioxide is among the major GHGs). According to the recent studies, forests constitute 54% of the total (2200GtC) carbon pool in the terrestrial ecosystem, which is approximately 1200GtC (Gigatonnes or 10^9 tonnes of Carbon) in vegetation and soil globally. The Intergovernmental Panel on Climate Change (IPCC) special report on Land Use, Land Use Change and Forestry (LULUCF) has noted that through suitable management regimes, the rate of the sequestration could be enhanced substantially . The role of world's forestry, as a sink for atmospheric carbon dioxide is thus a subject of active research and discussion.

There are several studies that establish the amount of carbon storage in Indian forests. One of the widely quotes ones – Ravindranath (1997) - puts the figure at approximately 9.6 billion tons of which vegetation and soil account for 44% and 56% respectively. Haripriya (2004) estimates carbon density in open forests at 16.5 Mg per hectare which is substantially lower as compared to dense forests (42 Mg/ha).

The Kyoto protocol sets concrete targets for reduction of GHG emissions for Annex B countries (developed countries), which can be met either by direct domestic action or through trading or other channels such as CDM (see below). The protocol allows countries to trade emissions, since the benefits are largely global, and it does not matter much where reductions are made. This necessitates determination of carbon prices acceptable internationally. While the process of price determination is a highly technical exercise, the overall price range (1991-2000) based on several studies is $5.3 to 20.3 per ton.

Biodiversity

Biodiversity is defined as the 'number, variety and variability of living organisms in a given assemblage' (Pearce and Moran, 1994). Most studies measure the value of biological resources rather than their biodiversity. What is required for biodiversity valuation is the willingness to pay for a range of species and habitats instead of the biological resources supported by them. Contingent valuation is well-suited for this purpose. Some studies estimate the value of plant-based drugs. Forests contain potential drugs that could be of immense use to medicine in future. The pay-off from such potential discoveries can provide a justification for preservation of rich ecosystems.

The Pearce and Moran (1994) study referred to earlier estimates the range of values of land for medicinal plants from negligible to Rs. 931 per hectare. Converting this value into NPV (5% and long time horizon) returns a value of Rs. 18,623 per hectare.

Non-use values

These include existence and bequest values that are quite difficult to estimate monetarily. Research studies of non-use values have been mostly in the developed world using contingent valuation techniques. It is also difficult to separate the non-use values from other values in willingness to pay studies and estimates (Bishop, 1999).

In USA a contingent valuation survey was conducted for households in which they were asked their willingness to pay to preserve 110 million hectares of the world's rainforest. The total willingness to pay was estimated to be between Rs. 840 and Rs. 1100 per hectare (Kramer et al, 1995).

Recent valuation studies in India

There have been relatively few Indian studies that have tried to capture the benefits of forest land comprehensively. Studies have mostly focused on specific forest goods and services, rather than the entire gamut in one sweep. Again, most of the studies have focused on tangibles such as (recorded extractions of) timber, fuelwood, and NTFPs.

The official contribution of the forestry sector to the country's GDP is about 1.5% though the country has forest cover over almost a fifth of its geographical area. This is due to the fact that non-marketed services of forests and the entire range of indirect values are not captured in these estimates. As a result, forests perhaps do not receive attention of planners proportionate to the value of the services they provide. If the relative importance of the forestry sector vis-à-vis other sectors (where all outputs are marketed) is to be decided, one would need to capture the total economic value (TEV) of forests, as opposed to the value of a small subset of product flows.

A similar argument can be applied to NPV calculations. Most studies look at the value of specific forest products (usually tangibles) rather than the total economic value. Whether for national accounting purposes (determination of share in GDP) or for calculation of the TEV for forestland, we need acceptable methodologies and good primary level data to arrive at reliable numerical results.

The recent studies that have attempted (relatively) comprehensive valuation are the ones by Verma (2000), Chopra

(2001), and Haripriya (2005). These studies however are based largely on secondary material, that is, valuation results are based on primary work done by others, and the data in government records. Verma (2000) estimates the *value of annual flows* from forests in Himachal Prdaesh at Rs 7.43 lakh per hectare (based on area under actual forest cover, rather than recorded forest area). The largest component of this value (70%) is watershed benefits, which is based on per hectare estimates by Chopra and Kadekodi (1997) in the Yamuna sub-basin. Likewise ecotourism values are extrapolated based on per hectare estimates (Chopra 1997). While the Verma study provides a convenient snapshot estimate of forest values, its reliance on a large number of secondary studies and a range of assumptions makes its practical utility somewhat limited. Relations between agricultural productivity and forests (due to water and soil conservation functions) are established as a rule of thumb rather than based on a scientifically established relationship. Extrapolation of these results at a state-wide scale is problematic. Moreover, certain benefits like biodiversity and recreation are not mutually exclusive and adding the two could result in partial double-counting.

Interestingly, the value of annual flows is consistent with the range of NPV (Rs 5.8 –9.2 lakh/ ha) that the MoEF has been empowered to charge on diverted forest land, based on recent Supreme Court orders. It may however be mentioned that the Verma (2000) estimate is for annual flows, which would obviously correspond to a much higher NPV when a benefit stream over an appropriate time horizon is considered. The implication would then be either an annual charge based on value of annual flows or a (higher) one-time charge based on NPV. Interpretation of annual flows as NPV is clearly problematic in terms of imposing charges on diverted land.

Haripriya (2005) provides perhaps the most recent estimate of per hectare values for NTFPs and fodder across Indian states. She puts the NPV of NTFPs at Rs 10763/ ha and the NPV of fodder at Rs 189.50/ha as national averages. There is significant variation across states for both these products.

The National Forestry Action Plan (NFAP) also provides NTFP values on a per hectare basis. Jammu & Kashmir and Himachal Pradesh have the highest values as per the NFAP estimate. The national average value is Rs 1671/ha per year.

There are several other estimates available for specific forest products motivated by resource accounting processes. Chopra (2001), for example in an attempt to calculate the contribution of the forestry sector to the GDP, estimates eco-tourism values at Rs 7443/ha and the value of carbon sequestration at Rs 1366.73/ha.

A challenging aspect of valuation is the issue of ecosystem services. The literature on valuation of hydrological benefits, soil conservation, biodiversity, religious and cultural services etc is diffuse, and often case-specific. But the table below lists below the major studies that have attempted valuation of services:

Table 7 Intangible benefits

Source	Intangible Benefit	Annual Value	Location	Methodology
Kumar P	Soil Conservation	Cost of soil erosion Rs 21593	Doon Valley	Replacement Cost approach
Chopra and Kadekodi 1997	Ecological functions for local residents	Rs 624 per ha	Yamuna Basin	Contingent Valuation Method
Chopra and Kadekodi 1997	Soil Conservation	Rs 2.0 lakh per ha m soil	Lower Shiwalikh	Indirect Method

Table 8 NPV estimates by type of forest land

Nature of Forest land	Selected economic benefit	Value of annual flow of goods & services per hectare (Rs.)		Present value* of goods & services per hectare (Rs.)	
		Mini.	Max.	Mini.	Max.
Plantation/Single species forest (teak, sal forests, etc.) (Crown density < 40%)	Timber	2701	9270	33660	115525
Multi-species plantation/open forests (crown density 10-40%)	Timber + NTFP	3239	12227	40365	152375
Dense forests (crown density >40%)	NTFP+ Ecological functions+ Carbon store	21287	322957	265283	4024758
Protected Areas (PA)	Eco tourism + ecological functions+ carbon store	21425	340444	267003	4242685

* At 5% rate for a period of 20 years

Source: Manoharan 2000

It is clear that NPV estimates depend on biophysical attributes (such a canopy density) and management regime such as PA – with certain kinds of values dominating over others in specific cases. For example, in a Protected Area, ecotourism and ecological functions would take precedence over timber or perhaps NTFP values. A more detailed description of these parameters is provided in a previous section.

The Expert Committee set up by the Supreme Court of India (Kanchan Chopra Committee) defines NPV as the discounted sum of values of ecosystem goods and services that would flow from a forest over a period of time net of costs incurred. This *does not* include the value created by the user agency that has diverted the forest land for non-forestry purposes. Such determination of NPV is to be site/ context specific.
The forest values considered are the following: Timber, carbon storage, fuelwood and fodder, NTFPs, watershed services and biodiversity
For illustrative purposes the Institute of Economic Growth conducted such a valuation exercise for Himachal Pradesh. Circlewise values range between Rs 4.1 lakh/ ha to Rs 7.7 lakh/ ha. The Committee considers a time horizon of 20 years and a discount rate of 5 percent. The NPV estimates are to be revised every five years in order to keep pace with the change in goods and services flowing from the forests. The Committee has chosen a 5 percent discount rate in the light of interest rates going down over the last few years in India. The 20 year horizon is chosen after taking into consideration the mix of tree species and their different maturity periods. But if NPV estimates are to carried out on a site-specific basis then it would be a better approach to consider different time horizons in different sites to account for different tree species having different maturity periods. This is especially true in India with its many ecological zones.[11]

Finally, we review a study under the Green Accounting for Indian States and Union Territories Project (GAISP) (2006) that places monetary value estimates on the benefits of soil conservation, water augmentation and flood prevention. The benefit estimate of soil conservation is carried out through an approach which estimates the resource value of soil loss. Soil has vital nutrients and forests help in preventing erosion by slowing down the velocity of raindrops. Sediment losses caused by erosion leads to losses in nutrients. Using a secondary study which estimated the average concentration of different soil nutrients, such as nitrogen, potassium and phosphorus, in run-off soil, the GAISP study multiplies these averages by the estimated soil loss in each state only in dense forests. (Open forests and scrub forests area not considered as they do not contribute as much to soil loss prevention and there is a lack of data on this front.) This study however only considers two regions- Doon Valley in the Kumaon Himalayas and the Nilgiri

[11] http://www.libertyindia.org/policy_reports/forest_conflict_2002.pdf accessed on 1st August 2006

area. Trying to extrapolate to all Indian states from here can be questioned as India has several ecological zones. But due to a lack of data from time to time, the study does provide indicative values. Using the market prices of artificial fertilizers as a proxy to value these nutrients, the study arrives at estimates of economic value of nutrient loss. In 2001-02 the all-India value stood at Rs. 50,244 million. Essentially a replacement cost approach has been used to value the benefits provided by forests to soil loss prevention.

Another benefit studied in the GAISP study is that of flood control. Forests prevent floods due to their ability to absorb water into the ground and thereby reduce surface flows and run-off. To monetise the benefits of flood control, the study looks at how damage can be prevented. Damage has been looked at in four dimensions- human lives lost, cattle lost, crop and house damage, and damage to public utilities. Avoided flood damage has been estimated for all India at Rs. 3,38,600 million in the year 2001. Forests act as a sponge for rainfall and so groundwater recharge is another benefit of forests. The approach used in this study is to estimate the incremental recharge facilitated by the forests compared to non-forest areas. Groundwater recharge is taken as total precipitation net of evaporation, water run-off and the moisture needed to saturate soil. Differential values for water recharge of forest and non-forest areas have been estimated using secondary data for states with a good amount of forest area. Using a secondary study to value water at Rs. 4.5/ m^3, the total value in 18 states of India works out to Rs. 1325 million in the year 2001. This cannot be taken as representative of India as there is a lack of data and the authors were thus not able to work out estimates for other states. Although most of the estimates are based on assumptions and averages drawn from secondary studies, the study does provide broad indicative values of soil conservation, water augmentation and flood control.

In the next chapter, we actually attempt to place a value on forestland that has been diverted for the two projects that are being studied. We note however that the focus is on tangible values based on primary surveys (in surrogate plots) and Forest Department records. We have however commented on the forest services applicable in both case-studies in a qualitative sense. Placing monetary estimates based on secondary estimates have not been attempted as the ranges provided in the secondary literature is too high to be plausible, and therefore of limited practical significance. These have to be necessarily based on site-specific primary studies over a longer time horizon.

CHAPTER 5 Dominant values of forestland diverted

Background and approach (Bhakra)

This section provides numerical estimates of the tangible benefits of forests that were submerged due to construction of the Bhakra reservoir. The approach used is based on vegetation sampling at surrogate sites and analysis of historical records about forest product availability (and management types).

It needs to be mentioned at the outset that measurement of intangibles have not been attempted in the present exercise. Valuation of services such as watershed benefits require a much more detailed and long term study. The indicative values for watershed benefits available in the literature are based on extrapolation of a few location-specific studies, and using these values for particular cases like Bhakra may not be meaningful. Likewise, services like ecotourism are of limited importance in the two cases; besides the estimates from secondary sources relate to areas that have a significant conservation value, being parts of the Protected Area network of the country.

In the final section of this chapter, we discuss this issue in more detail, and suggest possibilities for use of these values for sites that have similarly high conservation importance. However, a more general point made is this report needs to be emphasized here. If a site has high conservation value, the decision to divert it for any other use is essentially a policy decision based not necessarily on monetary valuation. From this view-point, the use of monetary estimates for ecotourism (which is just one of the many determinants of conservation value/importance) for the purpose of determining charges for diversion would be inappropriate.[12]

From an ecological point of view, the forest types provide a broad notional understanding of the species diversity, productivity, and ecological importance associated with the particular forest type. Hence, it is important to understand, at the outset, the forest types of the submerged areas. To establish the pre-submergence forest types, we have followed a retrospective approach. In doing so, we have followed a two-pronged strategy, which includes a critical analysis of Forest Working Plans (WPs) of relevant Forest Divisions for the period 1954—2008-9, and primary vegetation survey of representative areas using standard quantitative ecology methods.

[12] Conservation values reflect themselves through a bundle of services such as ecotourism, biodiversity and existence.

As a first step, we scrutinized the Working Plan in vogue at the time of construction of BNP to establish forest type/types. This led to the process of of selection of a suitable representative area for primary survey. Further, the results of the primary survey were validated against data pertaining (reconstructed) forest types as available in the WP. After determining orest types and calculating growing stock (biomass and volume) of different species in the submerged area, we have categorized the total submerged area into different working (management) circles as described in the WP. Further, the flow of tangible benefits such as timber, fuelwood, grasses, bamboos and selected NTFPs havebeen calculated based on appropriate predictions and prescriptions provided in the relevant WPs.

Review of Working Plan

Bhakra-Nangal Project was planned and executed well before the enactment of Forest Conservation Act (FCA), 1980. Therefore exact details on forest area submerged/ affected, type of vegetation, density of forests and diversity are not available in the standard format. This data is therefore, reconstructed, using Working Plans of the period when submergence occurred.

The total area affected amounts to 16,835 ha out of which 5746.54 ha is notified forest, affected or submerged during the construction of Bhakra project as per the records of Bilaspur Forest Division (Himachal Pradesh) and Working Plan for the period 1954 -1974 of Bilaspur. This forest was spread over Bilaspur and Mandi State Forest Divisions. Based on the Working Plan of Bilaspur (1954 -1974), it could be established that the total forest area that got submerged from Bilaspur State Forest was 340 ha as mentioned in Table 10 below.

Table 9 Total area submerged under Bhakra Project from Bilaspur Forest Division

Range	Name of Forest Settlement Block	Name of Plot	Areas which will be submerged in acres
1	2	3	4
Naina Devi	Naina Devi Forest	Naina Devi	145
Sadar	Chamyawan Sangan	Chamyawan Sangan	57
Sadar	Fatehpur	Dhindru	31
Sadar	Fatehpur	Dadnal	44
Ghumarwin	Ghaniri	Ghaniri	88
Ghumarwin	Rahan	Rahan	5
Ghumarwin	Rahan	Khurjahal	1
Ghumarwin	Rahan	Jhaula	17
Ghumarwin	Kot Dhar Bagphal	Jai Shri Devi	19
Ghumarwin	Kot Dhar Bagphal	Dhangu Baungar	35

Range	Name of Forest Settlement Block	Name of Plot	Areas which will be submerged in acres
1	2	3	4
Ghumarwin	Kot Dhar Bagphal	Chaunta Thathal	2
Ghumarwin	Kot Dhar Bagphal	Dhanola Sasota	78
Ghumarwin	Kot Dhar Bagphal	Bagphal	187
Ghumarwin	Kot Dhar Bagphal	Dhar Kot	132
Total			841 = 340 ha

Source. Working Plan of Bilaspur Forest Division for the period (1954 – 1974)

Following are the main species of trees and associated species that were present in these forests :

a) Trees: Anogeissus latifolia, Odina wodier, Acacia catechu, Stephegyne parvifolia, Aegle marmelos, Holarrhena antidysenterica, Bombax malabaricum, Eugenia Jambolana, Limonia acidissima, Ehretia laevis, Flacourtia ramontchi, Zizyphus jujba, Mangifera indica, Cassia fistula, Wendlandia Exerta, Phyllanthus emblca, Ficus rumphii, Ficus bengalensis, Casearia tomentosa, Bauhinia retusa, Sapium insigne, Diospyros cordifolia and Acacia leucophloea.

b) Brush-Wood:Carissa spinarum, Dodonaea viscose, Woodfordia floribunda, Adhatoda vasica, Murraya Koenigii, Nyctanthes arbor-tristis, Mallotus philippinensis, Euphorbia royleana, Zizyphus ummularia and Lantana camera.

c) Climbers: Bauhinia vahlii, Pueraria tuberosa, Mimosa rubicaulis, Zizyphus oenophia, Clissampelos pareira, Clematis gouriana, Caesalpinia sepiaria, Abrus precatorius, Cuscuta reflexa, Cryptolepis buchanani, Vallaris heynoi and Inchnocarpus frutescenes.

d) Grasses: Ischaemum angustifolium, Eriophorum comosum, cynodon Dactylon, Chrysopogon montanus, Hetropogon contortus, Botheriochloa intermedia, Themeda anathera, Cyomopogon marthi and Aristida depressa.

Further, the following important forest types in the Bilaspur State Forest are described in the Working Plan:

Scrub Forests: The scrub forests cover about 2/3 of the total forest area of the State and are mainly in the south western and eastern parts of the State. The scrub forests all over the state are burdened with heavy rights of grazing and lopping etc. Unrestricted grazing and lopping in these forests have caused extreme deterioration in many places. Dense good, miscellaneous jungle is fast deteriorating into open “Garna Mehndu”(Carissa spinarum and Dodonaea viscosa) forest which on further deterioration has changed into Thohar (Euphorbia royleana) plots in many places. Some areas in these forests have become quite blank and erosion has started in them. The tree species on the whole are deteriorating and decreasing in their extent. Brush-wood is replacing the tree species in many places. Reproduction of the tree species is rare except for Acacia catechu, Cassia fistula, Holarrhena antidysenterica and Anogeissus latifolia, which in certain places are found regenerating naturally. Coppice regeneration over the areas felled in the past is satisfactory, but the growth is generally poor.

Bamboo Forests: The Bamboo (Dendrocalamus strictus) occurs gregariously in many places in this state, but these forests are generally found mixed with miscellaneous scrub forests. Its presence all over the state ranging from small deteriorated groups to considerably large areas shows that this species had been growing extensively in this State in the past, and is now gradually disappearing from many places. At present the areas stock-mapped under bamboos are found in Dhar Naina Devi and Dhar Kot. On the Western parts of the State, sizeable plots are also found in Ghaniri, Pheti-Dhar, Kasal and Dadnal. Some scattered and inferior clumps are also met with the Sangan, Jamali, Ghan and Jhanjiar forests. It occupies a zone of elevation lying between 1200 and 3000 feet.

Chil Forests: The Chil (Pinus Longifolia) is a species of the Zone. Economically it is the most important tree of the tract dealt with. It is the source of resin which is the most valuable forest produce of the state and is the main source of timber for local use as well as for export from certain forests. The chil forests dominate the central belt of forest areas in the state and consists of five main blocks named Jhanjiar, Samoh, Seru Slasi (Ghaniri), Fatehpur, and Rahan. A few small areas named Kalri, Rattanpur, Harlog, Lehri, Dodian, Dholak Chaknar, Marotan, Dhanola, Chalawa, Chogan etc., are found scattered in other places. They occur at elevation from 1500 to 4000 feet on the North and North Eastern aspects of the main ridges. Aspect and geology play an important part in the distribution of the chil forest. They are all found generally on the tertiary sand rocks of the Siwalik and Kasauli formations and have not flourished on the Karo series and tertiaries constituting the Subathus and Dagshais. The main Western and Southern aspects are generally covered with scrub forests containing very few Chil trees, such as in Jhanjiar, Tiun, Samoh, Jhaula, Gochar etc. etc. The total area under chil forests is about 7000 acres.

Ban Forest: There is only one small plot of Ban (Quercus incana) forest called Bahadurpur at an elevation of 5200 to 6378 feet. It is situated on the north eastern aspect of Bahadurpur ridge and forms a dense forest of all age classes. The ban trees are of good height growth. Big trees upto 10 feet girth are still present in some parts, but they are not many. The age classes are present in groups, the older groups occupying the middle of the forest. The chief associates of ban in this forest are: Rhododendron arboreum, Pyrus pashia, Berberis aristata, Berberis lycium, Viburnum cotinifoeium, Rhamnus dahurica, Myrsine africana, {eiris ovalifolia, Lonicera quinq uelocularis, Rhus cotinus, Daphne cannabina Prinsepia utilis. Ilex dipyrena, Zanthoxylum alatum, Cotoeaster bacillaris, Rosa macrophylla, Rosa moschata and Hedera helix. These are all found generally as under-growth.

Classification of submerged area

The main project area including the lake (Govind Sagar) is situated at an altitude of approximately 1000 above MSL where only broad-leaved species are found. The coniferous forests of species like Chil starts from 1800 MSL in the region. The forest types upto 1000 MSL are similar for the whole of the region at the foothills of the Himachal Pradesh. Thus, the following forest types are proposed from the analysis of Working Plans for the submerged forests following the Champion and Seth (1968) scheme of forest classification.

Type BC 2 D.S.I. Dry Deciduous Scrub Forests:- This type is characterized by a low broken cover of shrubby growth 3 to 6 m high, including some trees and shrubs as *Holarrhena*, *Dodonea, Randia*, *Carissa,* etc. With further deterioration, the proportion of *Euphorbia royaleana* increases in this type of forest.

Type 5B-E/9 Dry Bamboo Brakes:- Predominantly *Dendrocalamus strictus* occurs and forms relatively low but dense brakes. More often, its occurrence is mixed with miscellaneous scrub species. Large blocks of bamboo forests are found on loose tertiary sandy soils of the Shivalik formations.

Type 5B-1 s2 Khair Sisoo Forests:- The occurrence of this type is limited to small patches of sandy alluviams where *khair* occurs mixed with *Dalbergia sisoo*.

We have categorised the total submerged area in the Bilaspur Forest Division into specific Working Circles based on the analysis of management prescriptions in respective Working

Circles of the Working Plan for the period 1954-74. These values are given in the table below.

Table 10 Working Circles for the submerged area of Bilaspur Forest Division

Working Circle	Submergence area from Bilaspur Forest Division (ha)	% of submergence area in Bilaspur Forest Division
Protection	149.80	44.00
Fuelwood / Timber	35.63	10.46
Bamboo	153.04	44.95
Total area	338.46	

Source. Compilation based from the Working Plan for the period 1954 to 1974

Each Working Circle is managed according the prescriptions of the Working Plan. The following section provides the management details of the various Working Circles.

Protection Working Circle: The species diversity and density is generally low (below optimal) in areas designated in protection working circle. Therefore, the overall objective of Protection Circle is to improve the growing stock and species diversity in the area by providing adequate protection measures. While achieving desired density of trees is the prime objective of management in the areas, some timber and other produce such as bamboo and grasses are harvested as and when these are available silviculturally. Accordingly, the prescriptions of Working Plan of the Bilaspur Forest Division (1954-74) prevent any kind of felling and extraction from 25% of total area allocated of the circle for a period of 15 years from each compartment. Hence, at any point of time 25% of 149 ha area would be closed. The remaining area under this circle will be made accessible to the right holders for grazing and other rights such as fuelwood collection and household use. The rest area designated as open will also produce *Khair* after every 15 years. Prescriptions for removal of grasses on annual basis has been provided in the management for the protection circle.

Fuelwood Working Circle – The vegetation in the of this circle is dominated by woody species which do not have timber value and hence used mainly for fuelwood. Therefore, Working Plan prescribes for management of areas allocated in this working circle with prime objective of fuelwood for local use and commercial purposes. However, these areas are also marked by presence of some large trees of timber species such as *Anogeissus latifolia, Dalbergia sisoo*,etc. which are managed for production of commercial timber. While fuwlwood in form of dead, dry and fallen branched is collected by local population in such areas, the commercial harvesting / felling for timber and fuelwood has been prescribed every 45 years.

Bamboo Working Circle – The forests in submerged area have sporadic distribution of bamboo, mainly belonging to species *Dendrocalamus strictus*. Such sporadic distribution arrangement is clssified as Bamboo brakes in the forestry literature. The extraction of bamboo is prescribed with the interval of four years. Usually after every 26 years, bamboos flower, disperse seeds for regeneration and die. After the flowering year, the area is protected for 10 years for regeneration followed by extraction on every fourth year.

Status of the forests in 1954

The Working Plan highlights the status of various categories of the forests. In terms of the management of the forests mainly scrub, bamboo, Chil and Ban forests were important for the Bilaspur Forest Division. The areas under Chil and Ban however did not come under the submergence zone.

The scrub forests as mentioned by the Working Plan for 1954 to 1974 (pg 32) was burdened with heavy rights of grazing and lopping Besides, these areas also had a problem of unrestricted grazing and lopping. Due to the consequent degradation, these areas were slowly getting converted to the 'Gurna-Mehendu' type of weed outcrops. The tree species were on the whole deteriorating and decreasing in extent.

The Working Plan for 1954 to 1974 (pg 33) mentioned that the general condition of the bamboo forests was very deplorable with congested clumps. The bamboos were managed poorly with respect to absence of thinning, careless fellings, etc. Unrestricted lopping and poor management had reduced the commercial value of the bamboo forests.

Thus in general the forest management practices in the study area relate to two broad objectives: production of material such as timber and bamboo, and protection for restoration.

Based on the description of submerged area from the Bilaspur Forest Division in various Working Circles, proportionate extrapolation for the area under respective Working Circle has been made for the total submerged area of Govind Sagar Reservoir. The following table summarizes the area designated to various Working Circles for management of 5746.54 ha of Govind Sagar Reservoir based on these extrapolations.

Table 11 Working Circles of area submerged under Govind Sagar

Working Circle	% submergence area Bilaspur	Area for Bhakra (ha)
Protection	44.00	1892.98
Fuelwood / Timber	10.46	601.30
Bamboo	44.95	2582.87
Total area		5077.15

Primary Survey: Method

As mentioned earlier, a primary survey for vegetation analysis was also conducted to establish forest types in submerged area. The primary survey generated data on the surrogate sites by using quantitative ecological techniques.

During the reconnaissance survey in the project area, we came across certain islands in the pondage area of Govind Sagar Reservoir. These islands were contiguous to the submerged forests and support natural vegetation due to the natural succession. The primary survey was done in three randomly selected accessible islands in Govind Sagar Reservoir.

The sample plots for trees/ shrubs were established using the nested sample plot method. Sampling was done with the use of sample quadrat of regular shape and dimensions 20 x 25m (for trees) and nested plots of 5x5 m (for shrubs) as per the following table. A stratified random sampling design was used to ensure representation of various forest types in the sampling plots. A total of 1 hectare area was sampled covering various forest tyrpes using the stratified random sampling by quadrat method.

Table 12 Use of nested quadrat plots for sampling and measurement

Quadrat dimension	Use of quadrat in measurements and sampling
20 x 25m	Identification of the species of the individual tree of DBH (Diameter at Breast Height) >= 10cm, measurement height in meters.
5 x 5m	Identification of the shrub species and individual shrub

Data analysis

The total above-ground biomass was estimated through measurements of volume, with use of allometric calculations based on standard forestry measurements (and related procedures) such as tree height –H, diameter at breast height-DBH (Ponce- Hernandez *et al* 2002).

Volume for each tree was calculated through quarter girth formulae $\pi r^2 (H/3)$ where π is equal to a value of 3.14, r is the radius and H is the height of a tree.

The volume of all the tree species in each sample plot was summed up and converted into tons per ha by multiplying the volume with specific gravity of wood for specific tree species wherever available.

Calculation of flows

The flow of forest produce per hectare is calculated based on the primary survey data. The per hectare calculations have been extrapolated to the total submerged as per the prescriptions for yield regulations in the relevant working circle.

The yield of timber was considered as 75% of the total biomass of the tree. The biomass for all the major timber species and miscellaneous species is calculated by using exploitable diameter (Diameter of tree x Mean Annual Increment x No. of years, after which tree reaches exploitable diameter range). This provides the number of trees that reach the harvestable diameter range in stipulated number of years.

The yield of fuelwood is calculated by considering 25kgs of fuelwood per tree multiplied with the number. of trees in that particular year.

The calculations of per hectare production of *Khair* and grasses are done for the submerged area under the Protection Circle.

For calculation of the monetary flows, the 2006 prices for timber, fuelwood and bamboo are used (as provided by the Himachal Pradesh State Forest Department.) The price of grasses has been calculated using the linear trend value based on the data of previous years. The present prevalent market price of *Khair* has been considered.

Results of primary survey

Results of primary survey are indicated in the table below. A total of 23 species were present in the sampling plots. These include 20 tree species and 3 shrub species. It is important to mention here that annuals such as grasses and other herbaceous species were not noticed, since the sampling was done in March 2006. Therefore , yield production of grasses are based on the estimates in the Working Plan of Bilaspur Forest Division.

Table 13 Species abundance based on the primary survey

Species	Per hectare abundance	Habit
Acacia catechu	51	Tree
Acacia leucophloea	14	Tree
Albizzia sp.	1	Tree
Anogeissus latifolia	33	Tree
Bamboo Clumps	40	Grass
Bauhinia purpurea	1	Tree
Bauhinia variegata	1	Tree
Bridelia sp.	1	Tree
Butea monosperma	11	Tree
Cassia fistula	20	Tree
Chamror	1	Tree
Dalbergia sisoo	11	Tree
Diospyros montana	8	Tree
Ehretia laevis	1	Tree
Eleocarpus sp.	3	Tree
Flacourtia montana	11	Tree
Lannea coromandelica	8	Tree
Limonia acidissima	2	Tree
Mallotus phillipeninsis	39	Tree
Murraya Koenigii	1	Shrub
Nyctanthes arbor-tristis	6	Shrub
Wendlandia exserta	1	Shrub
Zizyphus Zujuba	1	Tree

Validation of data

The area submerged from Bilaspur Forest Division was dominated by *Anogeissus latifolia* and *Acacia catechu*. Singh (1974) in the Working Plan for the period 1975-1994 provides the data on distribution and enumerations of the species *Anogeissus latifolia* and *Acacia catechu*. Based on these records we plotted data for the comparison of the relative density of the individual stems of *these* species in 1974 with that obtained during primary survey, which is shown in the following graphs.

These graphs show percentage of trees in different diameter classes as recorded in the primary survey and those recorded in the Working Plans of Bilaspur Forest Division. The results indicate that the trends of distribution of diameter class in natural population of two major tree species namely *Anogeissus latifolia* and *Acacia catechu* observed in primary survey are similar to those explained in the Working Plan. The distribution further indicates that the two tree species are represented by a normal population, where the number of younger individuals (lesser diameter class) is always higher than the number of adults (higher diameter class). Therefore, it can be reasonably concluded that the area sampled for primary survey is a true representative of the vegetation / forest types that existed before the submergence.

Furthermore, similar trends for the years 1974 and 2006 suggest that the selection of the sampling site as well as the sample are consistent. .

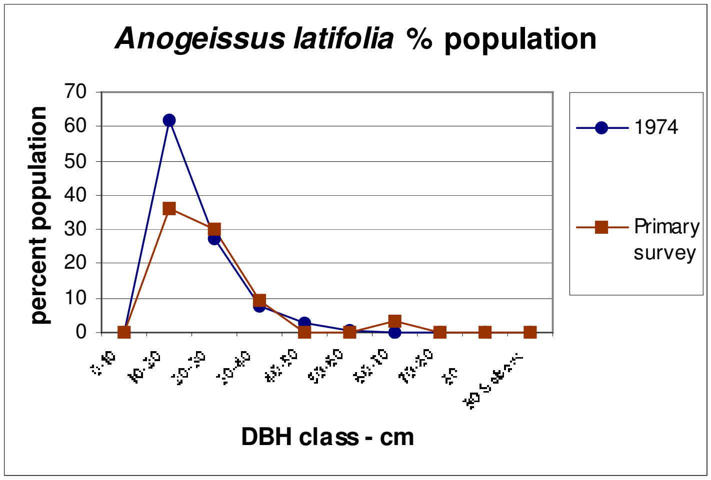


Figure 1 Population distribution of *Anogeissun latifolia*

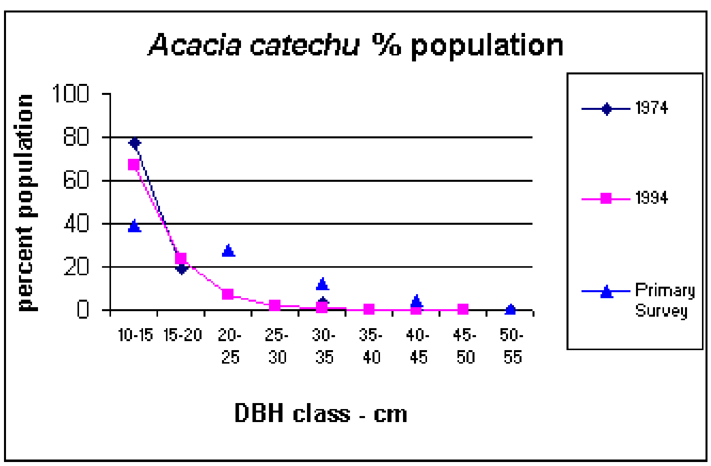


Figure 2 Population distribution of *Acacoa catechu*

Flows and benefits

The Net Present Value at 2006 prices of forests submerged in Govind Sagar Reservoir over a period of 100 years has finally been calculated. This value works out to Rs 65.4 crore for the entire area or Rs 1.1 lakh/ ha. These values indicate net income from sale of timber, fuelwood, bamboo and NTFPs (Non Timber Forest Products) such as grass and *Katha* (*khair*). It would be pertinent to point out that these values are based on maximum possible production, subject to strict implementation of the Working Plan prescriptions.

The observed MAI in the submerged area ranged between 0.62 m^3 / year to 0.68 m^3 / year. This low value of MAI is typical of highly degraded forests, which is characterised by open canopy and scanty vegetation. This observation is further supported by records of Working Plans, which mention that forests prior to submergence were burdened with heavy grazing and invaded by uneconomical weeds such as *Carissa, Dodonea* and *Euphorbia*. It has been further stated that these forests were continuously subjected to soil and water erosion due to sparse vegetation.

It will be safe to assume, therefore, that the affected forests would fall either into the category of restoration forests or forests of insignificant production value. (The category 'restoration forest' has been introduced in Chapter 2 of this report).

Discussion

When the Bhakra project was conceived and implemented, the Forest Conservation Act was not in place. Clearly, at that point of time, there was no question of having a budgetary allocation to meet the requirements of forest conservation. In the present scenario, a user agency replicating such a project would have had to pay for Compensatory Afforestation and Catchment Area Treatment, along with NPV of forestland diverted. In terms of our estimates, the NPV is slightly over Rs 1 lakh/ ha (corresponding to an undiscounted value of Rs 3 lakh/ha), which is significantly below the currently prescribed norms. It needs to be noted though that this is due to the fact that production functions of the submerged forests are of limited importance as compared to restorative functions (like nutrient recycling) which are notionally important but difficult to value.

Table 14. Potential flows from the different Working Circles for submerged area of Bhakra

Sr.No.	Forest produce	Working Circle	Interval of felling cycle (years)	No. of felling cycles	Per ha net value(undiscounted) (Rs.)	Net value for Bhakra (Rs.)
1	Timber	Fuelwood	45	2	102072.03	61376181.53
2	Fuelwood	Fuelwood	45	2	10462.5	6291128.868
3	Bamboo	Bamboo	4	8	4920	176169296
4	Grasses	Miscellaneous	1	49	291.16	22597904.48
5	Khair	Miscellaneous	15	4	181438.23	1030387680
	Total				299183.92	

Background and approach (Uri)

Uri hydroelectric project is a run-of- the river type project located on river Jhelum in the state of Jammu and Kashmir. Length of the barrage is 93.5 m and height is 21.5 m from the deepest foundation This project benefits Jammu and Kashmir, Punjab, Uttar Pradesh, Haryana, Delhi, Himachal Pradesh, Rajasthan and Chandigarh. A total of 300 ha of land including 54.7 ha of forest land and 55 ha of Government land has been used for activities like for construction of barrage, powerhouse, and administrative and residential complexes (NHPC 1992). The project was given clearance by the Government of India for diversion of 54.7 ha of forestland.

The forest flora is dominated by tree species such as Cedrus deodara, Juglans regia and Aesculus indica, and shrubby species like Parrotiopsis jacquemontiana, Indigofera spp., Fragaria spp.etc. As per the Working Plan of the Baramulla Forest Division, the natural vegetation of the area falls under Kashmir Montane and Valley sub-alpine forests types. Tree density of the forests ranged from 0 .2 to 0.5, which indicates that majority of this land had open and scanty vegetation. Working Plan records suggest that the area has economically important medicinal plant species namely Dioscorea deltoids, Sausuria lappa (roots), Atropa belladonna (leaves), Podophyllum emodii and dhoop, especially in the higher altitudes. The Forest Department has been collecting these species for sale.

Thus, apart from the standing biomass of the forests-a typical feature of the production forests-the forests of Uri have conservation value in terms of medicinal plants. However due to the seasonal nature of the medicinal plants, conservation value of the area could not be ascertained during the field survey.

Calculation of NPV

Four components of the project that are critical to the calculation of NPV are:

1. Actual forest area diverted out of the proposed 54.7 ha
2. Efforts and present status of the Compensatory Afforestation
3. Catchment Area Treatment (CAT) activities
4. Restoration of dumping sites.

In order to estimate the quantity of standing biomass a sample survey was undertaken in the last three categories, the details of which are given in the table below[13]. In case of diverted forest area, standing biomass was estimated using the data given in the Working Plan.

Table 15 Category- wise details of area sampled

	Compensatory afforestation	Catchment Area Treatment	Dumping Restoration
Area (ha)	123	240	95
No. of plots	6	10	5

Plantations raised as part of Compensatory Afforestation, Catchment Area Treatment and restoration of dumping sites are not going to be harvested in the future (Altaf Gilani[14] *pers. com.*). These plantations have been raised to control soil erosion, measurement of which is difficult in a very short duration[15].

Hence, calculation of (projected) timber and fuelwood flows from CA, CAT and dumping site plantations may not be meaningful in this specific case. (However, in a notional sense, we can consider a second scenario where these flows are computed, since the trees do have a standing value (timber, fuelwood) that would be relevant in situations where extractions would actually occur.)

Area diverted for the project

Out of the 54.7 ha forest area sanctioned for diversion, only 10 % of the area was actually diverted. This land was mainly used

13 It should be noted the methods adopted for quantification of biomass are similar to that in case of Bhakra, and hence not repeated.
14 DFO, Baramullah
15 Services offered by these plantations can be measured mainly in terms of soil conservation. However, soil not only from the nine micro-watershed catchments treated under CAT flows into Jhelum ,but the area all the way from Wullar lake contributes to the overall silt in the Jhelum. Hence, measurement of avoided soil erosion require a long term monitoring over a wider geographical scale which was not possible during this short duration study.

for construction of barrage. Therefore, we have considered only 5.47 ha of forest area for calculation of NPV.

As per the records of the Baramulla Forest Division about 134 *Cedrus deodara (Deodar)* trees have been felled for the purpose of the project, mainly from Buniyar village. For the purpose of NPV calculation, the net value of timber and fuel wood derived from the felled trees has been computed. The timber and fuelwood flows have been calculated based on the MAI (mean annual increment) figures given in the working plan, and assuming a rotation age of 120 years. During harvest of timber, the smaller branches, roots, etc. are used as fuelwood, and hence the periodicity of the fuelwood flow has also been assumed to be 120 years; the dead and fallen wood collected in between for fuelwood has not been considered for the purpose of calculations.

The NPV works out to Rs 10.17 lakh; this is the amount of forest goods that would have been obtained if the land was not diverted. It needs to be mentioned that such calculation is sensitive to the duration of the rotation cycle and time horizon of analysis. In our case, we have restricted our time horizon to 100 years for the sake of consistency with other flow calculations. Hence, we consider only one rotation period.

Table 16 Flow of timber and fuelwood from the diverted area*

	Product	Sale value	Extraction cost in Rs.	Net value Rs.	Per ha Net value
Timber (ton)	157.78	1120098	112009.79	1008088.17	184294
Fuel wood (kgs)	3350	10050	1005	9045	1653.56

Compensatory Afforestation

MoEF granted permission for the diversion of land with the with a condition of raising plantation (Compensatory Afforestation) over an equivalent area of land (54.7 ha). The Compensatory Afforestation was done by the State Forest Department , and was undertaken in a phased manner. The plantations were done using species like *Robina pseudoacacia, Ailanthus excelsa* and *Salix alba,* which are not native to the area.

Table 17 Area brought under Compensatory Afforestation

Year	Area (ha)
1986-87	25
1987-88	58
1991-92	40
Total	123

The initial plantations during 1986 to 1988 were not successful and hence, in 1992 another 40 ha plantation was raised. Therefore, for calculation of flows, expenditure for entire 123 ha has been considered while benefits from 40 ha have been used . The flows have been computed in the table below.

The calculation of flows is based on the duration of felling cycle and the harvestable diameter of the individual species. The information on duration of felling cycle and harvestable diameter for various species is extracted from the relevant Working Plans in case of Bhakra. In case of Uri, since the species are exotic, the information is procured from the State Forest Department. [16] In the tables below, flows have been presented based on the above logic, beginning from the first extraction year. Values of the remaining years of the 100 year time frame considered in this study would be zero; hence for the sakeof brevity, full tables covering 100 years have not been presented.

Table 18 Flows from Compensatory Afforestation#

Year	Total timber (ton/ha)	Total timber price yr wise (Rs. / ha)	Extraction Cost (Rs. / ha)	Net value Rs. / ha
1*	66.83	316306.39	31630.64	284675.75
2	183.07	866448.54	86644.85	779803.68
3	46.49	220050.42	22005.04	198045.38
4	17.43	82518.91	8251.89	74267.02
5	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00
7	0.80	5690.56	569.06	5121.50
8	1.60	7018.01	701.80	6316.21
9	2.40	17071.68	1707.17	15364.51
10	0.00	0.00	0.00	0.00
11	0.80	5690.56	569.06	5121.50
12	0.80	1327.45	132.74	1194.70
13	3.71	15080.60	1508.06	13572.54
14	1.60	11381.12	1138.11	10243.01
15	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
17	1.60	7018.01	701.80	6316.21
18	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00

[16] In case of Uri, beating up was done as per standard procedures. At the same time, due to site specificity, variation in growth of individual saplings was observed. Because of these reasons, in case of Uri, yield is calculated beyond the (defined) felling cycle of the plantations.

Year	Total timber (ton/ha)	Total timber price yr wise (Rs. / ha)	Extraction Cost (Rs. / ha)	Net value Rs. / ha
20	0.80	1327.45	132.74	1194.70
Total		1556929.68	155692.97	1401236.72

*2022 (first extraction year)

Flows have been calculated using 2006 price of fuelwood, provided by the forest department

CAT plantation

The State forest department of Jammu and Kashmir prepared a detailed CAT (Catchment Area Treatment) plan for NHPC in 1994. It covered about 5000 ha of degraded area spread over 13180 ha covering nine micro-watersheds. As part of CAT, plantations were raised over 240 ha area- using species which are not native to the area. The CAT was done by the State Forest Department by formulating Uri CAT Project.

The flows have been computed in the table below. For calculation of flows, as mentioned earlier, we have used the conventional economic rotation age of the species concerned.

Table 19 Flow of timber from the plantations of CAT

Year	Yr. Wise (ton/ha)	Price in Rs. / ha	Extraction cost (Rs. / ha)	Net value / ha
1*	48.42	92368.44	9236.84	83131.60
2	59.22	244287.36	24428.74	219858.62
3	47.22	216292.08	21629.21	194662.87
4	47.52	224912.16	22491.22	202420.94
5	13.20	62475.60	6247.56	56228.04

Table 20 Flow of fuelwood from the plantations of CAT

Year	Total fuel wood (kg/ha)	Price (in Rs /ha)	Extraction cost (Rs. / ha)	Net value / ha
1*	550	1156.25	115.625	1040.625
2	1025	2725	272.5	2452.5
3	875	2387.5	238.75	2148.75
4	900	2475	247.5	2227.5
5	250	687.5	68.75	618.75

* - Year 2025 (first extraction year)

Dumping site

Project activities have resulted in excavation of of approximately 55 lakh cu.m of muck. . This muck was dumped at ten designated sites. Similarly, a quarry site was selected for excavation of material for use in construction. In order to restore the area of dumping sites and the quarry, Uri CAT

Project and National Environmental Engineering Research Institute (NEERI), Nagpur suggested an action plan through an integrated biotechnological approach. Under this action plan plantations were raised over an area of 95 ha during the period 1997-1999. Exotic species namely *Robinia pseudoacacia, Ailanthus excelsa and Poplar* were planted under this scheme. The performance of these plantations has been assessed by field survey. The flow of timberand fuelwood from these plantations have been calculated based on volumetric equations and monetary benefits have been calculated based on 2006 prices.

Table 21 Flow of timber from the Dumping sites

Year	Year wise (ton/ha)	Price Rs. / ha	Extraction cost Rs. / ha	Net Value Rs. / ha
1*	616.89	1059703	105970.27	953732.42
2	45.84	97701.24	9770.124	87931.116
3	24.06	84061.11	8406.111	75654.999
4	5.4	25558.2	2555.82	23002.38
5	27	127791	12779.1	115011.9
6	59.4	281140.2	28114.02	253026.18
7	48.6	230023.8	23002.38	207021.42
8	23.4	110752.2	11075.22	99676.98
9	3.6	17038.8	1703.88	15334.92
10	0	0	0	0
11	0	0	0	0
12	1.8	8519.4	851.94	7667.46

Table 22 Flow of fuelwood from the Dumping sites

Year	Total fuelwood (kg/ha)	Price in Rs. / ha	Extraction cost in Rs. / ha	Net value Rs. / ha
1*	1850	3700	370	3330
2	100	200	20	180
3	200	531.25	53.125	478.125
4	75	206.25	20.625	185.625
5	375	1031.25	103.125	928.125
6	825	2268.75	226.875	2041.875
7	675	1856.25	185.625	1670.625
8	325	893.75	89.375	804.375
9	50	137.5	13.75	123.75
10	0	0	0	0
11	0	0	0	0
12	25	68.75	6.875	61.875

* - Year 2028 (First year of extraction)

It should be mentioned here that the plantations on the dumping sites have resulted in stabilization of dumps, as evident from natural regeneration of species such as *deodar* in the dump sites.

The Compensatory Afforestation, Catchment Area Treatment (CAT) and dumping site restoration activities under the Uri Project were undertaken by having a separate institutional arrangement with the State Forest Department of Jammu and Kashmir. NHPC supported the work financially for a defined period.

Discussion/ Issues for consideration

- Management of plantations and maintenance of bunds and other structures created by the project are eventually handed over to the Forest Department. This often imposes additional work on the Forest Department, given staff and resource constraints. A project therefore needs to build into its design adequate institutional provisions for maintenance functions.
- It is evident that the requirement for forestland was overestimated in case of this project. Use of appropriate technologies has made it possible to avoid use of all of the forestland that was initially asked for. There is perhaps a case for relaxing the requirements of FCA 1980 in terms of CA in such situations.
- Introduction of exotic species needs to be carefully considered, given that once such species are introduced, a mitigation strategy is difficult to adopt. The overall planning process for CA/ CAT needs to take into account the need to preferentially use indigenous species over exotics, as far as possible. *Funds consolidated into CAMPA may be used to develop stronger technical capacities to deal with the issue of the choice of species and to assess the trade-offs between planatation of indigenous and exotic species.*

Constraints in computation of goods and services

In this section, we discuss specific constraints that prevent a complete enumeration of flows from forest goods and services in a general context.

The Millennium Ecosystem Assessment (MA) process represents the most recent international initiative to assess functions of ecosystems and track these over time. The range of forest functions identified by MA includes those that are identified by the Chopra Committee. While one can conceptually argue for including large sets of ecosystem services as part of valuation (and tracking) exercises, inadequacy of institutional mechanisms (and knowledge gaps) prevent these from actually getting included in real-time decision processes.

For example, in the case of calculating watershed services from forests, there are usually no water flow monitoring arrangements (similar to rain gauge stations) in various kinds of forests. The same is true with regard to measurement of soil erosion phenomena. *Essentially, lack of periodic data prevent tracking of watershed and similar services.*

The following table summarizes the goods and services that the present report considers for the purpose of calculating NPV.

Table 23 Relevance of forest goods and services in the present cases

Goods and Services (as identified by Chopra Committee)	Bhakra	Uri
Timber	Done	Done
Carbon storage value	Done [17]	Not applicable due to small extent
Fuelwood and fodder	Done	Done
Non timber forest produce (including grass)	Done	Done
Eco-tourism	Data deficient	Data deficient
Watershed services	Data deficient	Data deficient
Biodiversity (treated notionally)	Data deficient	Data deficient

The data deficiency in case of eco-tourism and watershed services can only be tackled with the help of available studies with which are admittedly inadequate in terms of basis of data and methodologies used. But possible approaches to deal with the issue is discussed below.

Eco-tourism indicators: For each available case-study, we can assign some 'indicators' based on characteristics of the study area. These indicators would help in comparing other sites with those actually studied. In the table below, we do this for the few case-studies carried out in India. We note that the case-studies display an extremely wide range of values (Rs 36.85 – Rs 20944/ ha) due to differing methods used and site-specifc variations.

Table 24 Case-studies for ecotourism and recreation values

No	Study	Value (Rs.)	Indicators assigned
1	Keoladeo National Park (Chopra and Adhikari 2004)	Rs. 16197 per hectare	1. Migratory bird habitat 2. Developed infrastructure for tourism 3. Conservation of rare bird species 4. Important wetland
2	Keoladeo National Park (Murty and Menkhaus 1994)	Rs. 20944 per hectare	As above
3	Borivli National Park	Rs. 23300 per hectare	1. Conservation of forest ecosystem

[17] Discussed in this report in the context of avoided GHG emissions

No	Study	Value (Rs.)	Indicators assigned
	(Hadker et al 1997)		2. Crucial ecosystem next to financial capital of India 3. Conservation of species diversity
4	Kalakadu Mundathurai Tiger Reserve (Manoharan 2000)	Rs. 36.85 per hectare	1. Conservation of Western Ghats forest ecosystem 2. Conservation of flagship species – tiger along with other species diversity
5	Periyar Tiger Reserve (Manoharan 1996)	Rs 676 per hectare	1. Conservation of Western Ghats forest ecosystem 2. Conservation of flagship species – tiger along with other species diversity 3. Model of eco-development activities in India[18]

The above-mentioned studies have all been done in the context of areas already recognised for conservation importance (in the form of Protected Areas). There have been no studies which have looked at such services outside the protected area network. Neither Bhakra nor Uri therefore qualify for comparison with these studies. However, in case of sites that match the indicators, the relevant estimate can be picked up for valuation purposes.

Watershed services: The functions related to watershed depend upon extent of forests available in the catchment area, slope, type of soil, rainfall in the area and so on. India has diverse kinds of forests in various stages of anthropogenic influence. The available studies provide generalized estimates for forests at much coarse scale. A table sourced from Kumar et al (2006), that provides us an indicative value for watershed services at the state level, is provided in the Annexure. However, the values provided are at an aggregate level and are not amenable to site specifc application. The best that can be done is to enhance institutional capacities to generate values for watershed benefits at specific sites – through suitable measuring devices. We propose that till such time these arrangements are not implemented, watershed values calculated for specifc sites are not extrapolated to higher scales or applied to other sites.

[18] Periyar Tiger Reserve (PTR) represents a success story with respect to implementation of Integrated Conservation Development Projects, and was of the sites covered by the well-known Indian Ecodevelopment Project (IEDP).

CHAPTER 6 Payments regime for diverted forest land

Rationale of charging NPV for diversion of forest land

Determination of the rationale of any land-use change requires assessment of the net benefit of the change. Thus, when forest land is being converted to a reservoir for hydropower generation, one needs to look at the stream of benefits (and costs) associated with each of the two land-use types.

Land-use change is essentially a policy (political) decision. The planner must decide the weights to be attached to each of the benefits and costs, while the economist could help develop methods to value these (and provide possible scenarios). The policy decision could be motivated by the following considerations:

Deterrence (Nature of land diverted): Certain land-use types provide ecological services that cannot be substituted, and hence the value placed on these has to necessarily infinitely high. A natural forest hosting a large number of endangered or endemic species would belong to such a category. (In India, about 5% of land area has been declared “Protected Areas”, and human interference in these areas is severely restricted by law.) Clearly, numerical estimates of values for such lands cannot be used as a basis for a policy decision. In other words, trying to place a numerical estimate on the value of these forests, given our current understanding of the ecological services provided and the potential for future use, would result in a gross under-estimation and, hence, would be of limited policy use. An alternative approach to facilitating the policy decision on diversion of conservation forests could be based on three factors (i) a comparison of costs and benefits of *known* services/functions across the alternative land-uses (ii) the potential of the land diversion to destabilise the ecosystem balance, and (iii) the nature of the good being provided by the alternative land-use – public [19]. While, the first could have a quantitative basis, the second would necessarily be a more subjective evaluation governed by the ‘precautionary principle’[20].

[19] Public or private provision of a public good should not influence this decision as long as appropriate safeguards are put in place.
[20] The precautionary principle is the idea that if the consequences of an action are unknown or subject to a high degree of uncertainty, but are judged to have some potential for major or irreversible damage, then it is better to avoid that action.

In any case, determination of NPV of forest land with high ecological values is fraught with uncertainties. The existing literature reports a wide range of values for specific ecosystem functions such as soil conservation and biodiversity. Moreover, the results, wherever reported, are location specific and extrapolation of these to an entire forest category (such as dense or open) is problematic. Hence, we argue that for such forest land, numerical NPV estimates are of limited policy relevance.

Polluter Pays: Where a land-use type produces a stream of benefits that can be potentially replaced, then the agency causing the change could be asked to pay for the loss of benefits. In this case, however, the alternative land-use would also create a new stream of benefits, and the difference between the two needs to be taken as net benefit of the land-use change.

Nature of the alternative land-use (private or public): The alternative land-use may lead either to a creation of a public or a private good. The degree to which a public good is to be provided is essentially a policy decision. Typical public goods are defence, and environmental goods such as pure air and clean water in a stream. As mentioned below, conversion of a conservation forest to a land-use that generates a public good should be treated differently from one that generates a private good.

We argue that NPV calculations for forest land are relevant only for a subset of decisions. The following table illustrates:

Table 25 Forest types and alternative uses

Forest type / Alt. Use	Conservation	Production	Restoration
Public	Diversion through policy decision	NPV based on dominant values*	NPV based on restorative value
Private	No diversion by law	NPV based on dominant values*	NPV based on restorative value

* Production values and dominant ecosystem attributes

Thus, we argue that calculation of NPV of forestland is not relevant in case of conservation forests from a policy view-point. The decision of land-use change in this case depends on the alternative use (public and private). In case of other forests (production and restoration). NPV calculations are relevant; and these are to be based on the (known) dominant values. In these cases, NPV of forestland should not be looked at in isolation; it should be looked in conjunction with NPV of the project benefits and costs. (The Kanchan Chopra Committee report in fact lays down broad principles based on which users can be given exemption from payment of NPV.)

In this regime, Compensatory Afforestation (CA), is a mandatory obligation of the project as per the Forest Conservation Act 1980, and in the light of the National Forest Policy target of bringing 33% of the area under forest cover. The Planning Commission, in its "Approach Paper to the Tenth Five Year Plan, September 2001" has stipulated increase in forest/tree cover to 25% by 2007 and 33% by 2012 (end of 11th Five year Plan). This has now been included as one (out of thirteen) of the monitorable targets for the 10th plan and beyond. Catchment Area Treatment (CAT) is also an integral project component, benefiting the project itself while mitigating losses due to deforestation. (The Kanchan Chopra Committee suggests a different regime, stating that payment of NPV alongwith ground rent should replace all other payments)

The next two sections pay special attention to two issues that affect the payments regime for forestland diversion.

Electricty as a public good

A public good is a good that is hard or even impossible to produce for private profit, because the market fails to account for its large beneficial externalities.[21] The key characteristics of a public good are that its consumption is non-rival and non-excludable. It is a policy choice to treat electricty as a public good which must always to available to everyone at predictable and reasonable prices (as opposed to reaping the benefits of free market competition) (Morgan, 2005). Given adequate capacities in the system, it can be argued that electricity consumption is non-rival and non-excludable, and hence a public good.

Electricty clearly generates public benefits that cannot be captured in prices charged by private producers. In this sense, electricity has public good attributes contributing to the broader goals of social and economic development. This indeed is among the dominant rationales (along with the natural monopoly argument) for government regulation of the electricity sector.

In terms of our argument of building a suitable payments regime for diversion of forest land, this has important implications. Electricity generation, by our argument, is an activity of public interest much like defence or highways. If there is a case for diverting forestland with high conservation

[21] http://en.wikipedia.org/wiki/Public_good

value, then it becomes an issue of balancing two competing public interests, rather than a public and a provate one. In this case, as per FCA 1980, the hydro utility would be required to pay for CA, CAT etc; however, there would not be a case for payments for the ecological services lost since a monetary compensation can neither act as deterrent nor replace the services lost. The diversion can be justified only based on policy-level evaluation of two competeing interests.

Also, seen from the perspective of the Government India that is spending huge resources and effort in ensuring India's energy security, it is apparent that access to energy in adequate quantities and quality is imperative to the economic and social development of the country. By calling for bids for hydro power development based on the premiums offered by various bidders, the Government of India is ensuring that the rents accruing to project developers through the diversion of forest land are returned to the government for use as considered appropriate for the larger good of the people of India.

Provison of free power to home state

Hydropower producers are required to provide 12% free power to the home state. This can be viewed as a 'compensation' to the home state for utilisation of resources available in the state (a combination of water and topographical features in this case). (The free power provision is meant to faciltate local area development (LAD) and/or mitigate hardship caused to PAPs.) In a sense, this represents a payment to the home state for benefits that flow outside the state. The rationale for such payments can be critiqued on the ground that the hydroproject pays for R&R measures in any case, and also directly or indirectly contributes to LAD. This then becomes an issue of inter-state compensation sharing, where the state which hosts the resource receives (in effect) a monetary payment from states that benefit from the good that the resource generates. The extent to which this should be allowed is a policy decision beyond the scope of analysis of this report.

However, we do argue that payment of NPV of diverted forestland is not justified on the stronger ground that the project generates high volumes of benefits especially in terms of contribution of electricity to the GDP. The modes of sharing of these benefits among states (as in the case of free power) is an inter-state issue which should not affect the general argument that payments based on computation of values of forestland alone are not justified.

Critique of the Kanchan Chopra report

Background to the report

As mentioned earlier, the National Forest Policy 1988 mandates maintenance of a minimum of one-third of the land area of the country (and two-third in hilly and mountainous regions) under forest cover. The Policy also requires subordinating economic benefits from forests to ecological services that they provide over the long run. Currently, India has just over a fifth over its geographical area, and hence the Policy (in principle) demands bringing substantial amount of additional area under forest cover. At the same time, maintenance of land under forest cover imposes an opportunity cost – in the sense of foregone development activity. In other words, the limited (finite) amount of land available within the country must meet current development needs without compromising conservation (or future development needs) – the classic dilemma of sustainable development.

The mechanism through which the issue could be addressed is essentially based on the Polluter Pays Principle, where the user diverting forest land (for a non-forestry purpose) pays for afforesting at least equivalent amount of land. In the Indian context, the Forest Conservation Act 1980 lays down guidelines for such payment. Under Section 3.2 of the Act, Compensatory Afforestation (CA) needs to be done either over equivalent area of non-forest land, or over degraded forest land twice in extent to forest area being diverted, when non-forest lands are not available. In addition, for hydro-electric projects of more than 10MW capacity, payment for Catchment Area Treatment (CAT) is also mandatory. As per a 2003 G.O., users are also required to pay Net Present Value (NPV) at a rate in the range of Rs 5.8 – 9.2 lakh per ha to account for the loss of the full range of forest goods and services.

In this context, two broad issues arise:

1. Whether CA - in the sense of afforesting (at least) equivalent amount of land - compensates for the loss of the full range of ecological services, as per emphasis of the 1988 Policy.
2. Whether CA and NPV together compensate for the loss of the full range of forest goods and services, or does it amount to double counting

Besides these, at an empirical level, one can question the logic of determination of the specific range of per hectare values (NPV), since forests differ much more widely in terms of ecosystem services, thus making such a narrow range implausible. We have shown in this report that estimates for watershed services, for example, are too wide-ranging to have any site-specific applicability.

Content and critique of the report

The issues mentioned above is currently receiving added attention due to the recent (2005) Supreme Court judgment No. 826 [in I.A. No. 566], saying that NPV should be worked out on 'economic principles'. The Supreme Court also appointed an Expert Committee (Kanchan Chopra Committee), comprised of leading environmental economists to determine, among other things, the nature of uses that could be exempted from the payment of NPV.

The Committee has recommended 30% exemption to hydro projects from the payment of NPV. [22] The Committee also recommended that payment on account of NPV alongwith ground rent represents full payment for loss of forest goods and services, and there is no need for any further payment on account of compensatory afforestation or any other rental.

In a sense, therefore, the Committee takes the stand that the current regime is fraught with issues of double/ multiple counting, and the NPV route can do away with such multiple payments. In addition, the Committee also recommends that unlike the present arrangement where all forest-related payments are put in a centralized fund – Compensatory Afforestation Fund Management and Planning Authority (CAMPA), the payments now to be collected are to be split among a Local Forest Fund, a State Forest Fund and a National Forest Fund. Besides, the payments for each of these funds are to be based on the nature of forest good/ service being accounted for. Thus, payments for fuelwood and NTFPs accrue to the local fund, whereas payments for carbon values go to the national fund.

The Committee therefore envisages a regime shift for payments on account of diverted land on two counts:

- Shift from multiple payments to single payment
- Shift from centralized management of payments to (a scheme of) distribution of NPV at three levels – with due recognition to local stakeholders

This formulation can be critiqued on several counts:

- The extent to which NPV represents full payments can be questioned, as forest services have been defined in a relatively narrow sense (included only watershed and ecotourism, with biodiversity only accounted for at a notional level.)

[22] This exemption is based on principles laid down in Sec 4.2 of the Committee report

- The blanket prescription of 20 year time horizon, and 5 percent discount is unlikely to capture benefits associated with timber species with longer rotation periods, and those associated with forest services
- The linkages between the principles for claiming exemption from NPV payments, and actual exemptions have not been adequately explored.

We have already argued that except in the case of conservation forests, any payment regime needs to be based on a comparison of NPV of the project and NPV of the forestland lost. It is clearly inappropriate to consider the NPV of forest land (in whatever way determined) in isolation. There are obvious knowledge gaps that prevent us from assigning ecotourism and watershed values to any specific site based on estimates carried out elsewhere. Hence, a reasonable approach would be to focus on known values (largely tangibles) while determining NPV of forest land in any specific case unless a long-term study or appropriate measuring arrangements (say for watersheds) are implemented.

CHAPTER 7 Economic benefits of the two selected projects

Introduction

This chapter looks at the economic benefits of hydro projects. Typical benefits of reservoir type projects (like Bhakra) are irrigation, electricity, employment, and in most cases fisheries and tourism. In case of run-of-the-river projects (Uri), the key benefit is electricity along with employment creation. For each benefit, literature review is provided followed by methodology and results.

Broad approach

In this report we are considering two projects, Bhakra Nangal project and Uri HE project, that have been built in the past and benefits have been flowing from them after they were constructed. Since we have the advantage of having data on benefits after the construction, we are carrying out an exercise that discounts all benefits to the base year, which corresponds to the year of commencement of each respective project, i.e. 1954-55 for Bhakra and 1997-98 for Uri. The valuing of benefits is being carried out using a common numeraire which is the 2004-05 price level. Using constant year prices helps in assessing the real growth that has taken place thanks to a development project. The literature on discounting states that there are two ways to value benefits in present value terms[23]. One way is to value all benefits in current prices and discount them using a nominal discount rate 'i' that takes into account inflation as per the formula $(1 + i) * (1 + \pi)$, where π is the rate of inflation. The second way is to use constant prices and discount the flow of benefits using a real discount rate 'r'. Both these methods are equivalent as they lead to the same present value as can be seen by the following. If we represent real price by p_o and nominal price by p_t in year t, then they can be related by $p_t = (1 + \pi)^t * p_o$. The present value of benefits can be written as the following:

$$\Sigma\, p_t\, b_t / [(1+r)*(1+\pi)]^t = \Sigma\, p_o\, b_t / (1+r)^t$$

P_o can be considered as the numeraire when valuing at constant prices. In our report we the latter technique of constant prices by considering the 2004-05 price level to value all benefits in all years. The choice of numeraire does not affect the evaluation outcome. We have chosen a real discount rate 'r' of 8 percent.

[23] "The Economic Evaluation of Projects", R. Broadway, Queen's University, Kingston, Canada

Murty and Goldar (2006)[24] recommend this time preference rate of 8 percent for economic evaluation of investment projects in the Indian economy. This is based on their estimates of the value of elasticity of social marginal utility of income and targeted income growth rate by the Indian government.

Irrigation

Background

Agriculture has always occupied an important place in India's GDP. It has been and continues to be the major livelihood option for the rural masses. Agriculture in the country is largely rainfall dependent and is thus subject to the vagaries of the monsoons unless there are provisions in place to safeguard against them. Historically, rulers in India have tried to combat these vagaries by building irrigation and water storage systems for crops and drinking water supply (Rangachari et al, 2000). The latter half of the twentieth century saw the construction of more than 3000 dams in India[25]. Irrigation is at least one of the main objectives of 96 percent of all dams built in India. The other objectives include, hydropower generation, flood control and drinking water supply. Dams with irrigation as the main objective were constructed to turn India into a food secure nation (Rangachari et al, 2000).

Irrigation in Punjab developed from the ancient times. The land of the five rivers witnessed the development of a network of inundation canals (Shiva, 1991). Modern irrigation systems were preferred over these inundation canals towards the end of the 19th century in the Indus Valley. The Upper Bari Doab Canal (1859) and the Sirhind Canal (1872) were the major works benefiting Punjab during that time. However there was no storage system in place until the construction of BNP (Verghese, 1994).

At the time of independence Punjab was divided into East Punjab and West Punjab. Pakistan was given 18 mha of the total 117 mha of undivided India, of which 48 percent was irrigated. India got the remaining 99 mha, of which only 19 percent was irrigated (Rangachari et al, 2000). The Bhakra-Nangal dam, with irrigation as its main objective, was one of the major development programs outlined in India's first Five Year Plan (1952-57). Southeast Punjab was subject to periodic droughts in the beginning of the twentieth century (Verghese, 1994). The Bhakra project thus aimed at bringing drought-prone areas

[24] Economic Evaluation of Investment Projects in India: A Report submitted to Planning Commission (Murty and Goldar: August 2006); Institute of Economic Growth
[25] http://www.indiatogether.org/2005/dec/eco-damsnpv.htm accessed on 31st July 2006

under canal irrigation. The Bhakra project was designed to provide annual irrigation to 1.46 million hectares-0.55 million hectare in Punjab, 0.68 million hectare in Haryana and 0.23 million hectare in Rajasthan (Vaidyanathan, 2005).

Review of literature on irrigation contribution to agricultural production

As mentioned earlier, the spread of irrigation was undertaken to make India a food secure nation. Published literature on irrigation indicates how irrigation contributes to agricultural production (Pal, 1985; Dhawan, 1993; Vaidyanthan, 1994, Rangachari, 2006). In particular it contributes to increased agricultural production in three ways (Pal, 1985)-

- By making double or multiple cropping possible and thereby effectively increasing cropped area

- By facilitating changes in cropping patterns by inducing farmers to allocate their land towards high value and high yield crops, which require assured and timely water supply, such as wheat, paddy and sugarcane.

- By facilitating the use of complementary inputs such as fertilizer, pesticide and HYV seeds

A shift in the cropping patterns was indeed brought about as wheat and paddy began to divert acreage away from coarse grains, pulses, oilseeds and gram (Verghese, 1994). This shift in the cropping pattern was brought about with the advent of the Green Revolution in 1967 and was seen as being more profitable to the farmers (Verghese, 1994). Moreover, the Green Revolution laid stress on the use of new and improved high yielding variety (HYV) seeds, fertilisers, pesticides and more irrigation. High yielding variety wheat seeds were introduced in 1967 and high yielding variety rice seeds were introduced in 1970 (Rangachari, 2006). The rise in food-grains production has largely been attributed to the Green Revolution (Verghese, 1994; Rangachari, 2006). "*The main source of increase in the productivity of wheat and rice since the mid-1960s has been the introduction of irrigation and the adoption of HYV seeds.*", Rangachari (2006). Given that the Green Revolution entailed increased irrigation, the emergence of the Bhakra Nangal dam was seen to be a major contributor. "*... there is little doubt that the green revolution has transformed Punjab and Haryana and that this would not have been possible but for Bhakra-Pong. Deprived of their waters Punjab and Haryana would have remained semi-arid tracts except for some modest and uncertain inundation irrigation.*", Verghese (1994). With the initiation of the Green Revolution in 1967, Punjab increased its production of wheat from 2 million tons to 5 million tons between 1965 and 1971. In Haryana in the mid-1960s wheat production was about 1 million tons. This more than doubled by the end of the 1960s (Mathur et.al., 2005).

Other authors are more critical about the so-called “success” of the Green Revolution. It is argued by Shiva (1991) that the new “miracle” seeds introduced by Norman Borlaug were part of a technological “package” of the Green Revolution. This package was based on intensive use of chemical fertilisers and pesticides, as well as the increased use of irrigation. There were several associated biological and environmental costs that came about as a result of the Green Revolution. Historically peasants planted their own seeds which they considered the best and allowed nature itself to renew them, and this self-renewability ensured a rich genetic diversity in the grains. Traditional mixed farming systems were thus replaced by monoculture under the Green Revolution. Less diversity leads to lower resilience and resistance- this is noted by the author when she highlights that HYV seeds are more susceptible to new biotypes of diseases and pests as opposed to traditional varieties. The author also highlights associated environmental costs that came about as a result of increased pesticide and fertiliser use, and increased irrigation requirements. However, the author does not substantiate her argument with numbers when she states, “*In the absence of additional inputs of fertilisers and irrigation, the new seeds perform worse than indigenous varieties. With the additional inputs, the gain in output is insignificant compared to the increase in inputs*.” The many environmental costs listed out by the author include destruction of soil fertility, micronutrient deficiency, soil toxicity, water logging and salinisation, desertification, and contamination of food and water. One point that does however come across clearly from the author’s arguments is that the Green Revolution did not come without its costs.

Another detailed study of the Bhakra Nangal project concludes that the Bhakra Nangal project has not played a key role in India 's Green Revolution, food self- sufficiency or agricultural growth in Punjab or Haryana (Dharmadhikari, 2005). The author is of the opinion that the claims made about Bhakra’s contribution to agricultural production are exaggerated. The author claims that Bhakra canals have not reached their potential, as they did not add any new areas under irrigation. There has just been a transferring or shifting of irrigation from one area to another. The only additional areas that are served are the Hissar tracts in Haryana and some parts of Rajasthan. Questions are therefore raised about the necessity of Bhakra for extending the irrigated area and its contribution to increasing water availability in the dry season. The author claims that, “*It is not likely that the scenario in Punjab and Haryana would have been much different without Bhakra*”. But while reading this statement once must recall to mind that southeast Punjab was subject to periodic droughts in the beginning of the twentieth century as is mentioned in Verghese (1994). Making such a statement thus proves difficult to accept as it goes against historical fact. Dharmadhikari is of the opinion that the increase in foodgrain production is mostly attributable to tube well irrigation and not the irrigation from Bhakra canals. Dharmadhikari cites official figures on irrigated area by canals for the late 1990s. These stand at 24 percent and 50 percent respectively in Punjab and Haryana. Since there is more than one canal system operating in each of the states (Western Yamuna in Haryana and Sirhind in Punjab), the area served by the Bhakra canals would work out to be lower. The author estimates that the contribution of Bhakra canals to food grain production is 11 percent and 24 percent respectively for Punjab and Haryana. The remaining contribution comes from groundwater irrigation and seepage from rivers and canals into the groundwater. The author's estimates are based on the State Statistical Abstracts and appear too simplistic from the following statement. "*We estimate the irrigation from Bhakra canals in Punjab will not be more than 25% of the canal areas (in 1989-90). Thus, if the total contribution of the canals to production in Punjab is 43%, then from Bhakra it would be about 11%.*" A result which thus takes into account only one year (1989-90) as representative of the entire period is to be treated with caution.

These results have been challenged in the literature (Vaidyanathan, 2005; Mathur et.al., 2005). Rangachari wrote an article for the Mathur et.al. (2005) publication in which he gives a rebuttal to Dharmadhikari (2005). Rangachari refutes the claim made by Dharmadhikari that despite irrigation commencing in 1954, India still had to import foodgrains in the 1950s and 1960s. Rangachari states that it is incorrect for Dharmadhikari to assume that irrigation benefits should start accruing by 1963. Although physical construction of canals was complete by 1963, India was not free to fill up the reservoir as desired till 1970 under the provisions of the Indus Water Treaty and this affected the number of areas that were potentially irrigable. Irrigation was mostly for the Kharif season based on a run-of-the-river system and whatever limited storage was possible at that time. Hence it is incorrect to claim that Bhakra canals did not serve their purpose in this period. Rangachari also states that the full irrigation development and its associated benefits must be looked at beyond 1970. He says that Dharmadhikari's claims about non-wheat crops being non-performers is disputed by the facts since the increase has been seen for all foodgrains from 1970-71 onwards and this increase has not been limited to wheat alone. Rangachari also refutes the claim made by Dharmadhikari that only a few parts were brought under new irrigation from the Bhakra canals. Rangachari states that in Haryana, the new areas included large parts of districts Hisar, Sirsa and Fatehabad. Ganganagar and Hanumangarh districts in Rajasthan were entirely new in the Bhakra command area. The article by Vaidyanathan (2005) reports that in order to assess the impact of irrigation, one must cover all crops and not just rice and wheat as in done in the Dharmadhikari (2005) study. Estimating the contribution of groundwater and surface water separately requires information on gross irrigated area by source of irrigation for each crop. Such data is currently not available. In order to carry out a comprehensive study, one would have to conduct field-level studies at different time periods. While both the authors give importance to groundwater in irrigation, one criticises the other on the use of sweeping assumptions due to lack of data availability. We have later provided our own estimates for the contribution of canals to increased agricultural output for all crops over all years in each of the districts falling in the Bhakra command.

The Bhakra canals augment the supply of groundwater through seepage and the Bhakra power houses also supply electricity to energise tube wells to lift this groundwater for the purpose of irrigation (Hira et al., 2005). The authors of this study try to estimate the effects of BNP on agricultural production in Punjab. High yielding and high water requiring crops such as the new rice and wheat varieties saw an expansion in cropped area and this led to an increase in the demand for water after the 1970s. They analyse the contribution made by Bhakra towards enhanced agricultural production in terms of canal water supply, groundwater water usage and the electricity used to energise tubewells to lift groundwater. According to them, in the year 2000-01, 0.72 million-hectare meters of water and 3957 million kWh of hydroelectric power were supplied from BNP. Using these figures and the assumption that BNP water irrigates 70 percent of gross cultivated area and 50 percent of the 3957 million kWh are used to energize the tube well in the same area they found out that about two third of the state’s total food grain production is due to BNP. The study however does not account for all crops but only foodgrain crops in different districts. That all crops need to be studied in any analysis of this kind is mentioned earlier (Vaidyanathan, 2005). The study also uses assumptions that are very broad such as that the Bhakra canals irrigate 70 percent of gross cultivated area and that 50 percent of the 3957 million kWh is used to energize tube wells. The estimate of contribution is only for the year 2000-01 for the state of Punjab, and the methodology is not rigorous enough for one to adapt from. Despite the study’s limitations, two points do however comes across clearly- groundwater is important in terms of its contribution to enhancing agricultural productivity, and that Bhakra does provide electricity to energise tube wells to extract groundwater.

Another aspect that can be studied is the multiplier impact of irrigation projects in terms of increased income to the farmers of the region facilitated by increased agricultural production, and the increased employment opportunities for agricultural employment that can increase regional income. One such work in the literature tries to capture the effect of irrigation from the Bhakra canals on the net income of the region during the period 1946-47 to 1964-65 (Chopra, 1972). This study tries to look at the regional effect of the investment on the dualism it introduces between the income of the region in question and the rest of the economy. In the analysis the following benefits are accounted for- (a) additional income accruing to farmers after commencing of irrigation, (b) wage payments to workers, and (c) indirect benefits accruing from expenditure on social services. The costs accounted for include- (a) water rates, (b) land revenue/ rent, and (c) interest paid to the Centre by the project. While evaluating the multiplier effects of the increase in regional income, the beneficiaries from the project area divided into differing categories based on their propensities to respend that income in the region. For farmers the multiplier effects are assumed to accrue only to that part of produce that gets marketed. Another assumption being made is that since the region of study is small, the propensity to import of the rest of the economy would be small and thus can be considered negligible. This assumption seems restrictive since if we consider only Punjab, it has and continues to contribute to a large extent to the central pool of food grains,[26] i.e. approximately 40-50 percent of rice & 60-70 percent of wheat in the central pool in the 1980s and 1990s. The study estimates the stream of benefits and costs over the mentioned time period and their present values. Since only the irrigation aspects are covered in this study, it is not a complete evaluation of the project. The author thus admits that this study is limited in nature from a policy view point. The study uses “with project” and “without project” scenarios to analyse the additional income accruing to the region. But this requires time series data of farm income both “with” and “without” the project which is not available. The study thus draws upon a secondary source which has time series data for output and cost per acre of irrigated and unirrigated land for the period 1952-53 to 1964-65. But this study has a shortcoming as mentioned by the author that it is based on the study of a number of small holdings which have not been selected at random but based on where the requisite data has been collected with the cooperation

[26] http://punjabgovt.nic.in/punjabataglance/LeadingbyExample.htm accessed on 1st June 2006

of the farmer. But since there is no other data on this, the author is left without an option. The estimates arrived at in this study are given as incomes per acre at current prices. The author uses these to arrive at her own estimates after adjusting for costs by making them correspond to the region in question and also correcting for the existence of surplus labour or disguised unemployment. The value of additional income accruing to the region as a result of irrigation increased over the time period. The estimates vary widely with the assumptions made with respect to the extent of disguised unemployment and land rental cost.. As per the study the net present value estimates of the increased regional income vary from Rs. 281 million to Rs. 2508 million at current market prices, depending on the assumptions being made. The reasons why we will not refer to this study for our analysis is that we are restricting ourselves to canal irrigation benefits or the incremental yield from Bhakra canals in the entire network of the Bhakra command. The Chopra (1972) study does not make any distinction between canal and groundwater irrigation. We will later use the methodology outlined in the Dhawan (1999) study that does make this distinction. We later attempt to summarise some new work done on the multiplier effects of the Bhakra Nangal project (Bhatia and Malik, 2005). This study is carried out in a more holistic manner as it also includes the multiplier effects of power generated and not just the irrigation benefits, as is done in the Chopra (1972) study.

The use of contingent valuation methods can also be adopted to arrive at a farmer's willingness to pay for existing or improved irrigation water supply. Such methods lead to a "*direct measure of the economic value of water*" (Tiwari, 1998). In this methodology, respondents (farmers) are asked to think of a hypothetical market for water where water can only be attained for a price. In the Tiwari (1998) study, farmers in northern Thailand were asked if they were willing to pay a price for water supply, and what the price would be, in both the existing situation and a hypothetically improved situation. The results show that the average willingness to pay for existing water supply was $ 20.5/ha (Rs. 947/ ha). This went up to $ 25.75/ha (Rs 1,190/ ha) for an improved water supply condition. These numbers were noted to be higher than the current irrigation fee fixed by the government. The point that emerges from a study of this nature is that using the cost of irrigation supply to value its benefits for agricultural purposes may lead to an underestimation. The author cites other studies that also arrive at similar conclusions. Conducting a primary study of this nature is a project on its own, and hence is beyond the scope of this exercise of ours.

Noted agricultural economist B.D. Dhawan has tried to quantitatively estimate the irrigation benefits of canals in India by estimating the absolute difference between canal irrigated yield and rainfed or unirrigated yield (Dhawan, 1988). The author estimated that the incremental yield gain from canal irrigation has increased from Rs. 2,087 /ha to Rs. 7,132 /ha, at current prices, between 1980-81 and 1992-93 (as reported in Dhawan, 1999). In practice, it is difficult to accurately assess the sole impact of irrigation by source on output. The problem is the existence of complementarities among the inputs used in the production process. Theoretically, the net effect of irrigation on yield should be studied by comparing the yield differences between irrigated and unirrigated lands, after eliminating other sources of variation in yield. But these other sources of variation are complementary to irrigation because of which these cannot be eliminated in practice. Dealing with the problem of complementarity is outlined in the following section.

Methodology adopted

To tackle the problem of complementarity to some extent we use the methodology outlined in Dhawan (1999). This study assumes that irrigation, being an enabling factor for the use of its complementary inputs- such as fertiliser and pesticide- should be given all credit for the increase in agricultural output observed. The author, however, does caution readers not to take this as the sole contribution of the irrigation. Other factors such as fertilisers and chemicals are also important. The precise calculation of irrigation's contribution to increased agricultural production is very difficult in India because of the unavailability of the required data. This exercise requires data on the gross area under different crops as well as their respective yields under rain-fed and irrigated conditions, the latter further differentiated by source such as canal and tubewell. The lack of such data was pointed out earlier in Vaidyanathan (2005). Official statistics do not give the decomposition of net canal-irrigated area by different canals because of which we do not even have reliable estimates of net area irrigated by Bhakra canals, leave aside gross area irrigated by Bhakra canals. Keeping in view these limitations, we have adapted from Dhawan's methodology, through which we arrive at quantitative estimates of Bhakra's contribution towards agriculture in monetary terms.

We now briefly outline the method before proceeding with the calculations. There are two equations with two unknowns to be determined where unknowns are U and I.

$Y=w^{o}(U)+w^{1}(I)$, where $w^{o}+w^{1} = 1$ (1)

w^{o} -- Proportion of unirrigated area
w^{1} -- Proportion of irrigated area
Y -- Overall crop yield (Rs/ ha) which is obtained by dividing the crop output by the corresponding gross cropped area
U –- Overall unirrigated yield (Rs/ ha)
I –- Overall irrigated yield (Rs/ ha)

In equation (1) overall crop yield has been written as a weighted average of overall irrigated and overall unirrigated yield.

$I = m * U$ (2)

In equation (2) irrigated yield (I) has been proposed as a multiple of unirrigated yield (U) where 'm' is a positive number greater than one.

These two equations can be solved for two unknowns 'U' and 'I'. From equations (1) and (2) we can derive:
$U = Y (w^{o} + w^{1} m)^{-1}$
After calculating U, equation (2) can be used to derive the irrigated yield I. Now given the values of U and I, output impact of one hectare of canal-irrigated area is given by the following difference:
Output Impact (Rs/ha) = (f * I) – U, where f is the canal irrigated yield as a proportion of overall irrigated yield. Tube-wells are considered to be superior to canals for irrigation purposes since they contribute more to crop yield (Dhawan, 1999). Now this output impact can be multiplied by gross area irrigated by Bhakra canals to arrive at "gains due to BNP".

Calculation

Using the above-mentioned methodology, a detailed analysis has been carried out for Punjab and Haryana from 1966-67 to 2004-05, and for Rajasthan from 1966-67 to 2002-03. The year 1996-67 has been considered the first year for our analysis due to factors namely- (a) The completion of physical work on the canals was in October 1963. (b) India was not allowed to fill up the Bhakra reservoir as desired or to its capacity till 1970 under the Indus Water Treaty. (c) The green Revolution commenced in 1966-67 with the importing of 18,000 tons of HYV seeds for the first time. (d) The state of Haryana was formed out of Punjab in the year 1966-67 (Mathur et.al., 2005). We have thus chosen the year 1967 as the start of the irrigation benefits for the sake of simplicity and also because there is a lack of data on the exact areas served by the Bhakra canals until the period. Official BBMB records also take into account irrigation from that year onwards.

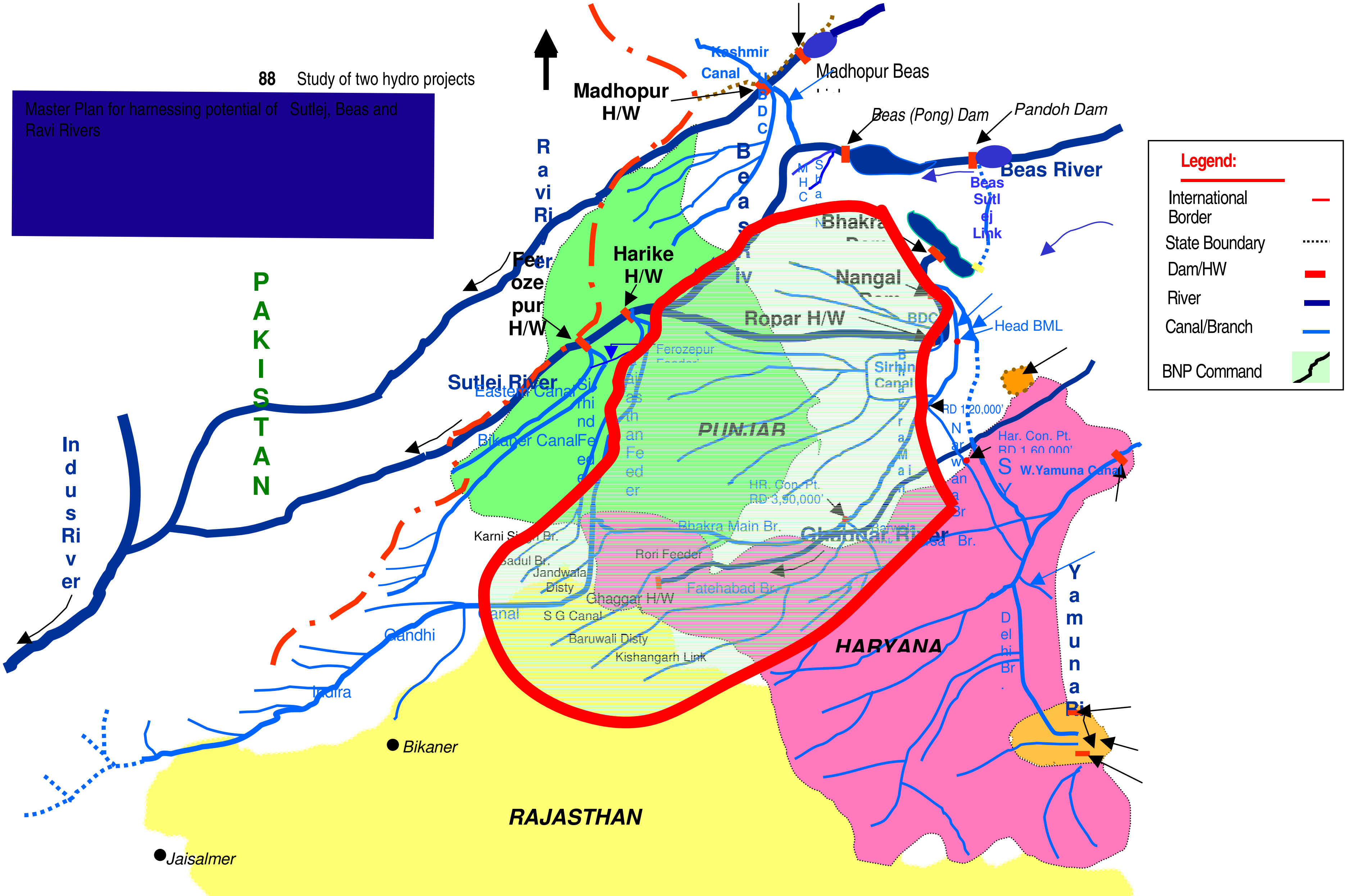
In the analysis three districts of Haryana (Hissar, Sirsa and Fatehbad) and nine districts of Punjab (Jullunder, Ludhiana, Faridkot, Moga, Bhatinda, Mansa, Sangrur, Patiala and Fatehgarh Sahib) have been considered. For Rajasthan we have studied Ganganagar and its break-away district Hanumangarh. These are the districts that come under the command area of Bhakra-Nangal as per a command area procured from BBMB (see map below). Districts in each of the states have undergone changes as shown in the table below. Some of the districts have been formed in more recent years and older districts have split into smaller ones as can be seen from the table below.

Table 26. Formation of new districts and splitting up of old ones

Punjab	Haryana	Rajasthan
Faridkot formed from parts of Firozepur and Bathinda in 1975	Fatehabad split from Hissar in 1997	Hanumangarh split from Ganganagar in 1994
Faridkot trifurcated into Faridkot, Moga and Muktsar in 1995	Sirsa split from Hissar in 1975	
Mansa formed in 1992 from Bathinda		
Fatehgarh Sahib formed from parts of Patiala and Rupnagar in 1992		

Source: http://www.statoids.com/yin.html accessed on 1st June 2006

Overlaps in area do not occur in our analysis since the areas reported in statistical abstracts take into account the formation of new districts.



Source: Map procured from BBMB office at Chandigarh

Figure 3 Command area of Bhakra canal system in the three states

In our study the following assumptions have been made to account for the paucity of data:

1. Since we do not have figures of gross irrigated area served by each source (canals), we have assumed that ratio of gross irrigated area served by canals to gross cropped area is the same as the ratio of net irrigated area served by canals to net cropped area.

2. We have assumed that for a particular state 'm' (irrigated yield/unirrigated yield) is same for all its districts and we have further assumed that this 'm' remains same during the period of our analysis i.e. implicitly we have assumed that overtime unirrigated and irrigated yield change in the same proportion.

3. Analogous to the second assumption we have assumed that 'f' (canal irrigated yield as a proportion of overall irrigated yield) remains same during the period of our analysis.

4. Since we do not have the exact figures of area irrigated by the Bhakra canals for each district, we have assumed that the percentage of the 'gross canal irrigated area' irrigated by Bhakra canals is equal to the percentage of 'district's geographical area' that is in 'Bhakra command' as indicated by the map.

Statistical abstracts of corresponding state have been used to find out district wise crop output, total cropped area, overall crop yield, gross cropped area and proportion of "net area irrigated" served by canals. All the major crops of Punjab, Haryana and Rajasthan as reported in the statistical abstracts have been considered. These include rice, jowar, bajra, wheat, maize, potato, barley, gram, arhar, moong, massar, mash, groundnut, mustard, sunflower, sesamum, sugarcane, chillies and cotton. The 2004-05 wholesale prices have been used to value agricultural output. Along with this, we have used indirect estimates of m (irrigated yield/unirrigated yield), reported in Vaidyanathan (1999) for 13 states for the five-year period 1979 to 1983-84, and f (canal irrigated yield as a proportion of overall irrigated yield), calculated by Dhawan (1999) for the latter half of 1970s. Separate estimates for irrigated and unirrigated yields are not available for all crops- only a few estimates are available which are based on crop cutting surveys (Vaidyanathan, 1999). Total yield estimates are published regularly every year in state statistical abstracts. Based on crop cutting surveys Vaidyanathan (1999) reports irrigated and unirrigated yields in Rs/ha for 13 states. This is derived by considering gross cropped output from irrigated and unirrigated areas. Using the available data estimates of aggregate and per hectare output from irrigated and unirrigated area have been derived. The reported values of m are 2.28 for Punjab, 3.48 for Haryana and 3.33 for Rajasthan. These estimates have been reported at 1983 price levels. But since these are ratios we are considering, inflating price levels to 2004-05 will not affect the ratios. Dhawan (1988) estimates land productivity by source of irrigation for 9 states in India for the second half of the 1970s. Land productivity under canal-irrigated areas is expressed in tons/ha after converting all crops into foodgrain equivalents based on their calorific values. The study indicates that for the 9 states, land productivity under canal-irrigated areas is 90 percent of overall land productivity under all irrigation sources. This 90 percent equivalence proposition between canal-irrigated and overall irrigated yields does not hold at the individual state level. Canal irrigated yield is lower than overall irrigated yield by 28 percent and 37 percent respectively in Haryana and Punjab. The values of f reported in Dhawan (1988) are thus 0.72 for Punjab and 0.63 for Haryana. Since Rajasthan is not covered in the study, we assume f to be the same as Haryana's value, i.e. 0.63.

w^o and w^1 in equation (1) have been calculated using the states' statistical abstracts. Using these values, unirrigated yield (U) has been calculated using the following relation:

$$U = Y (w^o + w^1 m) \exp(-1) \qquad (3)$$

After measuring U from relation (3), we have used the following relation to measure irrigated yield (I).

$$I = m U \qquad (4)$$

Given the values of U and I, output impact (OI) of one hectare of canal-irrigated area has been calculated using the following difference.

$$OI (Rs./ha) = f I - U \qquad (5)$$

Now to arrive at "gains due to BNP", following relation has been used.

$$\text{Gains due to BNP} = (OI)(GIA.\ PSC/100)(PBC) \qquad (6)$$

Where OI--------Output impact
GIA------Gross irrigated area
PSC------ Percentage of "net area irrigated" served by canals
PBC------ Proportion of district's geographical area that is in Bhakra command

Here it should be noted that (GIA. PSC/100)(PBC) is the gross area irrigated by Bhakra canals using assumptions 1 and 4. For the proportion of a district's geographical area that is in the

Bhakra command, Dharmadhikari's (2005) estimates have been used.

Data Analysis

NPV of the gains have been calculated using an 8 percent rate of discount. NPV of gains due to BNP during the period of our analysis comes out to be Rs. 2562 crore for Punjab, Rs. 2610 crore for Haryana, and Rs. 629 crore for Rajasthan. Sum total of NPV of gains for each district since 1966-67 or time of their inception (whichever is earlier) to 2054-55 has been given below.

Table 27: District wise distribution of gains in Punjab

PUNJAB District	Starting date/ formed from	% of district in Bhakra command (A)	Sum Total of NPV of Gains (STNG) (B) (in crores)	Gain (B) as % of total crop output value
Jullundur	1966	66	69	1.5%
Ludhiana	1966	100	123	1.6%
Faridkot	1973	100	492	14%
Moga	1995	100	26	7.2%
Bhatinda	1966	100	1012	22%
Mansa	1992	100	82	17%
Sangrur	1966	100	581	7.3%
Patiala	1966	85	164	2.1%
Fatehgarh sahib	1992	100	2.6	0.7%
Kapurthala	1966	66	10	0.5%

Source: Dharmadhikari (2005) (A) and own estimates (B)

Table 28. District wise distribution of gains in Haryana

HARYANA District	Starting date	Percentage of district in Bhakra command (A)	Sum Total of NPV of Gains (STNG) (B) (in crore)	Gain (B) as % of total crop output value
Hisar	1966	60	1470	17%
Sirsa	1975	100	979	26%
Fatehbad	1997	100	161	23%

Source: Dharmadhikari (2005) (A) and own estimates (B)

Table 29. District wise distribution of gains in Rajasthan

RAJASTHAN District	Starting date	Percentage of district in Bhakra command (A)	Sum Total of NPV of Gains (STNG) (B) (in crore)	Gain (B) as % of total crop output value
Ganganagar	1975	23	560	6%
Hanumangarh	1994	50	69	13%

Source: Dharmadhikari (2005) (A) and own estimates (B)

Sum total of NPV of gains (STNG) for a particular district has been calculated by adding the NPV of gains of that district over the time period in our analysis. One of the first things one notices is that there are variations amongst the districts that fall in the command of the Bhakra canals. This is because proportion of "net area irrigated" served by canals is lower in some districts as compared to others in the same state. Moreover some districts are entirely in the Bhakra command and others are only partially so.

As reported in the statistical abstracts of Punjab, most of the studied districts that lie in the Bhakra command area do not in fact rely too much on canal irrigation. Most of them rely more on groundwater irrigation. For instance, only three districts in Punjab- Faridkot, Bhatinda and Mansa- have more than 60 percent of their irrigated area served by surface canals. Sangrur district of Punjab has more than 32 percent of its irrigated area served by surface canals. The districts in Haryana rely to a much larger extent on surface water irrigation than those of Punjab. In districts Hisar and Sirsa, more than 80 percent of their irrigation is from surface water canals. This figure is more than 65 percent in Fatehabad district of Haryana. In both the districts of Rajasthan, between 90 and 98 percent of the net irrigated is served by canals. Thus the major reason for the decline in “Gains due to BNP” over time in Punjab is the decline in the proportion of "net area irrigated" served by canals. The two districts of Rajasthan do not show as great an increment from the Bhakra canals as do some of the districts of Punjab and Haryana since not a very large part of these districts lie in the command area.

The figures derived above are broad estimates of the gains derived from the BNP. The exact determination of gains requires solving the problem of complementarity and data gaps, which as stated earlier, are difficult in practice. Using this methodology, we do not get purely the irrigation benefits. What we get is in fact the combined contribution of all factors such as HYV seeds, fertilizers etc.

Comparing our results with Dharmadhikari (2005) we note that there are considerable inter-district differences (refer to the last column in each of the three tables above). For Punjab the contribution of Bhakra over the years has varied from lows of 0.5 percent in Kapurthala to 22 percent in Bhatinda. Dharmadhikari (2005) on the other hand derives a result of 11 percent average for Punjab. For Haryana, Dharmadhikari (2005) estimates an average contribution of 24 percent to agricultural output. Our own estimates say this lies in the range of 17 percent for Hisar to 26 percent for Sirsa. Dharmadhikari (2005) does not provide an estimate for the districts in

Rajasthan. Our estimates give us a figure of 6 percent for Ganganagar to 13 percent for Hanumangarh.

There are certain caveats in our analysis that must be kept in mind:

1. The value of the parameter 'm' used in the analysis holds good only for the 5-year period (1979-1984). But we have taken it as constant for all three states for the entire period in our analysis. This 'm' is likely to rise with time in the post-HYV period. This is because HYV technology has been applied more towards irrigated areas rather than rainfed areas in India (Dhawan, 1999). By not considering variations in this parameter, we are possibly underestimating the BNP benefits for the past two decades.

2. The parameter f has also been assumed constant during the period of our analysis. Over time, the use of tube wells, which are more productive than canals, has increased in Punjab and Haryana because of which f might have declined marginally overtime. But this would not affect the analysis much because irrigated farming has witnessed a long run improvement in crop yields for most categories of irrigation (Dhawan, 1999)

3. The amalysis is subject to the assumption that for a particular district, percentage of the 'gross canal irrigated area' irrigated by Bhakra canals is equal to the percentage of 'district's geographical area' that is in 'Bhakra command'

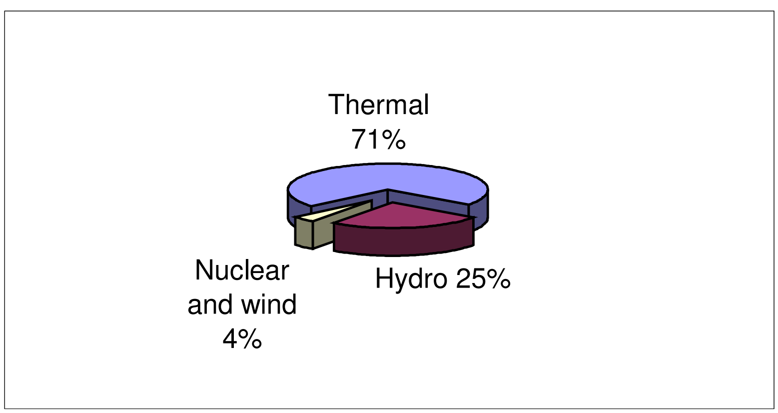
Hydroelectric power

Background

In the post-1947 period, India's policy makers placed emphasis on the development of agriculture and industry. Electricity was seen as a key contributing factor in this. The First Five Year Plan in India, 1951-56, stressed that electricity is essential for development of the country. Priority was thus given to developing and utilising coal resources as well as river-based hydroelectric sources to increase electricity supply to agriculture and industry (Saini, 2003). Large dams were seen as having the advantage of being able to simultaneously provide hydroelectric power and irrigation facilities (to make India a food secure nation- Rangachari *et al.*, 2000). Multipurpose river valley projects thus received a push when several projects were approved in the mid twentieth century. In the first three Five Year Plans of India, the major projects that were constructed were Bhakra Nangal, Hirakud, Damodar, Periyar, Rihand, Sabarigiri, Kundah and Sharavathy amongst others (Saini, 2003).

Coal was also given importance during the planning process in India post-1947. The First Five Year Plan stressed the need for increased and more efficient production of coal, which was a crucial energy resource for the country (Kumaramangalam, 1973). But the 1960s witnessed two major occurrence: (a) the coal industry went through a period of sustained demand deficiency, and (b) several multipurpose river valley projects were constructed. Coal was not relied upon solely to produce electricity. In fact, the thermal-to-hydro ratio went down from 65:35 in the First Five Year Plan to 54:46 in the Third Five Year Plan, 1961-66. A coal production target of 98.5 million tonnes was drawn up for the end of the Third Five Year Plan, 1965-66. But the actual production only reached 67.73 million tonnes (Kumaramangalam, 1973). The reasons why demand for coal in the 1960s could not pick up are stated in Kumaramangalam (1973). The author attributes this to shortfalls in the production of steel and other industries. There was also a sustained period of under-utilisation of coal mine capacity and an inadequate number of wagons to transport coal from mines to plants. Hydropower was an important resource and it was indeed an option utilised, alongside coal, from the 1950s onwards.

In seeking out ways to increase the availability of energy, various conventional and non-conventional energy sources have been developed in India, which include thermal, hydro and nuclear power. The total installed generating capacity stands at 93,952 MW in 2005 (see figure below). Out of this total, thermal accounts for 71 percent, hydro for 25 percent, and nuclear and wind together account for 4 percent.



Source: MoP, 2006

Figure 4. Distribution of electricity sources in India

Thermal generation of electricity has always been relied upon more than hydropower generation to produce electricity even in the past. However, the use of thermal sources, such as coal, for power generation has associated environmental costs such as the emission of green house gases that leads to global warming. Hydropower generation is recognised as being environmentally more benign compared to thermal generation (Srivastava et al., 1998). But the share of hydropower has been declining over the years. By the late 1940s, the installed capacity of hydropower was 37 percent of the total capacity in the electricity sector (Rangachari *et al*., 2000). In the 1960s this rose to 46 percent (see figure in the environmental chapter). In the 1970s it fell to 42 percent. This declined further to 33 percent by the mid-1980s, and then it has stayed constant at about 25 percent after the mid 1990s. This decline has been mainly attributed to the uneven distribution of hydro resources in states, inadequate emphasis on developing hydropower infrastructure during the planning process and inter-regional water disputes (Srivastava et al., 1998).

Srivastava et al. (1998) assert that hydropower generation also has economic advantages over fossil fuel sources because of the rise in their energy costs. Fossil fuels are also not renewable like water and thus there is a limit to the amount that they can be utilised. Thus, hydropower is of immense importance given India's fast-growing population, urbanisation, industrialization and increasing environmental concerns. Given these concerns, research carried out by the Central Electricity Authority of India has recommended that the ideal ratio of hydropower to thermal power should be 2:3. Srivastava et al. (1998) state that such a ratio would ensure an optimum use of financial and natural resources to generate electric power. However, the current installed capacity mix is 8 parts thermal and 3 parts hydro (see figure above). That India is under-utilising its hydropower potential as is evident when one notes that only 17 percent of the potentially exploitable hydropower of 150,000 MW is currently being utilised (MoP, 2006). It is only recently that hydropower generation has received a much needed fillip from the policy makers. The Ministry of Power of India has taken some steps to improve the thermal-hydro mix. A few of the recommendations include a higher budgetary allocation to the hydroelectric sector, planned investments for new hydroelectric projects be passed for approval, push ahead state sector projects that have been impeded due to inter-state disputes, and levying a 5 percent development surcharge that is to be used for garnering financial resources for hydroelectric projects by the National Hydropower Corporation.

The Bhakra Nangal dam contributes significantly to the hydropower sector in India with its current installed capacity of 1480 MW. When the Bhakra Nangal project was first thought of, its primary purpose was to provide irrigation facilities to combat drought in the area (Verghese, 1994). However, in its Project Report of 1939-42, it took into its gambit for the first time the development of hydroelectric power (Rangachari, 2006). The Bhakra project was initially set up with an installed capacity of 97 MW. But demand far exceeded supply and thus there was a felt need to increase the capacity of the project (Rangachari, 2006). By 1960, five units of 90 MW each were set up in the Bhakra left bank power house making it a total of 450 MW. By 1962, power houses on the Nangal Hydel Channel were set up with a total of 155 MW capacity. Subsequently, by 1968 five more units were added in the Bhakra right bank power house. Renovation and modernisation undertaken in the 1980s and 1990s increased the combined capacity of Right Bank, Left Bank, Ganguwal and Kotla power houses to a present total of 1480 MW. By 2011-12 the total capacity is planned to increase to 1570 MW (Rangachari, 2006). The Bhakra project has produced a total of 255 billion kWh of hydroelectric power from 1954-55 up to 2005-06 thus making its contribution to hydroelectric power significant. This contribution has also been significant in the Northern Regional Grid. Evening peak demand hours start at about 5 pm and lasting till about 9-10 pm. Morning peak demand hours begin at 5 am and is shorter in duration than the evening peak demand (Rangachari, 2006). The Bhakra generators play a major role in the regulation and stabilisation of frequency in the Northern grid. This is attributable to the flexibility of the generators, which is facilitated by a large reservoir (Rangachari, 2006). There are several beneficiary states in the Bhakra project for electric power. BNP supplies power to Punjab State Electricity Board, Haryana Vidyut Prasaran Nigam, Rajasthan Rajya Vidyut Prasaran Nigam, H.P.State Electricity Board, Power Department of Chandigarh, J&K SEB and the National Fertilizer Corporation in Nangal . It is important for us therefore to assess these benefits. This will be carried out in the following sections.

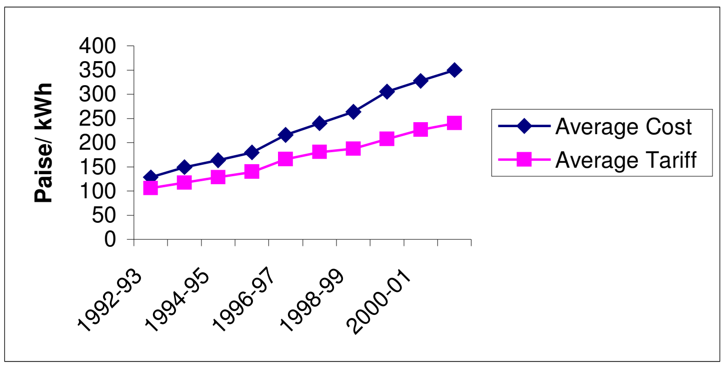
Methods to value electricity benefits

In this section we review some of the methods used in the literature to value electricity benefits. We review how benefit measurement can be done using per unit cost estimates. We then review the use of tariff rates to measure benefits. We also review how to value electricity using a contingent valuation or willingness to pay approach. Apart from this we also show how electricity can be valued by a value-added approach. Finally, we present a rationale for the approach selected and the estimates based on the selected method.

It is generally argued that using unit costs to value electricity is not a true estimate as this leads to an underestimation (Rangachari et al, 2000). The argument put forth by these authors is that the costs per unit capacity creation are generally low since the capital costs are usually under reported and external costs are excluded. Rangachari et al (2000) provide their own methodology for estimating the value of electricity. This involves using the net economic benefits accruing from an additional unit of hydroelectric power. For this they use the difference between the cost per kWh of thermal and hydroelectric power generation. Valuing electricity at this rate gives an estimate of the net amount saved by producing electricity through the hydropower route as compared to the thermal route. But while using such a method, one would have to be clear on which fuel and its associated cost is being considered for thermal power generation. Using coal and lignite to generate thermal power would differ in costs from a natural gas, diesel or heavy oil-fired power plant.

The contingent valuation method can be used to determine a consumer's willingness to pay for electricity supply in a reliable way. With this method consumer preferences for reliable electricity supply are assigned a monetary value. This value represents the true value to the end user and is a useful guide to assess the comprehensive value of electricity supply. TERI undertook a study for two Indian states- Haryana and Karnataka- to provide estimates of the willingness to pay for industrial and agricultural consumers for a reliable electricity supply (TERI, 2001). In this study 500 manufacturing industries and 900 farmers were surveyed in 1998-99 and the respondents were asked to imagine a hypothetical situation of improved electricity supply. Out of the subset of respondents who accepted this scenario, only a certain proportion of them were willing to pay more than what was currently being paid. The results show that the average willingness to pay of industrial consumers was Rs. 5.16/ kWh and Rs. 5.22/ kWh respectively in Haryana and Karnataka. For the agricultural sector, the average willingness to pay was Rs. 2.92/ kWh and Rs. 1.99/ kWh respectively in Haryana and Karnataka. As a result of the current situation of unreliable electricity supply, the associated cost is also calculated in terms of foregone domestic product in the two states by considering loss in value of output suffered by industry, and loss in value of crop output that the farmers were expected to get in the market. In 1998-99 the manufacturing sector lost Rs. 95,328 million and Rs. 120,222 million respectively in Haryana and Karnataka. In agriculture, the associated foregone domestic product was Rs. 165,155 million and Rs. 229,122 million respectively in Haryana and Karnataka. But this estimate holds only for those who are in fact willing to pay for improving the electricity supply. For our purposes we should estimate the value-added to GDP by the actual electricity supply and not the hypothetical forgone GDP through unreliable electricity supply. Before discussing the method of calculating electricity contribution to GDP, we review the nature of electricity tariffs. It needs to be mentioned though that tariffs represent costs rather than values.

Tariff rates in India are mainly determined by *cost-plus pricing*, which implies a margin over the average generation cost.[27] But even this method is fraught with problems. Rangachari *et al* (2000) report that agricultural consumers on average pay Rs. 0.21/ kwh compared to a supply cost of Rs. 1.86/ kwh. Domestic consumers and industries pay on average Rs. 0.91/ kwh and Rs. 3.50/ kwh respectively. Thus it appears that only industrial consumers are covering per unit costs. Besides, the recovery of costs through tariffs has seen a decline in percentage terms from 82 percent in 1992-93 to 68 percent in 2001-02 as can be seen in figure below.



Source: http://planningcommission.nic.in/reports/genrep/seb/ar_seb02.pdf accessed on 15th May 2006

Figure 5. Recovery of electricity cost through tariffs

The reason attributed to this widening gap is that the number of consumers has increased in this period and this increase has been mainly in the domestic and agriculture sectors, which are being supplied power at subsidised rates.[28] Moreover, it is observed that electricity is either stolen, not billed, or electricity bills are not paid. All this amounts to mass subsidization of electricity. The financial burden thus created undermines the economic efficiency and viability of the electricity supply chain and is not in the long-term interests of consumers. Thus the use of tariffs to estimate benefits would lead to an underestimation

[27] http://dercind.org/conceptpaper/settingup.html accessed on 15th May 2006
[28] http://planningcommission.nic.in/reports/genrep/seb/ar_seb02.pdf accessed on 1st June 2006

of the benefits. We thus build up a case later for why the use of a *value-added method* should be adopted.

For expository purposes we provide financial estimates of electric power supplied by BNP to various states using consumer/ category-wise tariff rates that different State Electricity Boards charge. This kind of analysis involves understanding of the way in which tariff rates are fixed by the Central Electricity Regulatory Commission (CERC). The CERC has a set of norms for the determining of power tariffs for hydro-generated electricity.[29] Hydro power stations selling electricity are to charge a two-part tariff, which comprises of an "Annual Capacity Charge" and a "Primary Energy Charge".

Annual capacity charges = Annual fixed costs – Primary energy charges

Annual fixed costs are defined to include Operation & Maintenance costs, interest on loan capital, depreciation and advance against depreciation, return on equity and interest on working capital. If the primary energy charges are greater than the annual fixed costs, then the capacity charges are set to zero level. Primary energy charges are worked out on the basis of paise/kWh rate on energy scheduled to be sent out from the station after adjusting for the free power given to the state where the plant is set up. This free power is to the tune of 12 percent of the amount of electricity generated by the hydropower plant (there is no economic justification provided by the CERC as to why this is taken as 12 percent). Excluding pumped storage stations, all hydro stations assume 90 percent of the lowest variable charges of the central sector thermal power station in the region (e.g. the Northern Grid for Uri HE project) as the rate of primary energy. The variable charge being referred to here is the fuel cost of the thermal power plant. The corresponding variable charge for a hydropower plant is zero since water is a free input. There is similarly no economic justification provided by the CERC as to why hydro power stations are allowed to charge 90 percent of the lowest primary energy charge of thermal stations. The primary energy charges are computed by using this primary energy rate and the saleable energy of the project:

Primary Energy Charge = Primary Saleable Energy * Primary Energy Rate/(1-r), where r = 12 percent

But the provision of 12 percent free power to the home state, where the hydropower plant is located, is however not a loss to the hydropower plant, as can be seen from the above

[29] http://cercind.gov.in/Tariiff/Notification.pdf accessed on 1st June 2006

formulation. In fact, the cost is recovered from the other beneficiary states as the entire electricity produced is being charged for as the primary energy charge and not the net amount of electricity after accounting for 12 percent free power to the home state. The tariff rate charged is computed as annual fixed charges (Rs.) divided by the saleable energy (i.e. after accounting for the 12 percent free power given to the home state of J&K). If the tariff rates were charged as annual fixed charges divided by the actual energy produced by the plant, the rate would be lower. This is evident from the numbers for the year 2004-05 for which the annual fixed charges were Rs. 395.95 crore and the sales to the beneficiary states recovered an amount of Rs. 582.36 crore. Hence the cost of providing of free power to the home state is recovered by the hydropower plant.

Calculation and data analysis

We now provide our estimates for costs of power using consumer-wise tariff rates that the different State electricity Boards charge. This method entails segregation of the proportion of power from BBMB to a particular state in terms of its uses i.e. industrial, domestic, agriculture, commercial and other. We further convert the units into monetary values terms using these differential tariff rates at the 2004-05 all-India level procured from the SEB Annual Reports[30]. Data on power supply by BBMB to different states from the Annual Reports of BBMB, and distribution of electric power amongst the end-consumers (i.e. proportions of electricity consumption by different users using the all-India average from 1970-71 up to 2004-05) have been used.

As mentioned earlier BBMB supplies power to Punjab State Electricity Board, Haryana Vidyut Prasaran Nigam, Rajasthan Rajya Vidyut Prasaran Nigam, H.P.State Electricity Board, Power Department UT Chandigarh and National Fertilizer Corporation Nangal, J&K SEB and Irrigation Department. Then the distributed power is valued at the tariff rates that the users have paid. These details are provided in tables in the annexure. The power units are converted into monetary terms by using the tariff rates charged from the three categories.

Power distributed to the domestic, industrial, agriculture, commercial and other sectors in these states have been estimated using the tariff rates. Present value of total power supplied has been calculated at 8 percent discount rate. Present value for the period 1955-56 up to 2004-05, at 2004-05 prices, has been calculated taking the year 1955-56 as year one. The

[30] http://planningcommission.nic.in/reports/genrep/reportsf.htm accessed on 1 June 2006

total present value estimate of power benefits supplied by Bhakra dam to all states is Rs. 14,392 crore.

Based on the new CERC method for setting tariffs for electricity, we estimate the power generation benefits from the Uri HE project. The total present value estimate of power benefit from the project stands at Rs. 6,092 crore for the period 1997-98 up to 2097-98. For the years beyond 2006 we have assumed that the project will continue to generate 2556 million kWh of electricity per year (since the saleable energy has been fixed for the all years of operation at 2249 million kWh in the past, we have assumed that the future generation will be such that 2249 million kWh forms 88 percent of it, i.e. to account for the 12 percent free power given to the home state).

Value-added approach

The above analysis using the tariff rates may not give accurate estimates of the benefits. As mentioned earlier, tariffs represent costs rather than values in a true sense. We must keep in mind that tariff revenue collection does not cover costs as was shown in figure earlier.

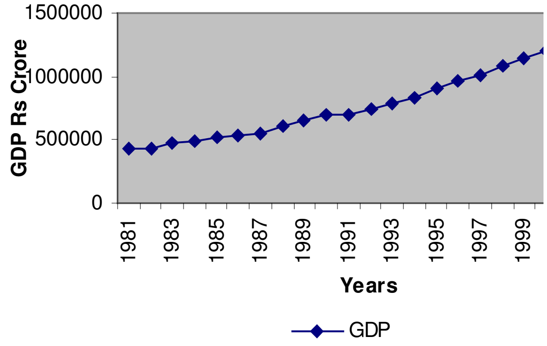
To capture the benefits in totality, value addition by a single unit of power from Bhakra and Uri should be calculated. We now outline the methodology used to determine the contribution of electricity consumption in GDP.

To estimate the value added to GDP by consumption of electricity for Indian economy the following simple regression analysis has been considered.

$$GDP_i = \alpha + \beta \text{ Electricity consumption}_i + \varepsilon_i$$

The estimate 'β' represents the value contributed to GDP by unit consumption of electricity. 'ε' represents the error term, and 'i' indicates the year for which the data for the variables have been considered.

To estimate the effect of electricity consumption on GDP, time series data has been considered for Indian economy for the period 1981 to 2003. GDP data, expressed in rupees crores at constant 1993-94 prices, has been used from economic survey, published by Ministry of Finance, Govt of India. Data related to electricity consumption, has been taken from TEDDY (TERI Energy Data Directory and Year Book). The data on consumption are expressed in gWh. The figures below depict the trends in values for GDP and electricity consumption for the Indian economy.



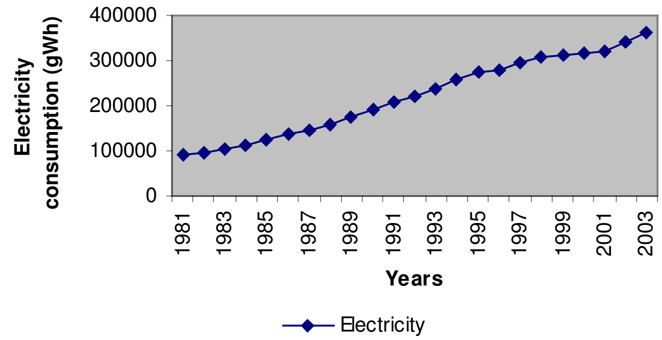


Figure 6. Trend in GDP / electricity consumption

Results and analysis

Regression analysis was carried out in which the GDP was regressed on electricity consumption. The summary statistics of the parameters are indicated in table below.

Table 30. Regression results – GDP and electricity (1)

Variable	Coefficients	T- Value	Sig
Constant	6.67775E+11	1.666	0.1117498
Electricity	33.98	20.016	3.691E-15

Adj R sq = 0.9478DW = 0.166

From the above table we see that coefficient of electricity is significant. More over the adjusted R sq is also high. However the Durbin Watson estimates says that the error terms are auto correlated.

To deal with the problem of autocorrelation, correlation estimates were carried out between the error terms and the error terms with 1 period lags. This estimate of correlation was used to derive the fresh coefficients for electricity and GDP. The revised results are identified in the table below.

Table 31. Regression results – GDP and electricity (2)

Variable	Coefficients	T- Value	Sig
Constant	-2.3E-10	-0.397	0.695
Electricity	39.41	44.506	0.000

Adj R sq = 0.989DW = 1.478

The table above suggests that there has been improvement in the estimates compared to initial one. The R sq has increased to 0.989. The Durbin Watson estimates has also increased to 1.478

indicating that new regression equation considered is free from auto correlation. The coefficient of electricity is found to be 39.41. This indicates that one kWh consumption of electricity in Indian economy raises output by Rs 39.41. The corresponding value at 2004-05 prices is Rs. 73.81.[31]

Contribution of electricity production by Bhakra and Uri HE projects to GDP

We now estimate the monetary value of the contribution made by the two large dams to the GDP at 2004-05 prices in present value terms for the period 1955-56 to 2055-56 for Bhakra, and 1997-98 to 2097-98 for the Uri HE project. Since our value-added estimate is arrived at using electricity consumption data, we assume that 30 percent is lost during transmission and distribution after production. We use a flat 30 percent for all years following the region-wise system losses as reported in the CEA General Review (2006). However, a part of this is technical loss and the rest is commercial loss. Since technical losses are usually of the order of 10-15%, we assume that 85% of electricity of electricity produced is actually consumed (that is 15 % is lost due to technical reasons and 15% is stolen or not paid for, but contributes to production).

The monetary estimate of the contribution made by Bhakra dam to GDP in present value terms stands at Rs. 2,50,817 crore. We have assumed that from the year 2011-12 the production of electric power from Bhakra power houses (Right and Left Power houses, Ganguwal and Kotla Power houses) is to the tune of 7115 million kWh. This figure has been arrived at through an average of the previous generation. The tariff-based calculation gave us a figure of Rs. 14,392 crore for the period 1955-56 up to 2004-05. The value-added method for the same period leads to an estimate of Rs. 2,38,379 crore.

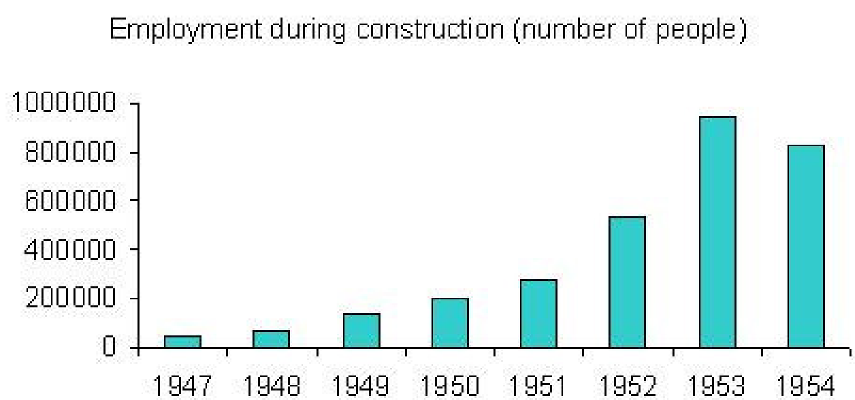
Similarly for the Uri HE project, the monetary estimate of the contribution made to GDP in present value terms stands at Rs. 2,04,636 crore for the time period 1997-98 to 2096-97. The tariff method led us to an estimate of Rs. 6,092 crore for the same period.

[31] The wholesale price index number for Indian Economy was considered for inflating the coefficients at 2004-05 prices. At 1993-94 prices the coefficients was found to be 39.41. The wholesale price index number for all commodities stood at 187.3 with weight-base 100 for the year 1993-94. Therefore the change in electricity consumption in the economy by one kWh contributes to 39.41*(187.3/100) i.e. Rs. 73.81 at constant 2004-05 prices. Source: http://indiabudget.nic.in accessed on 1st August 2006

Employment during construction

Benefits from Bhakra

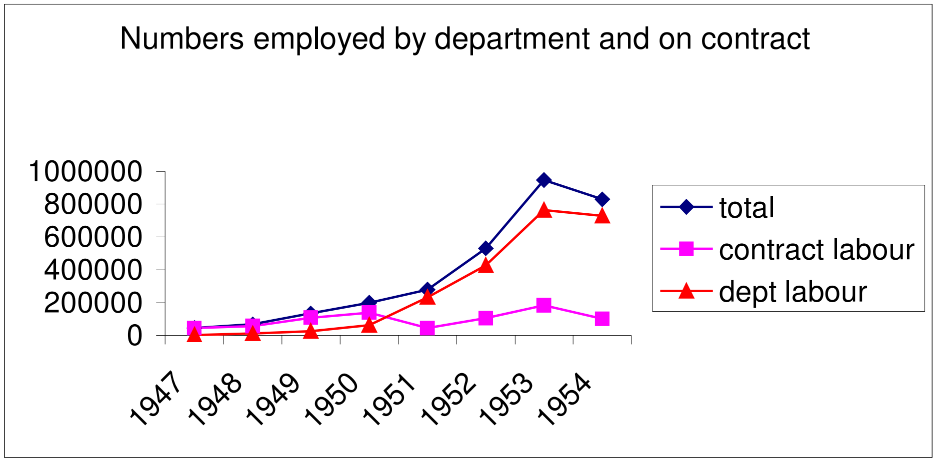
Direct employment opportunities arose from the Bhakra Nangal project during the construction phase. Skilled, semi-skilled and unskilled labour was employed on different components of the project. Investment on the Bhakra canals allowed for a significant amount of unskilled labour to be employed (Raj, 1959). On the Bhakra dam and Nangal dam there was a requirement for skilled and semi-skilled workers. At that time the workers came from East Punjab, Rajasthan, Uttar Pradesh, PEPSU and Himachal Pradesh. Figure 1 shows us the total number of people employed during the construction period. It reached a peak of 122,000 people in the dry season of March 1954, which was used to employ workers extensively to complete the construction of the Bhakra canals. After this the employment fell rapidly.



Source: Raj (1959)

Figure 7. Employment created during construction

Project authorities recruited skilled and semi-skilled labour on a departmental basis. Unskilled labour was usually hired on a contractual basis by private agents. In the beginning of the project most of the labour was hired by agencies on contractual basis. But later on there was more and more substitution of directly recruited departmental labour for contract labour. Between 1947 and 1954 the composition of contractual labour fell while that of department labour increased. This is shown in figure below.



Source: Raj (1959)

Figure 8. Employment during construction (Bhakra)

We now try to estimate the monetary value of employment created during construction. For the purpose of calculation wage rates as fixed by the Central Government of India in the year 2004-05 have been used.[32] Accordingly the monthly wages paid during construction to different categories of workers were-

Skilled labour: Rs. 3125 per month
Semi-skilled labour: Rs. 2900 per month
Unskilled labour: Rs. 2600 per month

These wage rates are at the 2004-05 level. For the construction of the dams at Bhakra and Nangal, the bulk of the labour was skilled and semi-skilled. At other places where the canals were being constructed, most of the labour was unskilled. In 1954, 36 percent of *departmental* labour was skilled, 6 percent was semi-skilled and 58 percent was unskilled labour. In the same year, 86 percent of *contract* labour was unskilled, and the remaining 14 percent was semi-skilled labour. Due to the absence of data for other years from 1947 to 1953, we use the 1954 as a proxy. Table below gives an estimate of the total wage bill paid to skilled, semi-skilled and unskilled labour under department and contract labour. This table shows us our estimate from Raj's work, at 2004-05 prices.

[32] www.indiastat.com accessed on 1st April 2006

Table 32. Wage bill between 1947 and 1954 (Rs)

	Skilled	Semi-skilled	Unskilled	Total
Departmental	253 crore	39 crore	339 crore	632 crore
Contract	0 crore	31 crore	174 crore	206 crore
Total	253 crore	70 crore	514 crore	839 crore

Source: Estimated from Raj (1959)

It is clear from the above table that the total wage bill at 2004-05 prices is estimated at Rs. 839 crore. The table below shows us our estimate of the year-wise break up of this wage bill.

Table 33. Wage bill from 1947 to 1954 (at 2004-05 prices)

Year	Wage bill (Rs. crore)	NPV (Rs. crore)
1947	12.32	12.32
1948	18.24	16.89
1949	35.96	30.83
1950	53.82	42.73
1951	77.32	56.83
1952	147.57	100.43
1953	263.00	165.74
1954	230.98	134.78

Source. Estimated from Raj (1959)

From the above table, taking a discount rate of 8 percent, we arrive at an aggregate present value of the monetary benefits of employment during the construction phase at 2004-05 prices. This present value amount stands at Rs. 560 crore.

Benefits from Uri HE Project

Direct employment was created by the Uri HE project during its construction phase. Skilled and unskilled labour was employed on different components of the project. The Uri HE project provided opportunities for local people and people from outside the region to get employed in the construction phase. The locals who were employed were those affected by the project in terms of displacement. “Project affected persons” were thus given opportunities for employment.

The contractor URICO employed and trained 9000 people in all. During the peak time of construction about 4700 Indians were employed .[33] The following table shows us the break up of the number of people employed over the years.

[33] Data regarding expatriate workers (precise numbers, salaries paid and other benefits, duration of emplyment etc) was not available. The calculation reflects benefits accruing to the local workers. The Scott-Wison report states that a total of 9000 people were trained and employed during the construction stage but does not provide further details on this.

Table 34. Number of Indian workers employed on the Uri project

Period	Number of people
Nov 1989 to Dec 1993	0 to 2500
Jan 1993 to Sep 95	2500 to 4700
Oct 95 to Oct 96	1000 to 2500
Nov 96 to March 97	500 to 1000
April 97 to Oct 97 and onwards	Less than 500

Source. Unpublished document of Scott Wilson- Uri Hydro-Electric Project, India. Evaluation of the Swedish Support. Draft Final Report, November 2005

There was some local unrest at the prospect of outsiders being employed in greater number. It was later decided to recruit mostly local labour. These conditions laid out that only skilled Indian labour could be employed from outside the region, and also that locals and outsiders would be hired in 3:1 ratio. URICO also employed one member from each of the project-affected families.

We now provide a monetary estimate of the employment benefits created during the time of construction. Using the same wage rates as those paid out by the Central Government of India in 2004-05, we summarise the wage bill estimates below. Thus the present value of the wage bill works out to Rs. 31.82 crore over the period 1989 (base year) to 1997.

Table 35. Wage bill paid out by URICO

Year	Wage bill-unskilled (Rs. crore)	Wage bill-skilled (Rs. crore)	Total (Rs. crore)	PV of wages (Rs. crore)
1989	0.48	0.19	0.68	0.68
1990	2.92	1.17	4.09	3.79
1991	2.92	1.17	4.09	3.51
1992	2.92	1.17	4.09	3.25
1993	2.92	1.17	4.09	3.01
1994	8.42	3.37	11.79	8.03
1995	7.00	2.80	9.80	6.17
1996	3.70	1.48	5.18	3.02
1997	0.43	0.17	0.61	0.33

Source. Scott-Wilson, 2005

Drinking water supply

Rationale/ background

The demand for water in India has been increasing rapidly. By the middle of the twentieth century, India's population was less than 400 million and the per capita availability over 5000 cubic meters per year (Raghuram, 2005). The author states that fresh water availability per capita had fallen to 1820 cubic meters in 2001. It is predicted that by 2025 it will be less than 1600 cubic meters, which is a stress level according to international standards. Water supply and its management thereby assumes importance for sustainable development of a country. Large dams that are of the storage type, such as Bhakra Nangla dam supply drinking water apart from providing irrigation supplies. Bhakra Nangla dam regulates the Sutlej, Beas and Ravi rivers and supplies water to the states like Haryana, Punjab, Rajasthan, Union territory of Chandigarh and the national capital territory of Delhi (Rangachari, 2006). Water is provided to these states by BBMB and it is up to the states to decide how to allocate this supply between irrigation, drinking water and industrial water supply (based on discussions held with senior BBMB officials in Nangal).

Drinking water is directly supplied by BBMB to the Delhi Jal Board (BBMB Annual Reports). BBMB supplies water through its canals to other states as well. The states include Punjab, Haryana and Jammu and Kashmir. Chandigarh is also supplied with water from BBMB, which is be used for drinking purposes. The states are free to do as they deem fit to distribute these waters between irrigation, drinking water and water supply to industry (based on discussions held with senior BBMB officials in Nangal). The present section provides a case-study on drinking water benefits based on data on water supply data to the NCR.

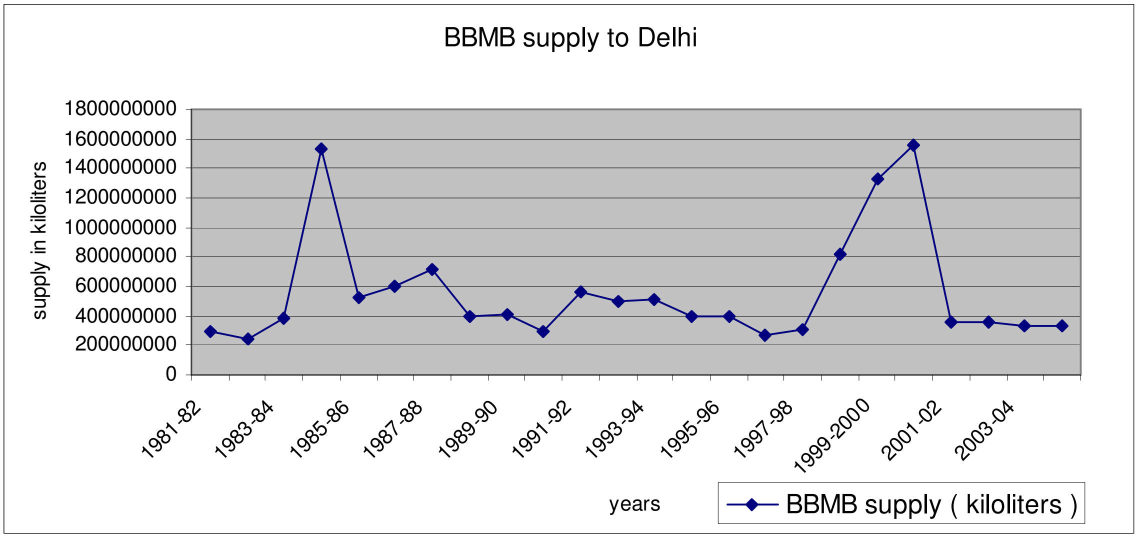
About 14 million people reside in the NCR and huge water supply shortages are encountered everyday. Though its water availability is higher than the national average, its distribution is skewed. The main sources of water for Delhi are the river Yamuna, rainwater, groundwater, Bhakra and upper Ganga Canal (Daga, 2004). The total supply capacity of DJB is around 650 million gallons of water per day (MGD). Out of this around 20-30 percent is lost due to transit inefficiencies, thus ultimately only around 520MGD water reaches the consumers. In the year 2004, about 79 percent of the total demand for water came from domestic sector and 11 percent from industrial and commercial users. Total demand for water from all sources is around 830 MGD, thus there is a shortage of about 300 MGD of water. This demand gap is filled by the using tube wells, bore wells, private water tankers and packaged water (Daga, 2004).

One method to value the services of water is the willingness to pay approach. This is a non-market questionnaire-based valuation technique where willingness to pay (or willingness to accept) is directly obtained from respondents with respect to a specific good. But this method requires one to develop a questionnaire with very specific objectives in mind and borrowing results from literature would have to be treated with caution. A study that uses such an approach for valuing water services in Delhi (Dutta, 2005) estimates that households from unplanned settlements are willing to pay almost double their average monthly water bill of Rs 56 for improved water services). A domestic customer in the unplanned area is willing to pay Rs 101 for securing a reliable water supply. But since this result relates to *improved* water services, and not the actual state of water supply, it is not suited for our purposes.

Benefit measurement of increased water availability due to the large dams can also be done in terms of the tariff rates of water charged in various states. Tariff rates set by the state agencies generally take into account only the cost of provision of water. The Vaidyanathan Committee on Pricing of Irrigation water, 1992 reports that in India the cost recovery from users is very low in almost all states.[34] It is seen that the recovery is hardly enough to meet even the O & M costs of projects, leave alone the capital costs. It is estimated that for the country as a whole, the cost recovered by way of user charges is about 34 percent of O & M cost (working expenses). If depreciation and interest costs are included in the total costs then the recovery rate is 10 percent (Rajagopal, 2001). Thus valuation of water supplied by large dams using tariff rates will lead to a gross underestimation of benefits.

Water tariff in Delhi consists of fixed access charges and water use charges. Fixed access charges are payable by all registered consumers to meet the cost of access to the network and operation and maintenance costs. Volumetric water charges are based on actual consumption by the different consumer categories. 40 percent of water supplied by DJB is not billed and 10 percent is supplied free of cost to slums/ JJ colonies and the Fire Department. Since tariff rates do not even cover the O&M costs and only 50 percent of total water supplied by DJB is billed, the total recovery from the consumer categories is a small proportion (24 percent in 2003-04) of the cost of production. Delhi Jal Board draws around 371 cusec (240 MGD) of water from Nangal since 1994-95. After a Supreme Court judgement in 2002, ex-Nangal supplies were to be increased by 125 cusec (DJB, 2006). The figure below shows the quantum of water supplied to DJB by BBMB in kilolitres.

[34] http://wrmin.nic.in/problems/pricing.htm accessed on 1st June 2006

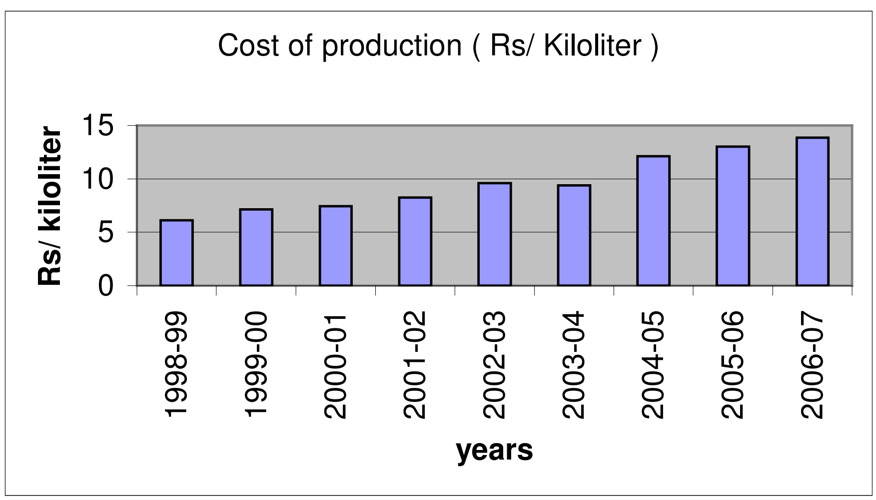


Source. Annual reports, BBMB

Figure 9. BBMB supply of water to Delhi Jal Board

Method

Benefit measurement of water supply has been done for the NCR using cost of production. Per unit cost of production figures were used for valuation since the tariff rates do not cover all costs completely. Costs of production have been calculated using the total annual expenditure and total water supplied by DJB. The annual expenditure of DJB includes administrative & power expenses, repair maintenance, cost of raw water, property tax, repayment of loan and interest, establishment expenses, depreciation, general stores and chemical expenses and cess. The figure below provides the cost of production of the water supplied by DJB.



Source. DJB, 2006

Figure 10. Cost of production of water by Delhi Jal Board

Result

Valuation of water is being carried out at the cost of supplying water from the Delhi Jal Board to consumers. The rate used is Rs. 12.10/ kilolitre, which is at the 2004-05 price level. For the period 1955-56 up to 2054-55, the present value of water supply benefits to the beneficiary states is as follows: National Capital Region: Rs. 3,249 crore; Jammu and Kashmir: Rs. 11,920 crore; and Chandigarh: Rs. 1,021 crore. This sums up to Rs. 16,190 crore. (Data for other states could not be accessed in spite of our best effort).

Fisheries

Background

The building of the Bhakra dam led to the creation of the Gobind Sagar reservoir in Himachal Pradesh. It is one of the largest man-made lakes of India. The catchment area of the reservoir is 56,980 km^2 (Government of Himachal Pradesh, 1997). At the tip of the reservoir at Dehar, water from the Beas flows in through the Beas-Sutlej link. The total length of the reservoir is 168 km with the widest stretch of 6 km near the dam. Annual inflow varies between 4.4 and 8.0 million cusecs and the outflow varies between 4.9 and 7.0 million cusecs. This reservoir is very important for fishing and forms an important part of the livelihoods of the displaced people. At present there are about 1522 active fishermen from the 5000 oustees settled around the reservoir. There are about 51 species of fish in the lake that belong to 9 families- cyprinidae, cobitidae, bagridae, schilbeidae, sisoridae,belonidae, ophiocephalidae, mastacembelidae and salmonidae. The commercially important varieties are H. molitrix, C. carpio var. specularis, C. catla, T. putitora, L. rohita, L. dero, L. calbasu, L. bata, L. dyocheilus, C. mrigala, W. o attu and M. seenghala.

The reservoir is managed by the Fisheries Department of the government of Himachal Pradesh in Bilaspur town. (Government of Himachal Pradesh, 1997). Fishermen are organised into cooperative societies who are given licences @ Rs. 50 for every gill net operated. The fish harvest of the fishermen is brought to fish landing centres where it is sold through contractors. Presently there are 18 cooperative societies located at the reservoir with the 1522 active fishermen. At the Bhakra landing centre there are 3 cooperative societies- Jayasree, Bharkra and Kashain. Contractors have to give 10 percent of the catch for local consumption and the rest can be sold at will. The Fisheries Department charges royalty @ 15 percent of the revenue. Each fisherman uses 1 boat which costs Rs. 2000, and an average of 1.2 to 1.4 gill net licences are issued to each active fisherman.

Calculations

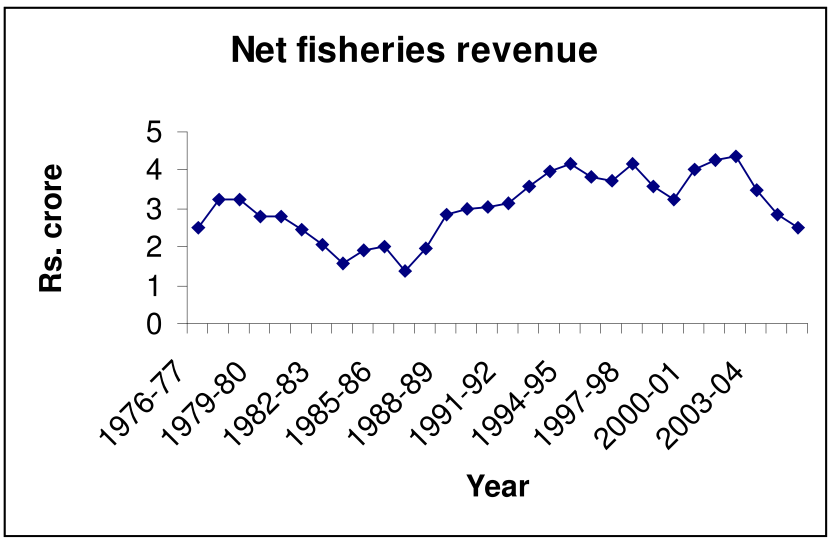
Using the wholesale price index of inland fish we take the value of fish harvest at constant prices at the 2004-05 wholesale price of inland fish level. The table below gives us the price per kilogram of different grades of fish caught in the Gobindsagar reservoir.

Table 36. Price of inland fish (Rs./ kg)

Fish grade	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	2004-05
A grade	13.9	16.7	20.58	20.52	20.68	20.7	65.88
B grade	9.45	10.25	11.85	11.8	12.02	13.0	41.37
Other	7.33	8.3	11.85	11.8	12.02	12.02	38.25

Source. Government of Himachal Pradesh, 1997; and www.indiastat.com accessed on 5th July 2006

The figure below shows the net revenue earned by the fishermen after accounting for the costs of gill net licences, boats and royalty paid out to the Fisheries Department.[35] The net revenue (undiscounted) fluctuates between Rs. 1.4 and Rs. 4.3 crore per annum. This amount reveals that fisheries income forms a significant part of the income of the oustees settled in the area.



Source. Government of Himachal Pradesh, 1997

Figure 11. Revenue (net) from fish harvest in the reservoir

[35] The reason for adjusting for royalties paid to the Fisheries Department is that the money so collected does not strictly flow to the local economy. The fact that fisheries essentially constitute a local livelihood activity for the project oustees in this context justifies this assumption. Besides, in terms of total benefits, since fisheries account for a relatively small fraction, relaxing this assumption will not make any significant difference to the total volume of benefits – with a total effect of Rs. 50 lakh.

The net present value from 1955-56 up to the year 2054-055 works out to Rs. 7.4 crore. [36]

Additional employment created

The following tables show the proportion of workforce employed in the agricultural sector in the states of Punjab and Haryana. It is noticeable that as a percentage, the employment increases significantly from the 1960s to the 1970s. This could be attributed to the advent of the Green Revolution in these states from the mid 1960s onwards. Since irrigation was a prerequisite for the Green Revolution, the contribution of the Bhakra canals is significant in terms of causing this increase in employment.

Table 37 Agricultural workforce (Percentage)

	1960-61	1970-71	1980-81	1990-91	2000-01
PUNJAB	55.89	62.67	58.97	55.26	38.95
Jullundur	42.44	50.69	45.74	40.78	24.97
Ludhiana	45.18	50.8	43.50	36.21	20.23
Faridkot	65.35	74.57	68.65	62.74	46.28
Moga	-	-	71.83	71.83	51.94
Bhatinda	72.92	76.42	71.11	65.81	51.23
Mansa	-	-	74.62	74.62	58.85
Sangrur	67.07	71.48	69.34	67.20	46.62
Patiala	53.54	63.23	58.03	52.84	38.73
Fatehgarh Sahib	-	-	57.96	57.96	33.94
Kapurthala	54.75	61.47	56.84	52.21	35.84

Table 38 Agricultural workforce (Percentage)

HARYANA	1960-61	1970-71	1980-81	1990-91	2000-01
Hisar	55.89	71.96	63.15	62.62	58.67
Sirsa	-	75.79	65.92	62.93	61.26
Fatehbad	-	-	-	69.33	67.31

'- ' indicates district not created or data not available

The value of additional employment created is manifested in the incremental agricultural income attributable to the Bhakra canals as mentioned in the report. (Analogously, in fisheries, the value of additional employment created has already been captured by the present value figure. In case of tourism, there is limited additional employment created, and the benefits in terms of recreational values enjoyed by tourists and travellers to the area has been captured separately)

[36] The reason for this relatively low value is the discounting process; in this case fisheries benefits started flowing several years after the completion of the project from the point of view of other benefits.

Tourism benefits

Tourism benefits of the project is somewhat diffuse in the sense that there are relatively few visitors to the dam area alone.
In order to place a value on the tourism benefits to the local economy in Nangal, we assume that 1 vehicle consumes 4 litres of petrol to travel 28 km from Nangal to the Bhakra dam and back, and 1 vehicle carries 5 tourists on average. Using the data from the following table we estimate that from 1954-55 up to 2054-55 the total value of tourism benefits stands at Rs. 115 crore. [37] The corresponding NPV is approximately Rs.8 crore.

Table 39 Visitors to the Bhakra dam

Year	Indians	Foreigners
1999-00	285616	405
2000-01	330024	474
2001-02	265786	279
2002-03	304800	371
2003-04	391300	362

Source: CBIP (2005)

Indirect economic impacts of the Bhakra project

Investments made in infrastructure have impacts at a local, regional, national and global level. These impacts are classified into direct and indirect impacts (Bhatia and Malik, 2005). Water infrastructure projects have associated direct impacts such as increased agricultural output, provision of navigation facilities, increased tourism, preventing droughts and reducing the probability of the occurrence of floods. These in turn generate a number of indirect impacts because of inter-industry linkages (backward and forward) which result in increasing demand for the produce of other sectors, and consumption impacts which are a result of increasing incomes created by the direct impacts. For instance electricity provided to farmers would help increase their crop yield because they can pump water through their pump sets and this will lead to increased agricultural incomes. These increased incomes can be used to purchase more commodities form other sectors such as industry and consumer goods. More purchases of these products increases the incomes of these sectors.

A regional value added method is used by Bhatia and Malik (2005) to estimate the magnitude of indirect impacts of a dam via inter-industry linkages and consumption-induced impacts.

[37] In effect we use a limited version of the travel cost method to assess the amount a person pays to pass through the dam area. The dam authorities do not charge a fee for allowing people to pass through this route though they keep a record of the number of people passing by. The entire amount of money spent by travellers is assumed to account for tourism benefits of the dam (aesthetic value of the reservoir and dam structures) although a section of tourists may just pass by this area to reach other (non-dam related) tourist or religious/cultural attractions).

This can be looked at in both "with" and "without" project scenarios. This multiplier analysis is one of the approaches to quantify these inter-industry linkages and consumption induced effects. Their methodology involves estimating a project multiplier value for a dam. The multiplier is defined as such-

Project multiplier = (Regional Value Added With Project - Regional Value Added Without Project)/ (Value Added of Agriculture and Electricity With Project - Value Added of Agriculture and Electricity Without Project)

The authors account for the following changes in their analysis- changes in the area irrigated, changes in electric power supplied, and changes in crop yields and the production technology. The study estimates that in 1979-80 the gross output in the region under the "with project" scenario was 27 percent larger than it would have been in a "without project" scenario. Agricultural output was found to be 61 percent large under a "with project" scenario than it would have been in a "without project" one. Analogously the aggregate regional value-added under the "with project" situation is higher by 30 percent. The total direct value-added (from agriculture and electricity sectors) in the "with project" scenario is higher by 54 percent. The multiplier value thus works out to be 1.90. Thus, for every one rupee of additional value added directly by the project in the agricultural and electricity sectors, another 90 paise is attributable to the indirect impacts. The authors also consider the income distribution impacts by looking at the differences in income levels of households in both "with" and "without" scenarios. They estimate that the dam provides income gains to even the poorest groups of households in the region. The authors thus arrive at a conclusion that "*dams act as a powerful vehicle for poverty alleviation*".

The links between infrastructure develeopment and added incomes is well researched. By its very nature, infrastructure causes a range of multiplier impacts flowing across the economy. We have provided our own estimates of direct estimates of several of the economic benefits. In case of electricity, the benefits have been captured in terms of contribution to the GDP. This, in a sense, captures indirect impacts of the power generated. In case of agricultural output, direct gains due to added irrigation has been calculated in our exercise. In case of Bhakra, applying the multiplier value estimated by Bhatia and Malik, the indirect effect on this count should amount to Rs 5220 crore for agriculture (with a multiplier value of 1.9). In case of Uri, irrigation benefits are not relevant, and electricity benefits have been captured already.

CHAPTER 8 Environmental benefits of the two selected projects

Introduction

This chapter provides estimates of environmental benefits of the two selected projects, focussing on GHG emissions avoided and flood control (not applicable for Uri). In the next chapter, issues related to groundwater and monetary valuation of gains from groundwater recharge (based on extraction costs) is estimated. Siltation related costs have not been covered since siltation of the reservoir is not expected to alter the flow of economic benefits within the time period considered. Siltation of canals are attributable to maintenance issues rather than the project itself and hence, it would not be appropriate to associate these costs to the project.

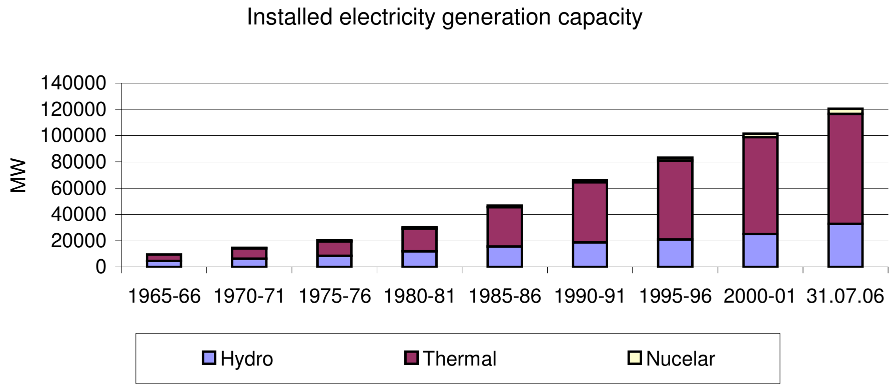
Background

The global economy, since the beginning of the Industrial Revolution, has been fuelled by energy. This energy is generated primarily through the combustion of fossil fuels. The use of fossil fuels is believed to be responsible for the largest share of anthropogenic greenhouse gas emissions affecting the global climate system.

Carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas. Atmospheric methane (CH_4) is considered the next biggest contributor to greenhouse gas emissions because it is estimated to be 21 times more effective at trapping heat in the atmosphere than CO_2.

In order to calculate the avoided emissions, one needs to compare emissions from the hydro-electric project with those of another technology. This comparison can be done by considering the past energy trends and the predicted future scenario.

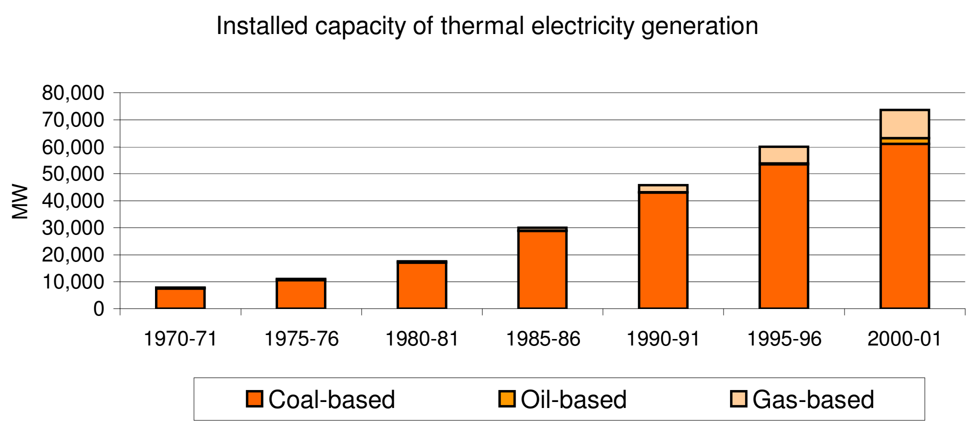
Over the past fifty years, electricity generation in the country has increased as evident from a ten-fold increase in the installed capacity from 10,173 MW in 1965-66 to 101,626 MW in 2000-01. From the visible trend presented in the graph below, we observe that the installed capacity of thermal electricity generation has been the major contributor to the overall increased capacity.



Source. Sootha and Mohan, 1991; CMIE, 2005; CEA 2006

Figure 12. Installed electricity generation capacity

Within the increased installed capacity of thermal electricity generation, coal-based thermal generation has been the most significant as evident from the graph below.



Source. CMIE, 2005.

Figure 13. Installed capacity of thermal electricity generation

Despite the increase in the installed capacity for electricity generation, the electricity demand in the country is not being met. Since demand has exceeded and still exceeds supply, it is reasonable to assume that at any point in the past fifty years the country would have gone in for thermal generation in the absence of hydro-electric generation. And for the thermal generation, coal-based power plants would have been used.

Given the country's plans for rapid economic growth, it is evident that the country's requirements for energy and supporting infrastructure would increase rapidly as well. An integrated assessment of all the technological available options available to the economy is crucial to examine the possible energy pathways and their impacts in terms of costs, infrastructure requirements and fuel mix patterns over time.

This assessment was entrusted to TERI by the Office of the Principal Scientific Advisor to the Government of India. In the ensuing study – "A National Energy Map for India – Technology Vision 2030" – TERI presented a Business-As-Usual (BAU) scenario in the period 2001-31 and incorporated the Government of India's targets and existing policies and plans.

Over the 30 year period (2001-31) in the BAU scenario, the total commercial energy increases from 285 mtoe in 2001-02 to 2123 mtoe in 2031-32, an increase by 7.5 times. Coal remains the dominant fuel in the commercial energy consumption; increasing from 150 mtoe in 2001-02 to 1176 mtoe in 2030-31. The graph below shows the variation in the percentage share of commercial fuels over the modelling timeframe.

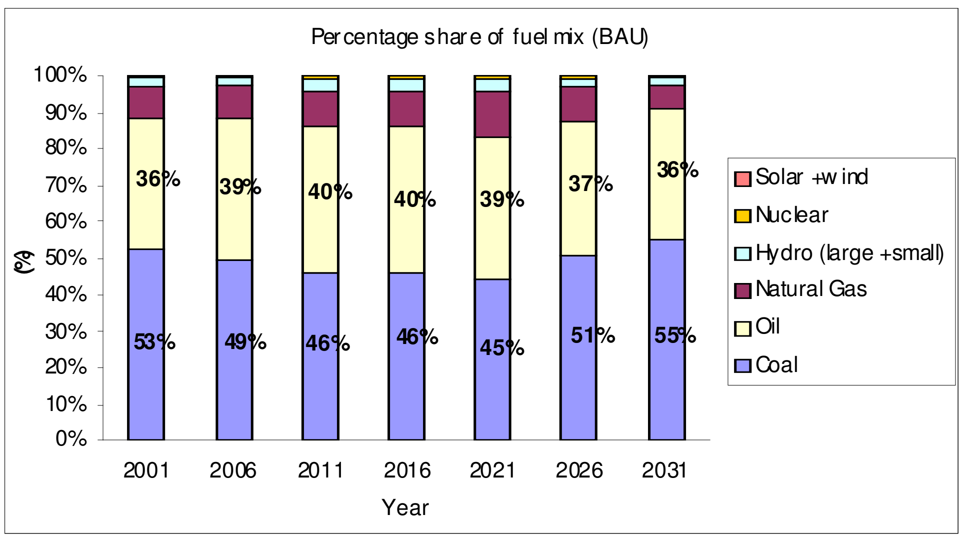


Figure 14. Percentage share of fuel mix (Business-as-usual scenario)

The percentage share of coal in the commercial energy mix is the highest, ranging from 45 % to 55% over the entire modelling period. This is followed by oil. We can therefore assume that the generation of electric energy in the near and distant future will be by use of coal and oil compared to other sources of energy.

There is a general impression that construction of hydro-electric projects lead to generation of electric energy using a renewable resource and, thus, has avoided to a certain degree emissions arising from the generation using coal-based thermal power plants. To get the complete picture, we would in this project component calculate the net avoided GHGs emissions from the hydro-electric project as compared to a thermal power plant generating the same amount of electric energy.

Both technologies generate greenhouse gases. In general, hydro-electric projects produce GHGs primarily in the following ways:

(i) The construction of the dam and associated structures consume large quantities of cement, steel, and other construction material. The production of these materials requires energy that in turn produces large quantities of GHGs.
(ii) Generally, hydro-electric projects are constructed in forested, hilly terrain. The forest land that is submerged in the reservoir would have otherwise sequestered carbon dioxide.
(iii) The land use changes arising from filling of the reservoir can result in decomposing biomass that produces both carbon dioxide and methane.

In a similar analysis, thermal power generation produces GHGs primarily in the following ways:

(i) Mining of coal beds releases methane.
(ii) The transportation of coal from the mines to the point of power generation requires expending energy that in turn produces large quantities of GHGs.
(iii) The actual burning of coal in the thermal power plants produces carbon dioxide.

Methodology

The GHGs emissions are calculated as the net of emissions arising from the hydro-electric project and the (avoided) emissions from an equivalent thermal power project.

$\gamma = \alpha - \beta$

where
γ = Net emissions
α = Total emissions from hydro-electric project
β = Total (avoided) emissions from an equivalent thermal power project

The various GHGs consideration that make up the total emissions from the hydro-electric project (α) can be summed up as:

$\alpha = \alpha1 + \alpha2 + \alpha3 + \alpha4$

where
$\alpha1$ = Total emissions from manufacture of cement
$\alpha2$ = Total emissions from manufacture of steel
$\alpha3$ = Total sequestration potential of submerged forest
$\alpha4$ = Total emissions from submerged biomass

Similarly, the various GHGs consideration that make up the total emissions from an equivalent thermal power project project (β) can be summed up as:

$\beta = \beta1 + \beta2 + \beta3$

where
$\beta1$ = Total emissions from burning of coal
$\beta2$ = Total emissions arising from transportation of coal
$\beta3$ = Total emissions from coal mining

Since carbon dioxide (CO_2) is considered the major contributor to global warming, our GHGs emissions were calculated for CO_2. All methane (CH_4) emissions were converted to CO_2 equivalent numbers. GHGs other than CO_2 and CH_4 have not been considered in this analysis.

In the final step, the net GHGs emissions emitted/avoided are assessed in monetary terms and the net present value is calculated.

The calculations, data analysis, results and discussions of Bhakra-Nangal project is presented below followed by those of Uri hydro-electric project.

Calculations and data analysis (Bhakra)

The Bhakra-Nangal project was conceived with the primary objective of meeting the irrigation requirements of the region. The water stored in the Gobind Sagar reservoir has a very high potential of generating hydro-electric power and it is being used to generate electric energy. While the generation of electric energy is a secondary consideration in this multi-purpose project, we consider the generation of electric energy a direct benefit in our analysis.

Emissions from Bhakra-Nangal project (α)

Total emissions from manufacture of cement ($\alpha1$):

Cement, an inorganic, non metallic substance with hydraulic binding properties, is used in the production of concrete together with other inert mineral aggregates such as sand, gravel, and crushed limestone. These materials consist of minerals containing calcium carbonate, silicon dioxide, aluminium oxide and iron oxide; these compounds react during a heating process to form 'clinker'. Cement is formed by grinding clinker to the desired fineness together with additives that regulate the properties of cement.

Cement production is an energy intensive process. The World Energy Council (1995) estimates the energy consumption by the cement industry at about 2 percent of the global primary energy consumption; this is almost 5 percent of the total global industrial energy consumption.

CO_2 emissions from the cement production process originate directly from:

1. Combustion of coal (or other fossil fuels) in the kiln to form clinker. The production of clinker is responsible for 70-80% of the total energy consumed (WEC 1995).
2. Calcination of limestone to clinker. CO_2 emissions from clinker production (called process emissions) amounts to roughly 0.5 kg per kg of clinker. The specific process CO_2 emission per tonne of cement depends on the ratio of clinker/cement that varies from 0.5 to 0.95; the ratio varies depending on adding more or less additives (like fly ash and slag from steel plants) to the cement.

An indirect source of CO_2 emissions is the consumption of electricity, assuming that the electricity is generated from fossil fuels. The electricity intensive production steps are the raw material preparation and finish grinding. CO_2 emissions from these steps are typically about 5% of the overall CO_2 emissions.

In a study for the International Energy Agency (IEA) Greenhouse Gas R&D Programme, Hendriks and others (1999) estimate the total carbon emissions from the production of 62.4 Mt of cement in India in 1994 at 15.8 Mt of carbon. The process carbon emissions is 7.6 Mt of carbon and carbon emissions from energy use is 8.2 Mt of carbon. This estimation is for a clinker/cement ratio of 85%.

The 15.8 Mt of carbon emissions is equivalent to 58 Mt of CO_2 emissions (using the 44/12 conversion factor between carbon and carbon dioxide based on atomic weight of carbon and oxygen). Therefore, CO_2 emissions per Mt of cement produced is 0.93 Mt. This is higher than the world average of 0.81 Mt of CO_2 emissions per Mt of cement produced.

During the construction of Bhakra-Nangal project, 812,838 tonnes of cement was consumed (Nangal Dam Administration, 1967) for the concreting of the dam and other appurtenant works and foundation grouting. Ordinary Portland cement conforming to IS No 269-1951 (T) was used in the 4.2 million cubic metres of finished concrete required for the construction of the project. All cement was supplied from Bhupinder Cement Works at Surajpur situated on the Ambala-Shimla sector of the Northern Railways. (BBMB, 1988)

In the 1950s, cement was produced by the wet process. The newer dry process requires less coal but more electricity. Using the 1994 estimate of emissions ratio, the CO_2 emissions arising out of the production of cement ($\alpha 1$) used in the Bharka-Nangal project turns out to be 0.76 Mt.

Total emissions from manufacture of steel ($\alpha 2$):

Other than power generation, greenhouse gases are produced from a variety of industries that chemically or physically transform materials from one state to another. Among these industries, the notable one is the iron and steel industry that produces considerable amounts of CO_2.

To calculate the emissions arising from the manufacture of steel used in the construction of the Bhakra-Nangal project, we followed the life cycle analysis of the process of iron and steel production that was prevalent in the country during the 1950s.

Production of steel by a steel plant such as the Bhilai Steel Plant can be grouped into the following stages:

1. Sintering

When the fines content of the ore is high, it is sintered in the sinter plant to make lumps that can be charged into the blast furnace without excessive fine losses. Coke breeze and furnace oil is usually used as a fuel in this process.

2. Coke making

In a coke oven, bituminous or coking coal is heated to high degree in the absence of oxygen to remove the volatile matter. Coke is used in the blast furnace for providing the energy required for the reduction of iron ore and act as a chemical reducer to convert iron ore to iron.

3. Iron making

A blast furnace is used to reduce iron ore to iron. The blast furnace is charged with sinter, ore pellets, coke and lime, and air is injected through the lower part of the furnace. The resulting pig iron contains 3-4% of carbon and some other impurities.

4. Steel making

Molten pig iron is heated in an open-hearth furnace to remove impurities from the pig iron by oxidation and reduce the concentration of carbon from 3-4% to less than 1%, and add necessary ingredients to make the desired type of steel. Furnace oil is generally used in this process.

5. Casting

Casting produce a series of semi-finished steel products such as billets, blooms, slabs and ingots. The semi-finished products are further processed in rolling and finishing operations, where furnace oil and electricity is used in this process to produce finished steel.

CO_2 emissions were calculated for all these stages. Actual 1979-80 usage data from Bhilai Steel Plant was used and it was supplemented with relevant data calculated for the Indian iron and steel industry.

CO_2 emissions from the iron and steel production process originate directly from combustion of:

1. Coke used in the blast furnace

The calculated industry average for coke consumed per tonne of crude steel produced is 700 Kg; this is equivalent to 700 Kg of carbon consumed per tonne of crude steel produced.

2. Furnace oil used in the sinter plant, blast furnace, open hearth furnace and rolling mill

Assuming the calorific value of furnace oil used to be 11,400 Kcal per Kg of furnace oil and the carbon content in furnace oil to be 84%, the total carbon produced per tonne of finished steel in the three stages is calculated to be:

i. 4 Kg in the sintering unit,
ii. 79 Kg in the open hearth furnace, and
iii. 33 Kg in the rolling mill

The carbon resulting from direct combustion of coke and furnace oil sums up to 816 Kg per tonne of finished steel produced, equivalent to 2991 Kg of CO_2 per tonne of finished steel produced.

An indirect source of CO_2 emissions is the consumption of electricity, assuming that the electricity is generated from fossil fuels. In industry average is 401 KWh of electricity consumed per tonne of finished steel produced. Assuming the average CO_2 emissions per KWh of electricity generated to be 1.39 Kg (as calculated for the equivalent thermal power generation, discussed in section on β1 in the report), the CO2 emissions from producing one tonne of finished steel is 571 Kg.

The total CO_2 emissions resulting from production of iron and steel is 3,562 Kg per tonne of finished steel. In terms of the 101,600 tonnes of steel used in the construction of Bhakra-Nangal project (Nangal Dam Administration, 1967), this translates to $\alpha 2$ = 0.36 Mt.

In a study for the International Energy Agency (IEA) Greenhouse Gas R&D Programme, de Beer and others (1999) estimated the CO_2 emissions associated with the specific energy consumption for various steel making routes. They estimated the blast furnace – open hearth furnace route CO_2 emissions at 2,450 – 3,080 Kg per tonne of finished steel. Our calculation also arrives at a very similar figure.

Total sequestration potential of submerged forest ($\alpha 3$):

Diverse methodologies have been used by various researchers in India and in different countries to account for the amount of carbon sequestered by forests. The results from these studies are not comparable as these studies vary in methodology and assumptions used. Accounting for carbon is very complicated and requires a very detailed analysis involving calculation of carbon flux between atmosphere and live biomass, dead biomass, forests soils and forest products.

In our calculation of the carbon sequestration potential of the forest land submerged by Bhakra Nangal reservoir, the mean annual increment in volume was used to estimate the accumulation of biomass. This is equated to carbon uptake and equivalent CO_2. The graph below shows the carbon sequestration scenario for various estimates of net increment in volume ranging from and average of 0.7 m^3/yr/ha for natural forest to 5 m^3/yr/ha for plantation forest (Haripriya 2003).

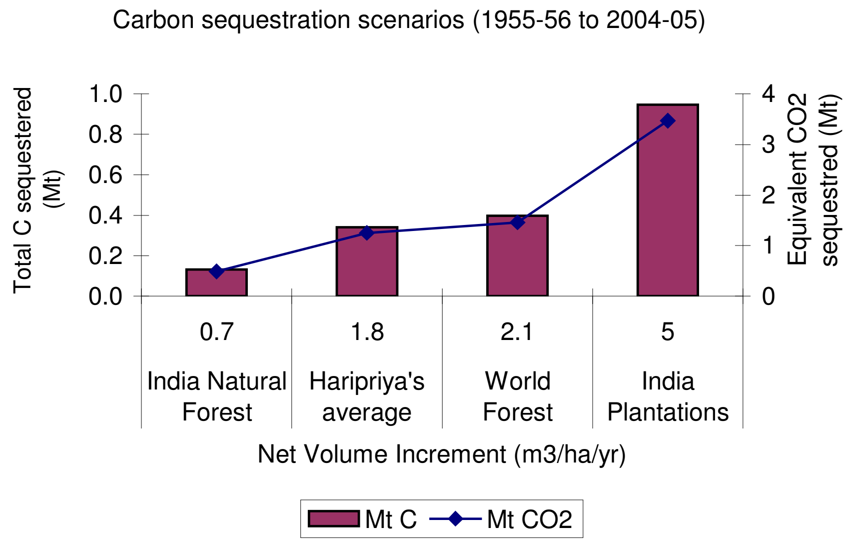


Figure 15. Carbon sequestration scenarios (1955-56 to 2004-05)

The total C that could potentially have been sequestered in the area (5,680 ha) under the Bhakra-Nangal reservoir over a fifty years period from 1955-56 to 2004-05 ranges from 0.1 Mt to 0.9 Mt. Taking the most conservative estimate, a maximum of 3.5 Mt of CO_2 would have been captured and stored.

The above calculations give the gross C sequestered. In any given year the carbon stock will change due to disturbances caused by removals from forest due to harvest, fire, mortality, etc. While these disturbances lead to a decrease in the carbon stock, regeneration/ afforestation leads to increase in the carbon stock. In addition, the carbon stock in the forest soil would also be affected by forest operations. Therefore, the net C sequestered would vary.

Assuming that the past trends in forest management would have continued into the future, the gross C sequestered from 2005-06 to 2055-56 would have been 3.5 Mt. Therefore, the total gross CO_2 that could have been captured and stored in the area under submergence over a 100 year period of the Bhakra-Nangal project is 7 Mt.

Total emissions from submerged biomass ($\alpha 4$):

Bacterial decomposition (both aerobic and anaerobic) of organic matter results in greenhouse gas (both CO_2 and CH_4) emissions from the reservoir following flooding. The magnitude and pattern of emissions varies depending on geography, altitude, latitude, temperature, size, depth, soil type, physico-chemical parameters of water, dam operations, depth of turbine intake, among other factors.

To predict the greenhouse gas emissions from reservoirs, one needs to calculate the net emissions from reservoirs above the natural background emissions. Quantification of the difference between greenhouse gas emissions in the natural pre-impoundment watershed and post dam construction requires an understanding of the carbon cycle at the level of the whole watershed. For example, paddy cultivation in the areas adjoining the river also would have resulted in methane emissions. The other sources of greenhouse gas emissions would include enteric fermentation in domestic livestock, livestock manure management, agricultural soil activities, and agricultural residue burning.

The flooding of biomass post dam construction is just one source of greenhouse gas emissions, though generally considered the major one. Management activities in the entire catchment area of the dam also determine the amount of carbon flowing into the reservoir.

The present use of 100-year Global Warming Potential (GWP) for methane for converting the CH_4 emissions to equivalent CO_2 emissions can significantly under-estimate the emissions over the first few decades as the CH_4 GWP declines significantly with longer time horizons.

Finally, there is a scientific controversy regarding the extrapolation of measured emissions per square metre in selected parts of the reservoir to the whole reservoir area in cases where such measurements have been carried out around the world. While there is a general consensus that (i) the emissions vary according to depth and distribution of the submerged biomass, and (ii) the emissions through time vary, peaking shortly after submergence and then tailing off at an unknown rate, scientific studies have not been carried out over long enough periods to characterize the full life-cycle curve of the emissions.

In light of the above-mentioned variables and experimental data requirements, it is not feasible to calculate the net emissions resulting from Bhakra-Nangal reservoir at this time.

Avoided emissions from an equivalent thermal power project (β)

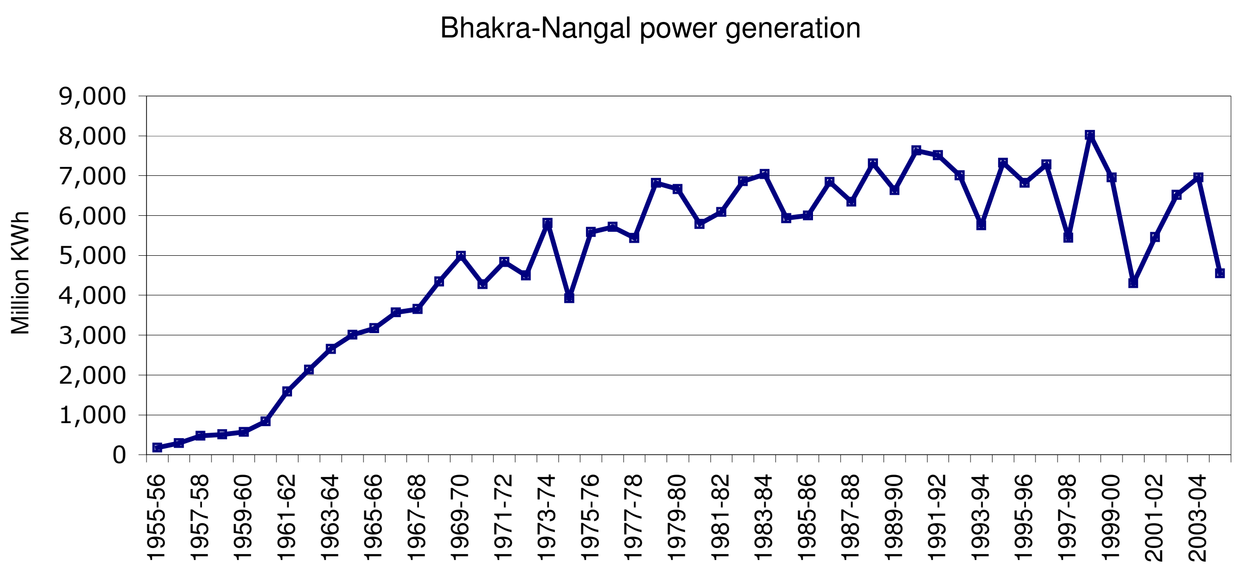
The Bhakra-Nangal project comprises the Ganguwal power house, Kotla power house, Bhakra Left Bank and Bhakra Right Bank. The present combined capacity of the project is 1480.3 MW. The table below provides the details of the four power houses.

Table 40. Bhakra-Nangal power houses

	Name	Year of commission	Capacity (MW)
1	Ganguwal	1955-62	77.65
2	Kotla	1955-61	77.65
3	Bhakra Left Bank	1960-61	540
4	Bhakra Right Bank	1966-68	785
	Total		1480.3

Source. History of Bhakra Nangal Project, BBMB.

The total generation from 1955-56 to 2004-05 is 247,844 million KWh. The generation over these years is given in the graph below.



Source. BBMB

Figure 16. Bhakra-Nangal power generation (1955-56 to 2004-05)

From the above graph it can be observed that in the initial years (1955-68) the actual generation increased with the increasing capacity following the commissioning of the various power houses. All the power houses were operational by 1968.

This generation data was used in the calculations for CO_2 emissions from an equivalent thermal power plant as given below.

Total emissions from burning of coal (β1):

Bokaro Thermal Power Station (BTPS) 'A' is located on the banks of river Konar in Bokaro district of Jharkhand. It was the nation's biggest thermal power station in the 1950s. BTPS 'A' Unit 1 was commissioned in February 1953. It had an installed capacity of 57.5 MW. We therefore assume that in case the country had not gone ahead with the Bhakra-Nangal project, we would have commissioned a thermal power plant similar to BTPS 'A' Unit 1 to generate an equivalent amount of electric energy.

A thermal power plant typically has a 35 year life; it is either decommissioned at the end of its useful life or refurbished. With the advancement of technologies, it is generally considered advantageous to construct a new thermal power plant rather than refurbish the old one. With that consideration, we would expect the equivalent thermal power plant to have been replaced by a higher capacity plant by 1990. In our country, we had started constructing 100 MW units by early 1970s, 200 MW units by late 1970s, and 500 MW units by mid 1980s. These were characterised by heat rates better than the earlier ones; this resulted in less coal consumption per unit of electricity generated. Therefore, the older unit would probably have been replaced by a 200 MW unit by 1990.

For each year from 1955-56 to 2004-05, the total number of units that have to be run to generate the equivalent amount of electric energy is calculated. To calculate the electric energy generated, it is assumed that a thermal power plants typically has an auxiliary power consumption of 8% and is available 80% of the time for generation of power. It is also assumed that when more than one unit have to be run to generate electric energy, each unit will be run at the same plant load factor.

The following values were assumed for calculating the coal consumption from the generation of electric energy over the years:

1) Unit heat rate (A) = 3600 Kcal/KWh for the older units, 2230 Kcal/KWh for the newer units
2) Gross calorific value of coal (B)= 4120 Kcal/Kg

The annual coal consumption (D_i) in units of weight was calculated as:

$D_i = (P_i \times A) / B$

where

P_i = Power generation in year i

A = Unit heat rate

B = Gross calorific value of coal
D_i = Coal consumption for year i

CO_2 emissions are primarily dependant on the carbon content of the coal. In our calculations the carbon content of coal (C) was taken to be 43.4 % based on the quality of coal used in BTPS 'A' Unit 1.

The annual CO_2 emissions avoided (E_i) was calculated as:

$E_i = D_i \times C \times (44/12)$
where
E_i = CO_2 emissions avoided in year i
D_i = Coal consumption for year i
C = Carbon content of coal
44/12 = Conversion factor between carbon and carbon dioxide based on atomic weight of carbon and oxygen

The annual (1955-56 to 2004-05) avoided coal consumption and CO_2 emissions are shown in the graph below.

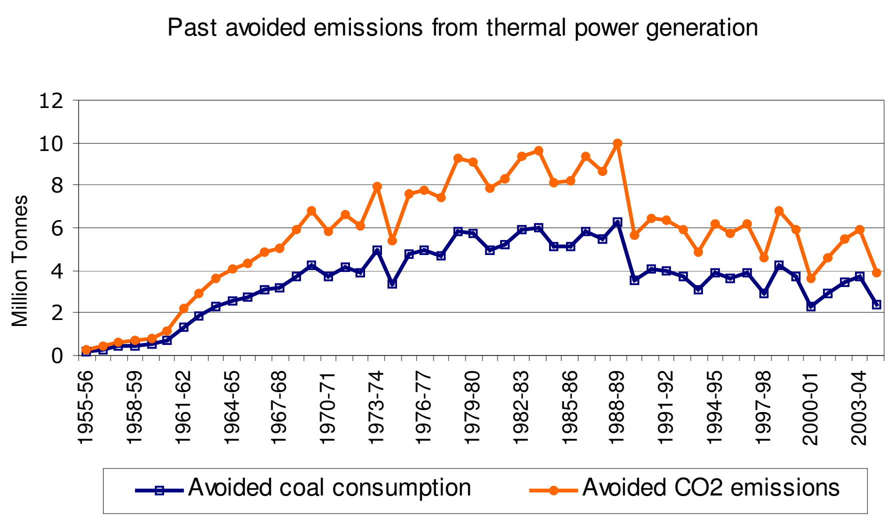


Figure 17. Avoided coal consumption and CO_2 emissions (1955-56 to 2004-05)

The average CO_2 emissions per KWh of electricity generated is calculated to be 1.39 Kg for the older units and 0.84 Kg for the newer units.

The total avoided coal consumption (D) (1955-56 to 2004-05) is calculated as:

$D = \Sigma D_i$
$= 179$ Mt

The total avoided CO_2 emissions (E) (1955-56 to 2004-05) is calculated as:

$$E = \Sigma E_i$$
$$= 284 \text{ Mt}$$

The past and future avoided emissions will be summed up to provide the total emissions from burning of coal (β1).

It is assumed that the thermal power plant will be replaced by 2030 with one of 1000 MW capacity. The new plant will have a unit heat rate (A) = 2000 Kcal/KWh.

The average CO_2 emissions per KWh of electricity generated is calculated to be 0.76 Kg for the future units

The total avoided coal consumption (D) (2005-06 to 2055-56) is calculated to be:

$$D = \Sigma D_i$$
$$= 182 \text{ Mt}$$

The total avoided CO_2 emissions (E) (2005-06 to 2055-56) is calculated to be:

$$E = \Sigma E_i$$
$$= 290 \text{ Mt}$$

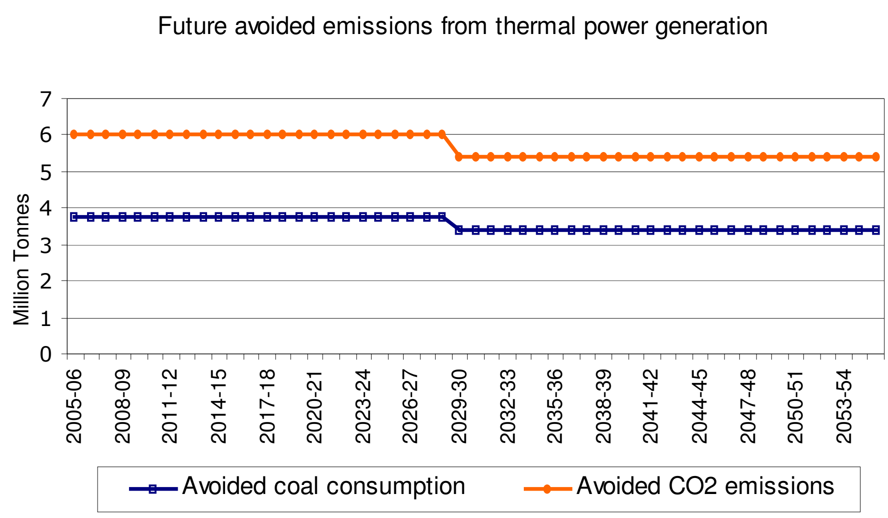


Figure 18. Avoided coal consumption and CO_2 emissions (2005-06 to 2055-56)

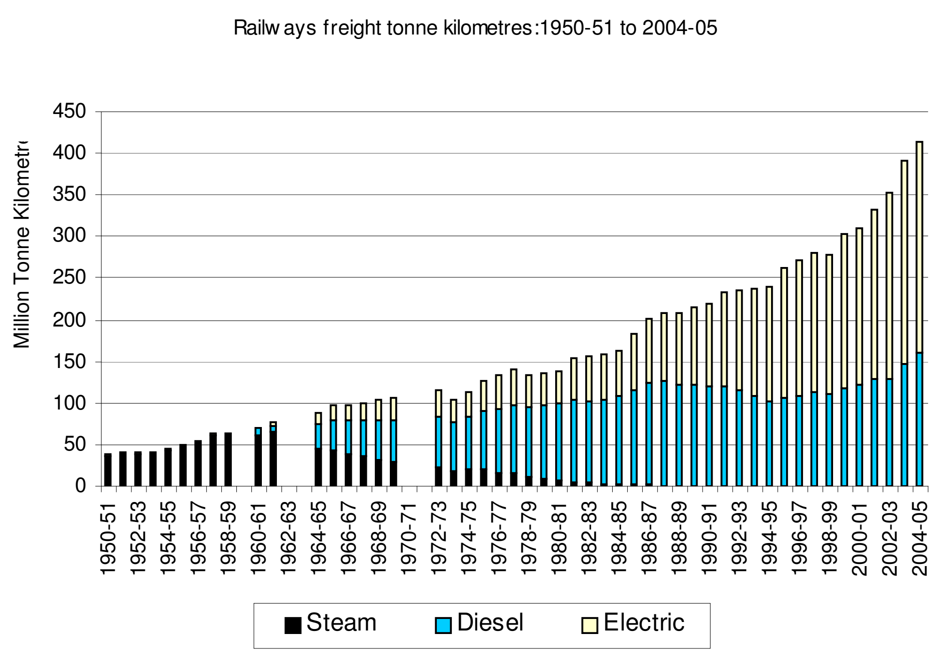
Therefore, the total CO_2 emissions from burning of coal avoided over a 100 year period of the Bhakra-Nangal project is 574 Mt.

Total emissions arising from transportation of coal (β2):

Most of the coal reserves in the country are in the eastern and central regions, primarily in the states of Jharkhand, West Bengal and Chattisgarh. As the demand for coal is spread all over the country, coal from this region has to be transported over long distances. Most of the coal is transported by rail and road. The other modes of transport of coal is coastal shipping.

While the mode of transport is sometimes based on distance, accessibility, and other considerations, it is sometimes felt that the energy content of diesel oil used for road transport of coal maybe more than the energy content of coal being transported. Bulk movement of coal by rail is considered more energy efficient and the Indian Railways has been increasing the movement of coal by using longer trains and/or wagons that can carry more coal by weight. For example, in the 1950s, the railways were using 70 wagons of the 22-tonner, 4-wheeler type in a goods train. They increased their load carrying capacity in the 1980s by using 58 wagons of the 58-tonner, 4-wheeler Box N type per train.

The majority of the coal transported by the Indian Railways is through its broad gauge network though some of it also moves on metre gauge. The railways was the largest consumer of coal till the early 1970s; its consumption has gone down since it decided to adopt a policy to phase out its steam locomotives.



Source. Annual Statistical Statements of the Railway Board (various years)

Figure 19. Railways freight tonne kilometres (1950-51 to 2004-05)

We have used historical data of the freight tonne kilometrage pertaining to steam, diesel and electric locomotives (Annual Statistical Statements of the Railway Board, various years). This data is supplemented with historical data of fuel consumption by classes of fuel on the railways, consumed both by the locomotives and all other purposes such as for pumping engines, workshops, steamers, electric generating stations, etc. The fuel consumed is therefore the total of coal, high speed diesel oil, kerosene, petrol, furnace oil and other fuel oils; each of them is calculated in terms of coal equivalent.

The total coal equivalent used in the transportation of coal over an average lead distance of 750 Km (Indian Railways, 2003-04) for the period 1955-56 to 2004-05 is calculated to be 14 Mt; leading to CO_2 emissions of 22 Mt.

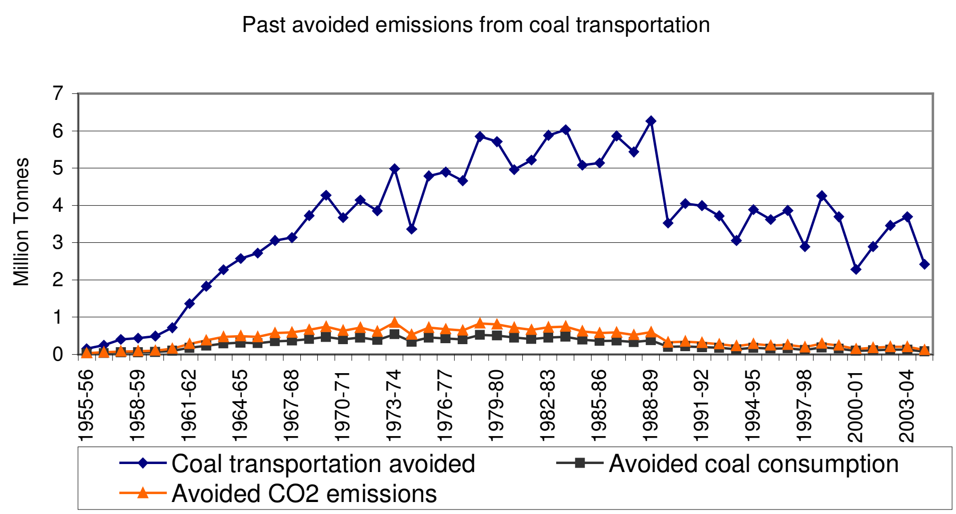


Figure 20. Avoided coal consumption and CO_2 emissions from transportation of coal (1955-56 to 2004-05)

Taking a conservative stand, we can assume that the future freight tonne kilometrage pertaining to steam, diesel and electric locomotives will remain at the 2004-05 level. In this case, the total coal equivalent used in the transportation of coal over an average lead distance of 750 Km for the period 2005-06 to 2055-56 is calculated to be 6 Mt; leading to CO_2 emissions of 9 Mt.

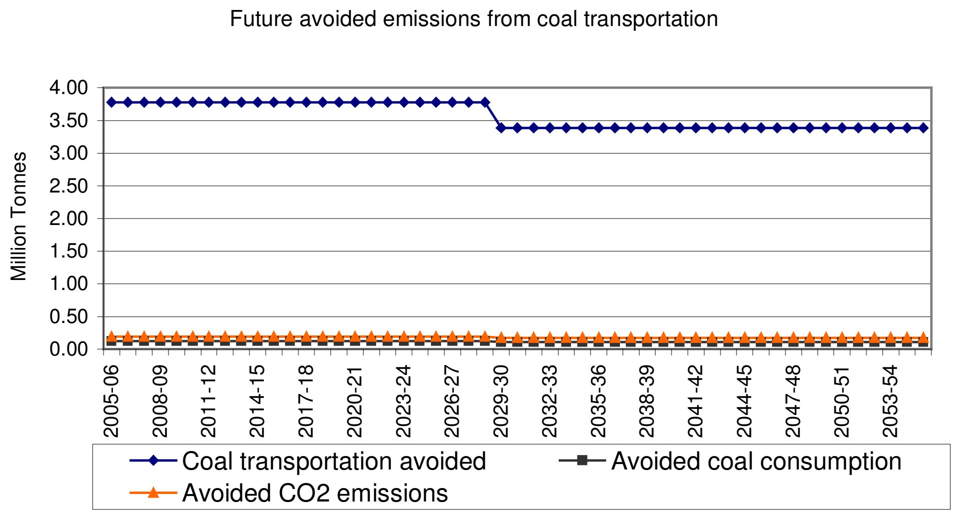


Figure 21. Avoided coal consumption and CO_2 emissions from transportation of coal (2005-06 to 2055-56)

Therefore, the total avoided CO_2 emissions from transportation of coal over a 100 year period of the Bhakra-Nangal project is 31 Mt.

Total emissions from coal mining (β3):

Coal seams were formed over millions of years by the biochemical decay and metamorphic transformation of the original biomass. The process of coalification produces large quantities of by-product gases; 90-95% of the gas produced from coal seams is methane (and other hydrocarbons) and the rest are mostly inert gases (e.g., nitrogen, carbon dioxide, etc.).

The volume of these by-product gases increases with the rank or quality of the coal. Most of these gases escape to the atmosphere during coalification but a small fraction of the gases is retained in the coal itself. This retention of gases, primarily methane, depends on the rank of the coal, geologic characteristics such a depth, temperature, pressure, intermediate roof and floor, etc.

This methane trapped within coal seams and surrounding rock strata is released when the pressure on the coal is reduced, which can occur through the erosion of the overlying strata or the process of coal mining. The quantity of methane released to the atmosphere during coal mining operations depends on the rank of the coal being mined and the depth is mined from. Underground coal mines, as against surface mines, contribute the largest share of methane emissions.

Methane is also emitted from the post-processing activities such as coal processing, transportation and use. As part of coal processing, coal is broken into smaller pieces, crushed, and thermal dried; the resulting increased surface area allows more methane to desorb from the coal.

In the 1980s, India increased its annual coal production from 147 Mt to about 200 Mt (TERI 1993) by expanding opencast mining. Compared to underground mining, open cast mining is an economical way to produce coal due to its shorter gestation period, lower production costs and less manpower requirements. While the annual production of coal from underground mining has hovered around 65 Mt for the past few decades, the annual production from open cast mining has increased from about 25 Mt to more than 150 Mt.

The thermal power sector in the country is the largest consumers of the coal mined. This sector consumes low rank or inferior grades of coal produced largely from open cast mines.

Based on India's First National Communication to UN Framework Convention on Climate Change, 1994, the US Environmental Protection Agency estimated the value of methane emissions per tonne of coal mined in India at 0.05 tonne of CO_2 equivalent. Based on this, the total quantity of methane emissions avoided by generating electricity using Bhakra-Nangal hydro-electric project instead of using coal during the period 1955-2005 is about 9 Mt of CO_2 equivalent.

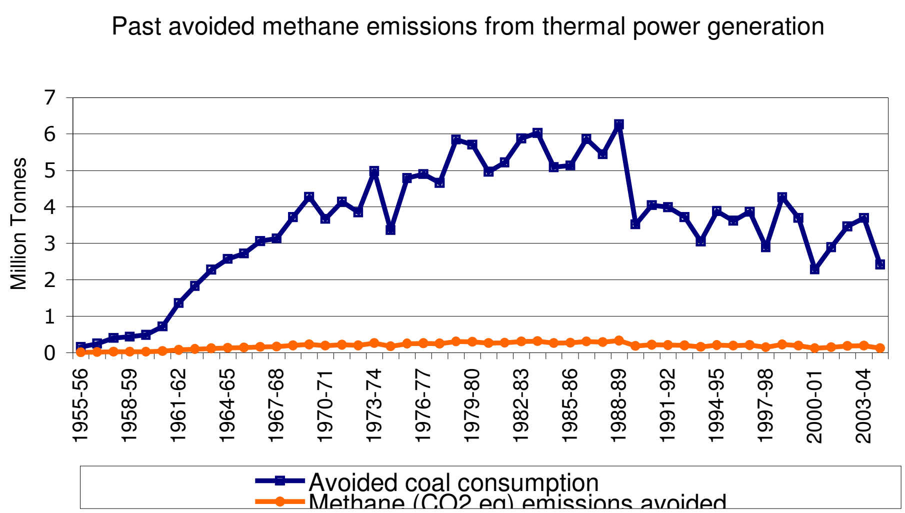


Figure 22. Avoided methane emissions from mining of coal (1955-56 to 2004-05)

Assuming that the same trend continues, the total quantity of methane emissions avoided by generating electricity using Bhakra-Nangal hydro-electric project instead of using coal during the period 2006-2055 will be about 10 Mt of CO_2 equivalent

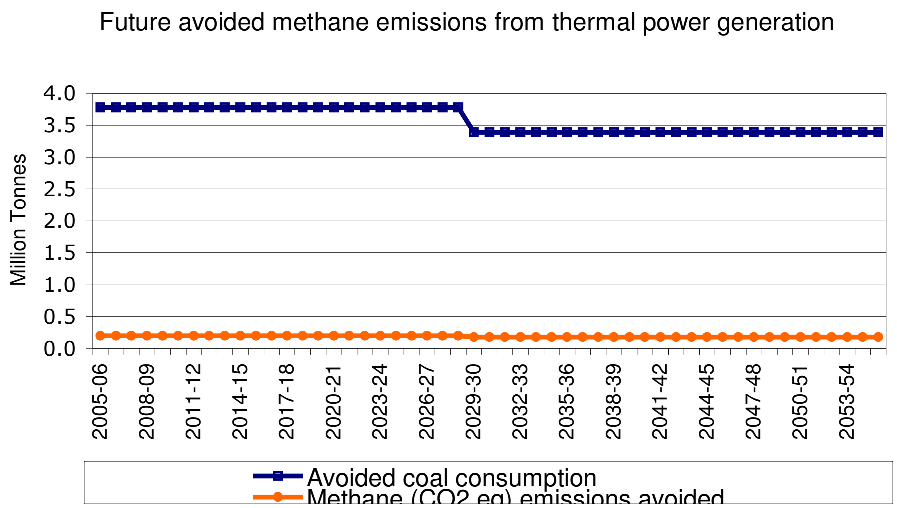


Figure 23. Avoided methane emissions from mining of coal (2005-06 to 2055-56)

Therefore, the total methane emissions from coal mining avoided over a 100 year period of the Bhakra-Nangal project is 19 Mt.

Results and discussions (Bhakra)

The GHGs emissions were calculated as the net of emissions arising from the Bhakra-Nangal project and the avoided emissions from an equivalent thermal power project.

$\gamma = \alpha - \beta$
where
γ = Net emissions
α = Total emissions from Bhakra-Nangal project
β = Total (avoided) emissions from an equivalent thermal power project

The total emissions CO_2 from the Bhakra-Nangal project (α) was calculated to be:

$\alpha = \alpha 1 + \alpha 2 + \alpha 3 + \alpha 4$
= 8 Mt
where
$\alpha 1$ = Total emissions from manufacture of cement
= 0.76 Mt
$\alpha 2$ = Total emissions from manufacture of steel
= 0.36 Mt
$\alpha 3$ = Total sequestration potential of submerged forest
= 7 Mt

$\alpha4$ = Total emissions from submerged biomass
= Not feasible

The total CO_2 emissions from an equivalent thermal power project (β) was calculated to be (1955-56 to 2004-05):

$\beta = \beta1 + \beta2 + \beta3$
= 624 Mt

where
$\beta1$ = Total emissions from burning of coal
= 574 Mt
$\beta2$ = Total emissions arising from transportation of coal
= 31 Mt
$\beta3$ = Total emissions from coal mining
= 19 Mt

The graph below (with slightly different notation: a for α and b for β) shows the total CO_2 emissions arising out of Bhakra-Nangal project and avoided emissions from an equivalent thermal power project. The net CO_2 emissions (γ) are calculated to be 616 Mt.

While it was not feasible to calculate the net emissions resulting from submergence of biomass, assuming that the forested area in the ~340 ha of area submerged by the reservoir had been cleared prior to submergence, we can probably say that the greenhouse gas emissions from the reservoir had been reduced by a significant amount.

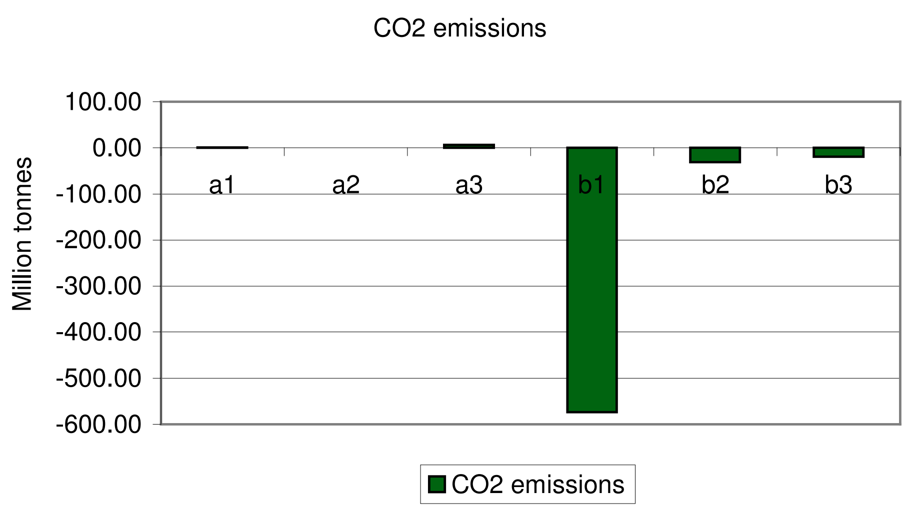


Figure 24. Net CO_2 emissions arising from Bhakra-Nangal project

Not considering $\alpha4$ (total emissions from submerged biomass), we can see from the graph of CO_2 emissions that the avoided emission from the total emissions from burning of coal (β1) is by far the largest component that determines the net CO_2 emissions.

Internationally, the certified emission reduction (CER) approved by the UNFCCC qualify for trading in global markets. These emission reductions are obtained by countries that are signatories to the Kyoto Protocol. These certified emission reductions generated under the Clean Development Mechanism/ Joint Implementation (CDM/JI) are internationally traded at the European Carbon Exchange. The current price of a CER is Euros 16/tonne of carbon dioxide. This has been taken into consideration for the calculation purpose. Based on this price, the net present value (at 8 percent discount rate) for GHG emissions avoided by having Bhakra Nangal Project for the 100 year period 1955-56 to 2055-56 works out to be Rs. 5,420 crore.

In our calculation of CO_2 emissions from production of cement used in the construction of Bhakra-Nangal project we did not take into account the emissions arising from the transport of limestone and other raw material to the cement production site or those arising from transport of cement and other raw material for making concrete at the site of construction. We did not consider the energy consumption in mining of limestone and other material either.

In coke production, coal is crushed to a particle size of less than 5 mm; this increases the surface area of the coal, allowing more methane to desorb. During the coking process, methane, carbon monoxide, and other volatile gases are released. We are not calculating these process emissions in our study. Also emissions arising from energy use and methane emissions in mining of the ore is not included. Also not included are the emissions from transportation of raw material and finished products. Finally, not included is the embodied energy of construction of plant and machinery. Also, in case of both steel and cement, we have not considered the requirement of the building material in repairs and maintenance of the structures.

IEA (2004) estimates CO_2 emissions from fuel consumption using IEA energy balances and default methods and emissions factors from the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. The 2000-02 average CO_2 emissions per KWh from electricity and heat generation using coal in India is estimated at 1.242 Kg. Our calculations differ from the country average.

Calculations and data analysis (Uri)

Uri hydro-electric project (Uri HEP) is situated on River Jhelum in Uri Tehsil of Baramulla District in Jammu and Kashmir. It is a run-of-the-river scheme consisting of a barrage, cut-and-cover desilting basin, open channel, 10 km headrace tunnel, 2 pressure shafts, underground power house and 2 km tailrace tunnel. The project was commissioned in 1996-97 and has an installed capacity of the project is 480 MW (4 x 120 MW).

Emissions from Uri hydro-electric project (α)

In our analysis of the GHG emissions arising from the Bhakra-Nangal project, we found that the major emission factor is the avoided coal consumption in an equivalent thermal power plant. The emissions arising from the construction of the dam was negligible compared to emissions avoided.

In the case of Uri HEP, the quantum of construction material used is quite less than that used in the Bhakra-Nangal project. For example, the total steel used is 23,616 tonnes and the total cement used is 180,185 tonnes. The emission arising from the production of these quantities of steel and cement is therefore assumed negligible. Since Uri HEP is a run-of-the-river project, water is not stored in large quantity in a reservoir. This implies that not much of biomass is submerged following construction of the barrage. Therefore, CO_2 and CH_4 emissions arising from the construction is assumed to be negligible.

Avoided emissions from an equivalent thermal power project (β)

The total generation from Uri HEP from 1997-98 to 2005-06 is 20,737 million KWh. The generation over these years is given in the graph below.

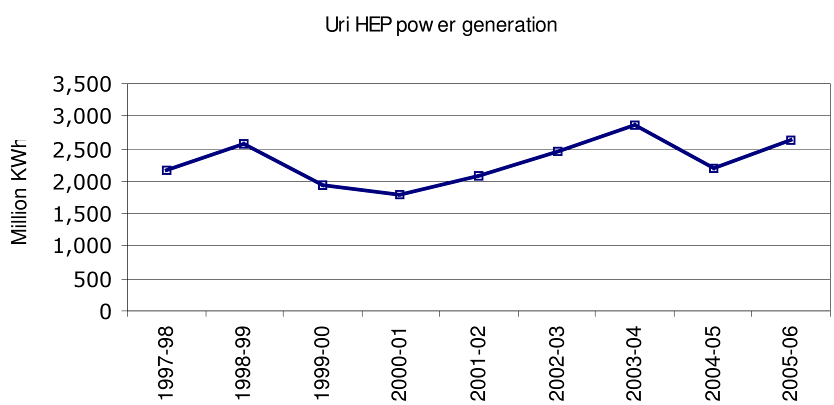


Figure 25. Uri HEP power generation (1997-98 to 2005-06)

This generation data was used in the calculations for CO_2 emissions from an equivalent thermal power plant as given below.

Total emissions from burning of coal (β1):

As discussed earlier, it is reasonable to assume that in case the country had not gone ahead with the Uri HEP, we would have commissioned a thermal power plant to generate an equivalent amount of electric energy.

By the mid 1980s, 500 MW thermal units had started to be constructed. So it is assumed that an equivalent thermal power plant would have been of such a capacity. As previously mentioned, a thermal power plant typically has a 35-40 year life; it is either decommissioned at the end of its useful life or refurbished. With the advancement of technologies, it is generally considered advantageous to construct a new thermal power plant rather than refurbish the old one. With that consideration, we would expect the equivalent thermal power plant to have been replaced by a higher capacity plant (1000 MW) by 2035. This will have a substantially better heat rate than the 500 MW units; resulting in less coal consumption per unit of electricity generated.

For each year from 1997-98 to 2004-05, the total number of units that have to be run to generate the equivalent amount of electric energy is calculated. To calculate the electric energy generated, it is assumed that a thermal power plants typically has an auxiliary power consumption of 8% and is available 80% of the time for generation of power. It is also assumed that when more than one unit have to be run to generate electric energy, each unit will be run at the same plant load factor.

The following values were assumed for calculating the coal consumption from the generation of electric energy over the years:

1) Unit heat rate (A) = 2230 Kcal/KWh for the older units, 2000 Kcal/KWh for the newer units
2) Gross calorific value of coal (B)= 4120 Kcal/Kg

The annual coal consumption (D_i) in units of weight was calculated as:

$D_i = (P_i \times A) / B$

where

P_i = Power generation in year i

A = Unit heat rate

B = Gross calorific value of coal

D_i = Coal consumption for year i

CO_2 emissions are primarily dependant on the carbon content of the coal. In our calculations the carbon content of coal (C) was taken to be 43.4 % based on the quality of coal used in BTPS 'A' Unit 1. This is assumed to remain unchanged. (The BTPS 'A' data used in Uri calculations is a rrespresentative example of coal quality (Grade E) used in thermal power stations.)

The annual CO_2 emissions avoided (E_i) was calculated as:

$E_i = D_i \times C \times (44/12)$

where
E_i = CO_2 emissions avoided in year i
D_i = Coal consumption for year i
C = Carbon content of coal
44/12 = Conversion factor between carbon and carbon dioxide based on atomic weight of carbon and oxygen

The annual (1997-98 to 2004-05) avoided coal consumption and CO_2 emissions are shown in the graph below.

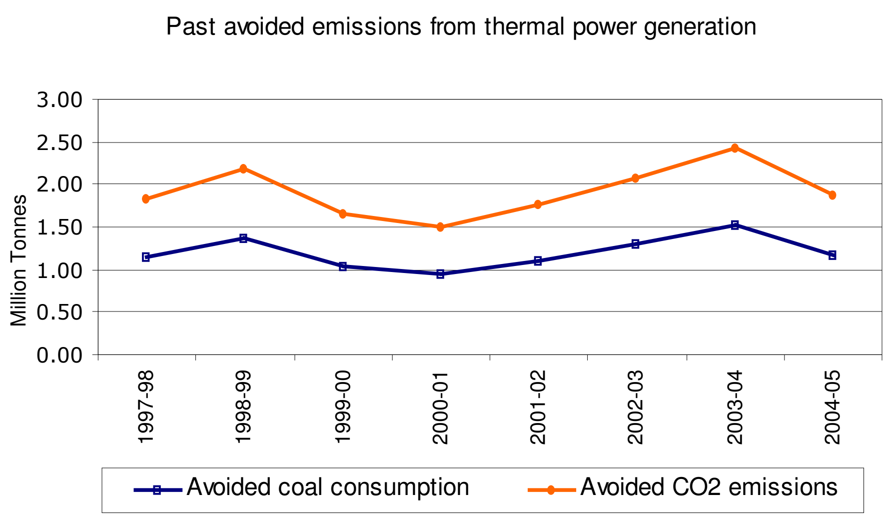


Figure 26. Avoided coal consumption and CO_2 emissions (1997-98 to 2004-05)

The average CO_2 emissions per KWh of electricity generated is calculated to be 0.95 Kg for the older units and 0.08 Kg for the newer units.

The total avoided coal consumption (D) (1997-98 to 2004-05) is calculated as:

$D = \Sigma D_i$
$= 10$ Mt

The total avoided CO_2 emissions (E) (1997-98 to 2004-05) is calculated as:

$$E = \Sigma E_i$$
$$= 15 \text{ Mt}$$

The annual (2005-06 to 2097-98) avoided coal consumption and CO_2 emissions are shown in the graph below.

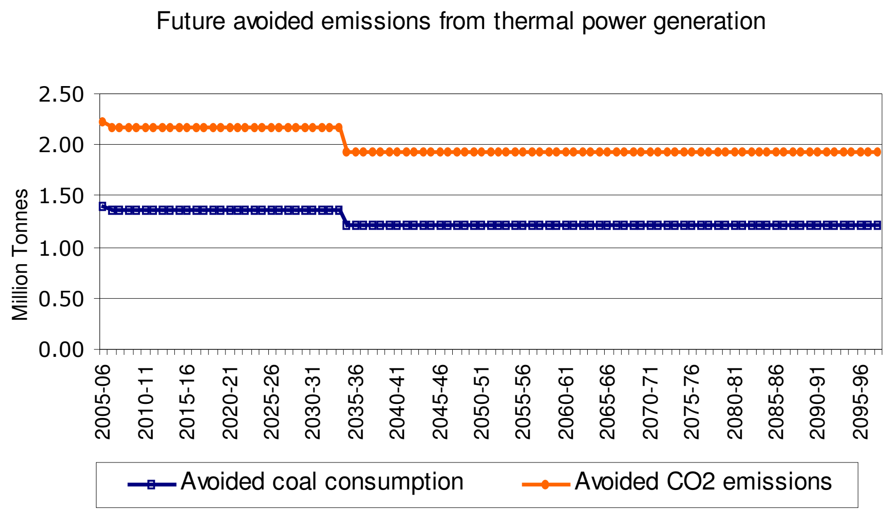


Figure 27. Avoided coal consumption and CO_2 emissions (2005-06 to 2097-98)

The future total avoided coal consumption (D) (2005-06 to 2097-98) is calculated as:

$$D = \Sigma D_i$$
$$= 117 \text{ Mt}$$

The future total avoided CO_2 emissions (E) (2005-06 to 2097-98) is calculated as:

$$E = \Sigma E_i$$
$$= 187 \text{ Mt}$$

Therefore, the total CO_2 emissions from burning of coal avoided over a 100 year period of the Uri HEP is 202 Mt.

Total emissions arising from transportation of coal (β2):

As in the case of calculation for Bhakra-Nangal project, we have used historical data of the freight tonne kilometrage pertaining to steam, diesel and electric locomotives (Annual Statistical

Statements of the Railway Board, 1997-98 to 2004-05). This data is supplemented with historical data of fuel consumption by classes of fuel on the railways, consumed both by the locomotives and all other purposes such as for pumping engines, workshops, steamers, electric generating stations, etc. The fuel consumed is therefore the total of coal, high speed diesel oil, kerosene, petrol, furnace oil and other fuel oils; each of them is calculated in terms of coal equivalent.

The total coal equivalent used in the transportation of coal over an average lead distance of 750 Km for the period 1997-98 to 2004-05 is calculated to be 0.4 Mt; leading to CO_2 emissions of 0.6 Mt.

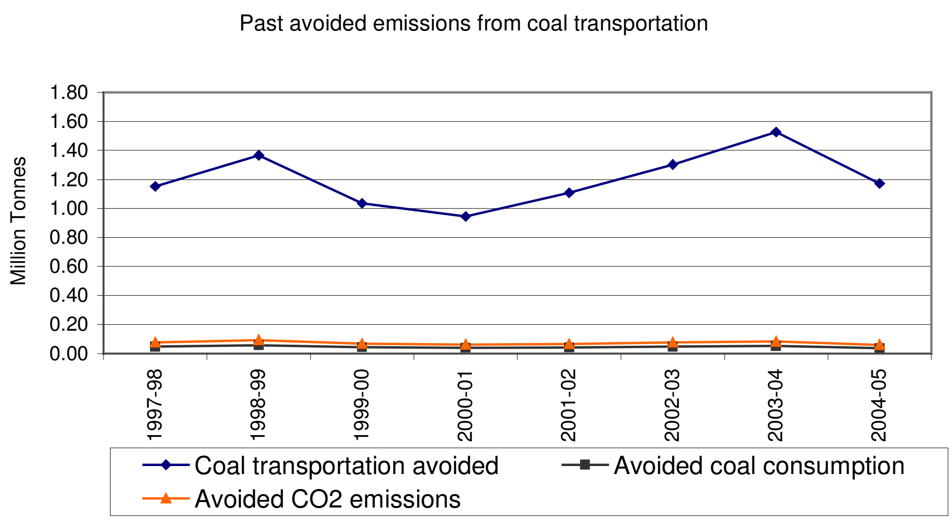


Figure 28. Avoided coal consumption and CO_2 emissions from transportation of coal (1997-98 to 2004-05)

As in the case of Bhakra-Nangal project calculations, we take a conservative stand and assume that the future freight tonne kilometrage pertaining to steam, diesel and electric locomotives will remain at the 2004-05 level. In this case, the total coal equivalent used in the transportation of coal over an average lead distance of 750 Km for the period 2005-06 to 2097-98 is calculated to be 3.8 Mt; leading to CO_2 emissions of 6.1 Mt.

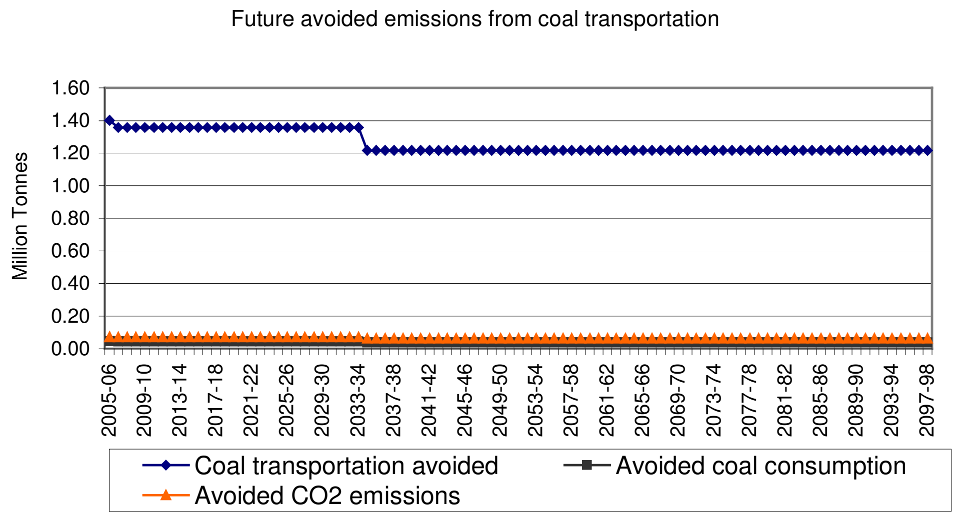


Figure 29. Avoided coal consumption and CO_2 emissions from transportation of coal (2005-06 to 2097-98)

Therefore, the total avoided CO_2 emissions from transportation of coal over a 100 year period of the Uri HEP is 6.6 Mt.

Total emissions from coal mining (β3)

Based on India's First National Communication to UN Framework Convention on Climate Change, 1994, the US Environmental Protection Agency estimated the value of methane emissions per tonne of coal mined in India at 0.05 tonne of CO_2 equivalent. Based on this, the total quantity of methane emissions avoided by generating electricity using Uri HEP instead of using coal during the period 1997-2005 is about 0.5 Mt of CO_2 equivalent.

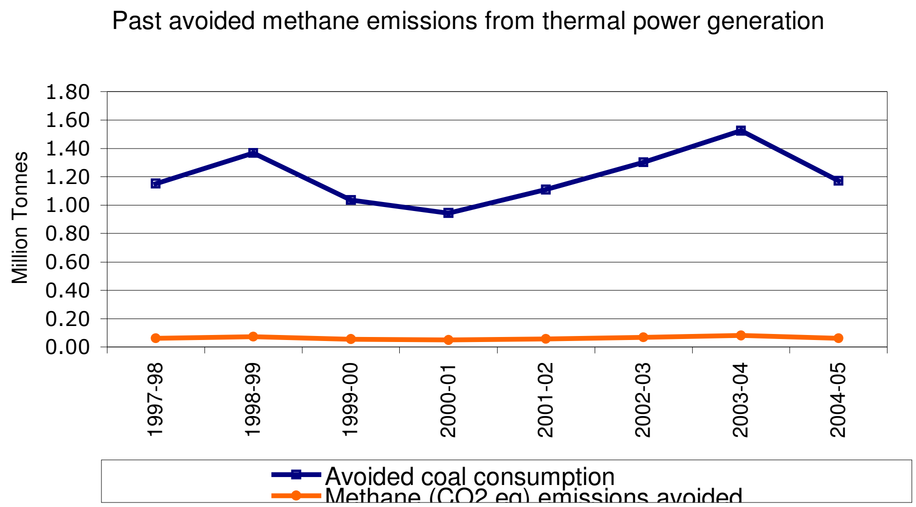


Figure 30. Avoided methane emissions from mining of coal (1997-98 to 2004-05)

Assuming that the emissions factor remains constant, the future avoided emissions in the period 2006-98 would be about 6.7 Mt of CO_2 equivalent. The graph below shows the trend.

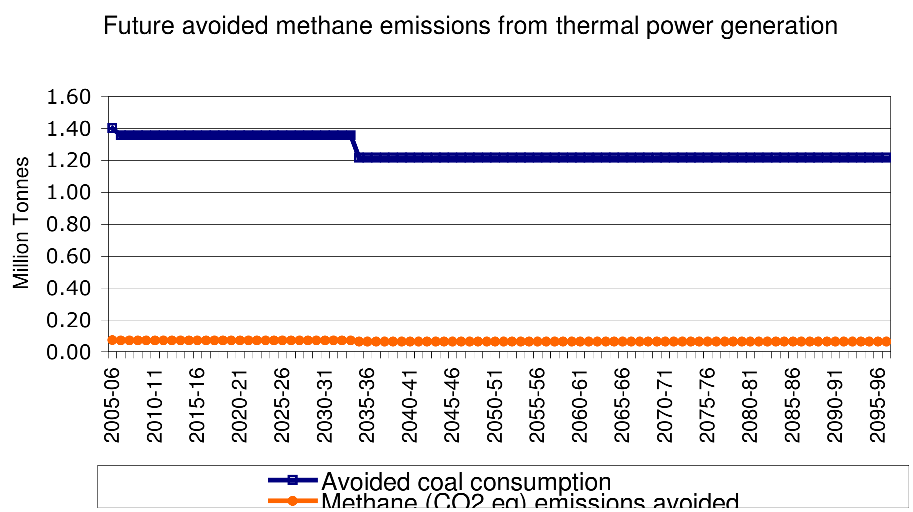


Figure 31. Avoided methane emissions from mining of coal (2005-06 to 2097-98)

Therefore, the total methane emissions from coal mining avoided over a 100 year period of the Uri HEP is 3.3 Mt.

Results and discussion (Uri)

The GHGs emissions were calculated as the net of emissions arising from the Uri HEP and the avoided emissions from an equivalent thermal power project.

$\gamma = \alpha - \beta$

where
γ = Net emissions
α = Total emissions from Uri HEP
β = Total (avoided) emissions from an equivalent thermal power project

Since the total emissions from Uri HEP is considered negligible when compared to the avoided emissions and therefore not used in the calculation.

The total CO_2 emissions from an equivalent thermal power project (β) was calculated to be:

$\beta = \beta1 + \beta2 + \beta3$
$= 215$ Mt

where
$\beta1$ = Total emissions from burning of coal
= 202 Mt
$\beta2$ = Total emissions arising from transportation of coal
= 6.6 Mt
$\beta3$ = Total emissions from coal mining
= 6.7 Mt

The graph below (with slightly different notation: a for α and b for β) shows the total CO_2 emissions arising out of Uri HEP and avoided emissions from an equivalent thermal power project. Since α is negligible, the net CO_2 emissions (γ) calculates out to be 215 Mt.

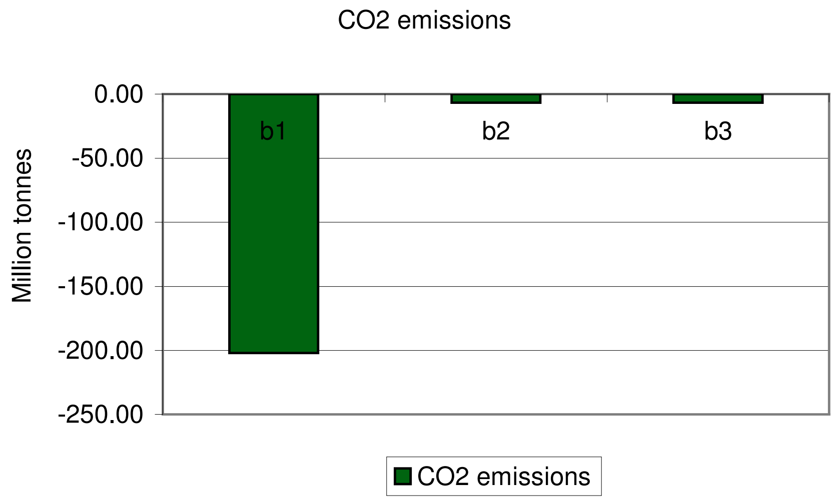


Figure 32 Net CO_2 emissions arising from Uri HEP

Internationally, the certified emission reduction (CER) approved by the UNFCCC qualify for trading in global markets. These emission reductions are obtained by countries that are signatories to the Kyoto Protocol. These certified emission reductions generated under the Clean Development Mechanism/ Joint Implementation (CDM/JI) are internationally traded at the European Carbon Exchange. The current price of a CER is Euros 16/tonne of carbon dioxide. This has been taken into consideration for the calculation purpose. Based on this price, the net present value (at 8 percent discount rate) for GHG emissions avoided by having Uri HEP for the 100 year period 1997-98 to 2097-98 works out to be Rs. 2,743 crore.

Impact of Bhakra on floods in downstream area

Background

Flood refers to ‘ a general or temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters or from the unusual and rapid accumulation or runoff of surface waters from any source’ (Karnic and Murthy, undated). Impact of large dams, which obstruct natural flows and store large volumes of water on floods, is not well known. There are different views in this regard. Roy (undated) in a study on the correlation of dams and floods puts his views thus: “ The structures which were supposed to protect the populations from floods, namely dams and embankments, are also those that have aggravated the damage potential of floods, evident for one, from the recurrence of floods in sates like Himachal Pradesh which has seen considerable dam construction activity." On the other hand, in a multi country study, Hawker (2000) finds large dams to be quite effective in moderating floods though with a set of conditions like correct hydrological analysis, proportion of catchment structure commands, storage allocated for flood control vs. volume of floods etc.

The same debate extends to Bhakra, one of the biggest dams of the country. There are divergent views regarding Bhakra's role in flood management. According to Shiva (1991) floods of 1988 in Punjab ' were very much man made with a major share of the blame due to BBMB (Bhakra Beas Management Board)'. She further refers to opinions of Punjab Agriculture University experts: ' deluge in these areas (Punjab) was not entirely due to rains as was being made out but due to criminal water management by the BBMB who went about irrationally releasing water discharges in lakhs of cusecs without warning to the thousands of people who live close to the embankment of two rivers' (Ibid) . The other viewpoint is that Bhakra dam has been able to moderate most of the high inflows except during the years of 1978 and 1988. According to this line of thinking, if Bhakra was not there, floods of 1978 and 1988 would have caused much greater losses (Rangachari, 2006, Verghese, 2004).

The objective of this section up is to study and value the benefits or losses incurred due to Bhakra in flood management based on the available information.

Before BNP was operationalised in the year 1963, Satluj used to flow freely without any obstruction. In the downstream of Bhakra, rivers like Soan, Sirsa and seasonal nullahs merged in the river. These tributaries were capable of adding another 2,00,000 cusec of water in the main river during rainy season. There was a 7 to 8km wide natural flood plain area between, (Rangachari,2006). Flood absorption capacity of this area was in the range of 4,50,000 to 5,00,000 cusec. So, discharges greater than this capacity used to cause floods in the downstream areas.

Subsequent to construction and operaltionalisation of Bhakra dam, all the inflows during initial years were absorbed in the reservoir and it was thought that all the inflows coming to Bhakra would be moderated. In this situation, Punjab Government took a decision to canalise the river in downstream and divert the flood plain area for agriculture and other purposes. Embankments were created on both sides upto Harike barrage. This canalised part was designed to carry a discharge of 2,00000 cusec. This design was based 'on the basis of the last observed high flood level' (ibid). However, this design discharge capacity of 2.00-lac cusec has been contested ever since. In the year 1973, a spill over from the dam was observed for the first time, which proved the embankments inadequate for flow of flood discharge. There were 'many breaches in the canalised reach on both the banks' (ibid).

After 1973, there were major floods in 1978 and 1988. In 1978, peak inflow to Bhakra was 378,769 cusec on 19th of August. At that time, reservoir was at 1682.19 feet, which was very close to its Full Reservoir Level (FRL) of 1685 ft. For the safety of the dam, discharges of one lakh cusec and above were made. The problem was further aggravated with heavy rainfall in the downstream areas, which added discharges of the order of 2 lac cusec in the river and created flood situation in the downstream areas.

A similar kind of situation occurred in the year 1988. Peak inflow to Bhakra was 318,182 cusec on 26th September. At that reservoir has reached 1687 ft[38] i.e. above its FRL. Outflows of the order of 1 lac cusec and above were made continuously for twelve hours. Once again, the situation was aggravated by unprecedented rainfall in the area. It is reported that 'about 50 percent of the normal annual precipitation was experienced during those four days' (Verghese, 1994). As a result downstream tributaries added around 3 lakh cusec of discharge in the river and at Ropar a discharge of 4,78,000 cusec was measured. This resulted in a large flood in the state of Punjab.

It is clear from above two cases that high inflows could not be absorbed in the reservoir as it was close or above FRL, and to save the dam outflows greater than 1 lakh cusec were made. Though Bhakra moderated the flood in these two years as well but these could have been averted or at least their impact could have been much diluted if there was a proper policy and emphasis on flood management.

After the 1988 floods, it was decided to lower the FRL of Bhakra from 1685 to 1680 ft. , and the space between 1680 and 1686.5 was kept as a buffer for flood absorption. The rule curve of Bhakra was modified as follows with effect from September 1990 .

Table 41. Maximum reservoir levels

Maximum Level to which reservoir can be filled (ft)	Date
1650	31st July
1670	15th August
1680	31st August

Source. Adopted from (Mathur, Subramaniam and Wahi, 2005)

[38] 1687 ft is the top level of Bhakra reservoir

It becomes imperative to study the situation without Bhakra to understand Bhakra's impact on floods.

In the absence of Bhakra, there was little chance that embankments on the river were constructed. In that case, flood absorption capacity of the flood plain would have been same as it was before construction of dam. Hence, inflows greater than 3 lakh cusec would have resulted in floods. This is based on the assumption that downstream tributaries would have added around 2 lakh cusec or more in this discharge. Based on this assumption and inflow data available from Bhakra Beas Management Board (BBMB), one can infer that there would have been three flood years since Bhakra's operaltionalisation up to 2006. These years are 1971, 1978 and 1988. Highest inflows at Bhakra in these three years were 608383, 3,78, 769 and 3,18,182 cusecs respectively. As discussed above, floods in 1978 and 1988 could not be averted because of lack of proper management of floods. But Bhakra was able to moderate floods in the year 1971. In 1971, maximum inflow to Bhakra was 6,08,383 cusec which was significantly higher than the flood absorption capacity. As this was during the initial years when dam was still in the filling phase, the entire floodwater was absorbed in the reservoir. Without Bhakra, it would have resulted in a larger flood and more losses than 1988.

Valuation of Bhakra's impact on floods

Methodology

- With the available data on inflows and corresponding outflows from Bhakra, year/s when Bhakra was able to moderate the inflows and saved the potential floods were found out. It was found out that Bhakra averted the flood in1971.
- During 1971, value of impact of Bhakra on averting flood was estimated by valuing net losses saved
- For the estimation of potential losses, it was compared to the year of 1988, where intensity of peak inflow and resulting economic losses were known.
- Partial information on economic losses was available for the year 1988. For example, monetary value of the houses and crops damaged were available from secondary data. Rest of the losses like loss of cattle and human lives were available in terms of physical numbers, which were monetised according to 1988 flood relief guidelines. All the monetary values for 1988 losses were added up to calculate the overall loss due to 1988 floods.
- Proportionate to the peak inflow of 1988, monetary losses were calculated for the year 1971. This was the value of potential losses saved by Bhakra by averting the

flood in 1971. It was converted to 2005 wholesale prices and its Net Present Value (NPV) was calculated as per the methodology used throughout this report.

Assumptions

- Downstream tributaries add up to 2 lakh cusec of water in the river
- Impact of flood and losses are in proportion to peak inflow
- Cattle population in Punjab in 1988 was similar figures reported in the 1990 livestock census of the state
- Out of the total cattle in 1988, 50% cattle were milch cattle
- In 1988 minors constituted 35% of total population

Table 42. 1988 Flood Losses

No. of Villages/Towns affected	Population affected (No.)	Human lives lost (No.)	Cattle heads lost (No.)	Damage caused to area under crops (ha)	Houses damaged (No.)
8715	41,98,149	699	68,110	27,90,407	5,23,503

Source. Economic and Statistical Organisation Punjab, 1991

Table 43. Monetary Value of 1988 flood losses (Rs crore)

Losses due to crop Damage	Losses due to house Damage	Losses due to loss of human lives	Losses due to loss of cattle lives	Total Losses
519.9	293.42	0.80	3.14	817.26

Table 44. Calculation of 1971 flood losses

	Peak Inflow (Cusec)	Losses at 1988 prices	Losses at 2005 prices and discounting at 8% rate till 1955
1988 Floods	3,18,182	817.26	
1971 floods	608,383	1562.66	**1431**

As discussed above, Bhakra's impact on averting floods in the year 1971 can be measured by valuing the potential losses saved. Losses of 1971 can be valued by comparing with the losses of 1988. In 1988 , peak inflow at Bhakra was 3,18,182 cusec which resulted in the losses shown in the above table. Value of crops and houses damaged was Rs 817.26 crore (Economic and Statistical organisation of Punjab, 1991).

In addition, we can calculate the value of human lives lost and dead cattle as per 1988 flood relief guidelines. According to

1988 flood relief norms, Rs 15000 per adult and Rs. 5000 per minor was given to next of kin of the deceased person as *ex gratia* grant. In accordance with 2001 census data, we assume that minors constitute around 35% of the population. Then out of 699 deceased, 454 were adult and rest 245 were minor. Accordingly value of human lives lost is Rs.80,35,000.

Likewise, as per 1988 flood relief guidelines of Punjab an amount of Rs. 1000 per milch cattle and Rs. 200 per sheep and goat was provided to the flood affected people. According to 1990 livestock census of Punjab, cattle and buffalo constituted around 87% , camel 0.44%,sheep and goat 10.78% of total livestock population excluding poultry (Economic and Statistical organisation of Punjab, 1990). If we distribute cattle heads lost proportionately, number of cattle and buffalo, camels, sheep and goat comes out to be 59256, 300 and 7492 respectively. We have made an assumption that out of the total number of cattle and buffalo only 50% were milch cattle, making their number to be 29628. If we put value to these different animals as per guidelines, it comes out to be Rs. 3,14,26400 or Rs 3.14 crore.

Total value of losses in 1988 for human and cattle lives, crop damages and house damages comes out to be 817.26 crore rupees.

Highest inflow during 1971 was 608,383 cusec. If we compare it with highest inflow of 1988, then proportionate value of 1971 losses comes out to be Rs 15,62,66,17,032 or 1562. 66 crore rupees at 1988 prices. If we convert this value to 2005 whole sale index prices and discount it at 8% to the year 1955, which was the first year of the Bhakra Nangal Project, net present value of the losses saved by Bhakra comes out to be 1431 crore rupees.

The above analysis reflects a benefit of Rs. 1431 crore due to Bhakra in terms of averting flood in 1971. These benefits could have been much higher if reservoir was properly managed for floods of 1978 and 1988. However, in case of multipurpose schemes such as Bhakra, there are competing interests of irrigation, power generation and flood control that demand maintenance of different water levels in the reservoir. In such cases, the management has to balance these. On pure economic grounds, there is a case for according priority to flood control as all the economic benefits due to irrigation and power are undone if floods occur even once in several years.

CHAPTER 9 Groundwater issues for the Bhakra Project

Introduction

Application of geographic information system (GIS) techniques has been used in this chapter to analyse the groundwater water situation of the Bhakra Irrigation System in India. The objective here has been to study the spatial variations in waterlogging, groundwater exploitation, and salinity in the Bhakra command area based on the secondary information collected from several state departments for irrigation and state groundwater boards. The datasets have been converted into digital form, which were transferred into GIS platform for doing area-differentiated analysis for different time periods since the operation of Bhakra Project.

GIS applications were a means for uncovering the need for certain macro-level corrective management, such as identifying percentage areas that have potential waterlogging problems that require reclamation. The regional scale of information on some parameters, such as water-table depth and groundwater quality, prevented microlevel analysis.

Background on ground water situation

Haryana

Haryana is bounded by river Yamuna in the east, Shivaliks in the north-east, and river Ghaggar in the north. The southern and western boundary is through the Aravali range. Rainfall in this arid/semi-arid state is erratic and ill-distributed, and varied from 1100 mm in the north-eastern region to 300 mm in the south and south western region. Irrigation requirements in the state is supplemented either by surface water or ground water or both. The state has two major canal systems, namely the Bhakra Canal System and Western Yamuna Canal System. The Bhakra Canal System brought surface water from Bhakra and distributed it in the previously unirrigated areas of Hisar, Sirsa and Fatehabad, among other areas in Jind and Kaithal. The earlier unlined canals led to seepage and percolation through the primary, secondary and tertiary stages of irrigation and recharged the ground water. Ground water is also partly recharged by seepage from irrigated fields. Ground water in the command of Bhakra (as well as other parts of the state) is of poor quality and therefore ground water extraction for irrigation has been rather limited.

The rising water table leads to waterlogging and increasing salinity; capillary action transport salts from deeper soil layers to the surface and rising water table limits the natural drainage and hinders the leaching of salts. The central region of Haryana can be compared to a bowl and surface water accumulates in the area. Ground water flows predominantly from north and south into this central region. This is a major reason for the inter-dependant phenomena of waterlogging and salinity.

The annual replenishable ground water resource in Haryana has been assessed as 8.53 BCM, the available groundwater for irrigation as 7.25 BCM and net draft as 8.13 BCM with a stage of development as 112% (Romani 2005).

A draft bill to regulate and control the development of ground water in Haryana is under preparation.

Punjab

Agriculture and dairy are the main sources of livelihood in Punjab. Of the 5 million ha geographical area of Punjab, 4.2 ha (almost 83% of the total area) is under cultivation. Wheat and paddy rotation dominates the cropping pattern, accounting for more than 70% of the gross cropped area. This cropping pattern has increased the demand for water for irrigation (estimated at 4.38 million-ha-m). Since the supply from both surface and annual recharge of ground water is only 3.13 million-ha-m, the deficit of 1.25 million-ha-m is met from over-exploitation of ground water resources through tubewells, leading to declining water table. In the southern region of Punjab where ground water is not fit for irrigation, intensive use of canal irrigation has led to a rise in water table, making the area prone to waterlogging (Government of Punjab 2004)

In the period 1975-2005, there has been a decline of water level in fresh ground water areas covering about 80% of Punjab ranging from 4-16 m (Romani 2005). Other estimates of the falling water table peg it at 0.7-1.7 m for the period 1974-84 and 1.5-5.1 m for the period 1984-94 (Government of Punjab 2004)

The annual replenishable ground water resource in Punjab has been assessed as 18.66 BCM, the available groundwater for irrigation as 16.79 BCM and net draft as 16.40 BCM with a stage of development as 98% (Romani 2005).

The Punjab Ground Water (Control and Regulation) Act has been framed. It is yet to be enacted.

In the present project component, we analysed the ground water in the command of Bhakra Nangal project on a spatial as well as temporal scale.

Results and discussion

After partition, Punjab was left with two canal systems — the Upper Bari Doab and the Sirhind Canal. Steps were taken to increase their discharge. More significantly, the Bhakra Canal System was laid during 1948-63. It had three components: (i) construction of a new Bhakra Canal, (ii) augmenting the capacity of the old Sirhind Canal and (iii) laying out of the Bist Doab Canal. By 1966, Punjab had 52.9 per cent of its net area sown under irrigation. It ranked first in India; the Indian average being 19.5 per cent. Of the net irrigated area at that time, 57.8 per cent was served by canals, 39.5 per cent by wells / tubewells and the remaining 2.7 per cent by other means, such as traditional Persian wells, ponds and rivers. The extension of the canal network resulted in waterlogging conditions in Punjab during the fifties. About 1.6 million hectares had a water table close to the surface. Figure 1 shows the groundwater situation in fifties with water levels less than 10 feet below the ground level.

Around 1967 came the Green Revolution, primarily with the advent of high yielding variety (HYV) seeds. These needed increased inputs like chemical fertilizers, pesticides, cheap credit, minimum support prices and, of course, water.
Far more important than canal irrigation has been the role of ground water. The explosive growth of groundwater was the real driving force behind the green revolution. Hence groundwater use and exploitation became visible as the dependency on groundwater systems over canal or surface irrigation systems grew primarily since farmers could have greater control on use and better quality water especially by the villages around middle and tail end reaches of the canal system. While the region experienced rise in groundwater irrigation through tubewells, it also saw, since 1985, rise in the water tables in canal command areas the range of 0.2 – 0.6 m annually. Patches of salinity started appearing at the farm level. The situation got worse in higher rainfall areas where waterlogging followed shortly after the rains. Apart from affecting agricultural crops, a high water table caused floods even during slight rains because of the reduced moisture storage capacity of the soil. In Hissar, the bearing strength of the soil declined to less than 50 % in 50 years (Chaudhri et al., 1991).

Anti-waterlogging measures were adopted in late eighties by way of laying out a network of drainage channels. Lining of canals and watercourses was begun and is continuing to reduce seepage and to improve the conveyance efficiency of canal networks, as well as to control the groundwater rise. More than seventy percent of the 17,500 kilometers of watercourses in the command are now lined (Sakthivadivel et. al., 1999). This reduced the waterlogging menace to some extent. Saline soils were also reclaimed in some areas. Figures 2 to 7 show the spatial changes in groundwater tables and quality for certain time periods in a chronological order after the operation of Bhakra system. The figures reveal that around twenty-five percent of the command area is underlain by marginally saline to saline water (salinity > 2000 mhos/cm), and in the last three decades (since mid 75's) the water table has risen substantially (5 to 10 m) in a large portion (> 50 percent) of the command. The continuing rise in water tables in these areas is one of the major problems in the command. But in Kaithal, Kurukshetra, and Ambala districts, due to extensive development of good quality groundwater, the water table dropped by 0.2 – 0.5 m per year after 1980's.

According to Sakthivadivel et. al. (1999), the spatial variability in canal water supplies is related to groundwater quality. Areas supplied with relatively small amounts of canal water are mostly in zones of fresh groundwater, and areas of high canal water supply are in zones of marginally saline to saline groundwater. Under the warabandi principle, all areas should receive a roughly equal supply of water per unit command area. However, the canal water supplies vary. Thirty-five percent of the command area received less than 150 millimeters and 41 percent received over 300 millimeters. The rest of the command area received 150 to 300 millimeters. The water supply, based on the warabandi principle, follows a rigid rotational cycle of fixed duration, frequency, and priority level. A hypothesis is that when water is supplied to the tail reach, an area of highly permeable sandy loam, at fairly long intervals (once in 8 to 16 days), most of the water is not retained and available in the root zone for crop growth. Instead the water percolates to the underlying saline groundwater. Inadequate root-zone soil moisture probably is a major factor in the low wheat yield. As a result more canal water reaches the saline groundwater, and the water table rises rapidly (http://www.iwmi.cgiar.org/ pubs/ pub028/ RR028.htm).

Punjab now witnesses a sharp fall in the water table at the rate of 25-30 cm/year. The fall in the share of canals for irrigation from 35% in 1995 to 28% in 2003 is matched by the increase in the share of wells from 65% in 1995 to 71% in 2003. Ground water development in the state is already 97.66%, and overexploitation has aggravated water quality problems, which now affect 7 of the 17 districts. One of the reasons for this critical situation is a shift in the cropping pattern wherein a rainfed crop (maize) is being rapidly replaced by a water intensive crop (paddy). 97% of the state's paddy fields are irrigated, largely from ground water sources. This shift in the cropping pattern has been largely aided by access to cheap inputs and assured income, in addition to higher realizations per hectare from rice. Further, the development and accessibility of new irrigational technologies and government policies have accelerated the shift to paddy cultivation. As a result, the area under paddy as a percentage of the net-cropped area has increased 2.5 times over the last two decades (TERI, 2006, in press).

Hence at present, the twin problem in the States of Haryana and Punjab are mostly of drainage and water logging including salinity, as well as groundwater depletion. More than the rest of India, both Punjab and Haryana, have been guilty of over-exploitation of their ground water resources. Districts of Punjab — Kapurthala, Jalandhar, Sangrur, Patiala, and Ludhiana — are facing ground water depletion. Keeping them company are Kurukshetra, Karnal and Mahendragarh in Haryana. On the other hand, Hissar and Sirsa circles including Mansa, Fatehbad, Bhatinda, which are underlain by marginally saline and saline groundwater, have the waterlogging problems.

Future water management strategies for the Bhakra command should address the problem of rising water tables in the zones that have saline groundwater and the problem of declining water tables in the zones that have fresh groundwater. Although a lasting solution to salinity problems cannot be achieved without a drainage outlet to remove the salts imported with irrigation water (because of poor natural drainage condition in this saucer-shaped basin), better management strategies could delay the rise or fall of the water table in the endangered zones. One such strategy should focus on reducing aquifer recharge and increasing groundwater use in the areas where the water table is rising (http://www.iwmi.cgiar.org/ pubs/ pub028/ RR028.htm). Conjunctive use of surface and groundwater in saline areas is one of the options. Another option looks at installation of horizontal sub-surface drainages. The agro-climatic and soil conditions determine the most appropriate combination of drain depth and spacing. To avoid costs for pumping the drainage effluent, gravity outlets should be preferred by reducing the drain depth and narrowing the spacing. Flushing of lateral and collector pipe drains is essential when horizontal pipe drainage systems are laid under high water table conditions. Amongst the institutional strategies there is an urgent need to improve the system performance through efforts like Participatory Irrigation Management (PIM).

The issues raised in this report need to be thoroughly investigated by combining satellite remote sensing and GIS techniques with hydrologic modeling, supported by selective and intensive data collection campaigns. Hydrologic modeling is an important tool for understanding the transfer process of salt and water from surface to groundwater and the causes of rising groundwater. There is an urgent need for the irrigation agency to thoroughly examine water management problems on the farm, regionally, and systemwide. By combining satellite remote sensing and GIS techniques with hydrologic modeling, appropriate ways can be found to modify the present water allocation and distribution practices to sustain productivity and maintain the health of the Bhakra system.

Modelling at the sub-catchment or river basin level can integrate the hydrological, technical, ecological, environmental, economic, social, institutional and legal aspects of water problems into a coherent framework. Hence effective watershed management requires an understanding of basic hydrologic and biophysical processes in the watershed. Presently hydrological models simulating water balance elements (such as river run-off, groundwater and evapo-transpiration) are quite well developed. So are water quality models for rivers, groundwater and lakes. With wide adoption of geographic information system (GIS) technology, a user-friendly and interactive decision support system appears to be an efficient tool in watershed management. At the river basin level, GIS-based modelling techniques can allow policy-makers and managers to test "what if" scenarios, on topics like integrated water quantity, water quality and environmental regulation, the impacts of land use changes on flow regimes, climate change effects on flood and drought frequency / severity, inter-sectoral water allocation policies, effects of uncertainty and risk on water resources management and the impacts of economic incentives for pollution control, water conservation and more efficient irrigation. A number of simulation models have been developed to evaluate water resources and quality parameters affected by agricultural land management at both field and watershed scale. Widely used field scale models include CREAMS (Chemicals, Runoff, Erosion from Agricultural Management Systems), EPIC (Erosion-Productivity Impact Calculator), and GLEAMS (Groundwater Loading Effects of Agricultural Management System). Watershed scale models include storm event based AGNPS (Agricultural Non-Point Source Pollution Model) and continuous daily time step model SWRRB (Simulator for Water Resources in Rural Basins). Expansion of SWRRB model's capacities to facilitate more subbasins and sophisticated routing structure resulted in a new watershed scale model SWAT (Soil and Water Assessment Tool) (Arnold et al., 1993). SWAT model, is a river basin, or watershed, scale model developed to predict the impact of land management practices on water, sediment, and agricultural chemical yields on complex watersheds with varying soils, land use, and management conditions. The model combines these with point source contributions, and performs flow and water quality routing in stream reaches. The model is physically based and computationally efficient, uses readily available inputs and enables users to study long-term impacts.

SWAT is a continuous time model operating on daily time step. The SWAT-ArcView interface is a tight coupling between a model and GIS (Burrough, 1995). The export of data from GIS to the SWAT model and the return of results for display are accomplished by Avenue routines that are addressed directly by the interactive tools of GIS (e.g. setting up parameter values via customized menus) and the exchange of data is fully automatic. GIS can elucidate landscape characteristics (e.g. topography, soil, climate, land cover and management) and effects of agricultural activities overlaying intrinsic hydrological attributes.

Economic benefit of groundwater recharge

To compute the monetary benefit from groundwater recharge due to irrigation by Bhakra Nangal project, the historic data on water input to ground water in Punjab and Haryana (Karnath 1987) was used to calculate the increase in water column.

Table 45 Recharge from irrigation

	Water input (mm)		Mean annual recharge	Recharge from irrigation
	Rainfall	Irrigation	(mm)	(mm)
Punjab	460	210	82	25.7
Haryana	470	70	80	10.4

The average recharge from irrigation for the states of Punjab and Haryana is calculated to be 18.03 mm per annum. The soil in these two states is predominantly alluvial. Based on an assumed porosity of 0.08 for alluvial soils, the annual recharge from irrigation would result in (maximum) increase of approximately 0.2 m in the height of the water column.

The recharge of groundwater would have benefited in terms of the decreased cost of extraction. The cost of extraction of groundwater depends on the depth. TERI (1998) has modeled the cost of groundwater extraction from different depth categories as is presented in the form of a stepped cost curve given below:

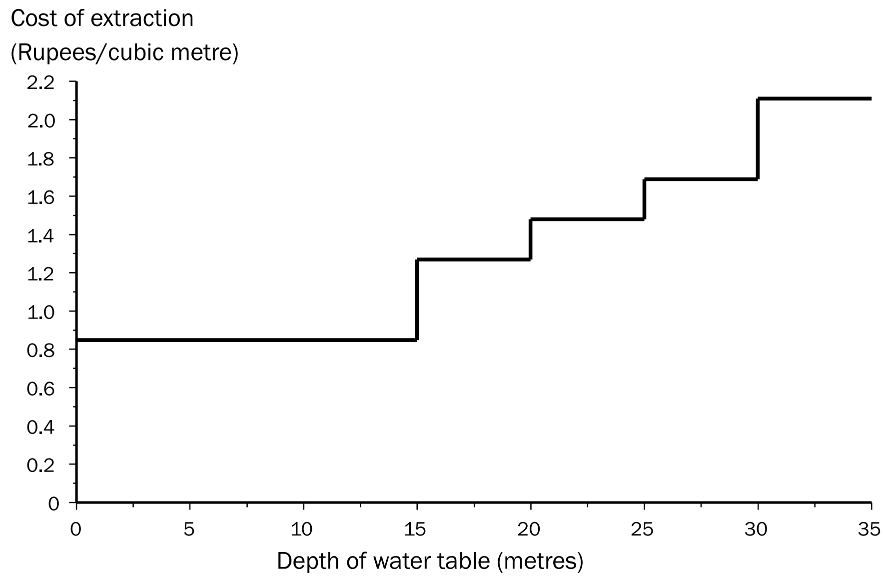


Figure 33 Cost of groundwater extraction from different depth categories

Based on this cost curve, we estimate that for a rise in the groundwater level of 0.2 m, the cost saved per cubic metre is Rs. 0.01 per cubic metre (at 1994-95 prices). Inflating this to the 2004-05 level using the wholesale price index for the Indian economy (for the sake of consistency with other estimates), we derive a value of Rs. 0.017 per cubic metre.

The Bhakra project was designed to provide annual irrigation to 1.46 million ha: 0.55 million ha in Punjab, 0.68 million ha in Haryana and 0.23 million ha in Rajasthan (Vaidyanathan, 2005). For a 0.2 m increase in groundwater level every year, the total increase in water in volumetric terms for the entire command area works out to be 2.46 billion cubic metres. Thus if 1 cubic metre increase in volume saves cost by Rs. 0.017, the corresponding cost saved for a 2.46 billion cubic metre increase in volume works out to be Rs. 41.82 million per year. Since the construction of all canals competed in the year 1966-67, we calculate the cost saved from this year up to 2054-55. The present value estimate for the relevant time period works out to be Rs. 24.2 crore.

CHAPTER 10 Social issues related to the two projects

Introduction

Construction of large dams, in one dominant discourse, has been considered a symbol of economic growth and development, and man's ability to harness nature. This peaked in 1970 when on an average two or three large dams were commissioned each day somewhere in the world (WCD 2000). However, rationale of large dams has been questioned lately because of increasing realisation of the complex and diverse social and the environmental costs associated with them. Besides, these costs have a distributional impact, since these are largely borne by local community (who are displaced or suffer due to loss of livelihoods), while the gains accrue usually at a larger geographical scale.

This section discusses the social costs associated with the two projects being covered in the present case-study. The two projects are very different in nature and scale and therefore the nature of social costs hugely vary. The study discusses the social costs from the project based on the living condition of the oustees, compensation given, resettlement and rehabilitation work undertaken. The first part discusses the international discourses on dams - the benefits and costs from such projects bearing in mind the social aspects. The following section discusses the methodology that has been followed to assess the social costs in context of the two case studies. The next sections discuss the Bhakra and Uri project in detail in context of the chapter. For both the projects, design and implementation issues based on the study findings have been discussed. The last section consolidates the findings from both the cases.

Literature review

Development projects are intended to alleviate poverty and provide essential services to all but this cannot be at the cost of marginalisation of the displaced. The potential winners and losers from dam construction are clearly identifiable: those who live downstream of a dam (in its command area) stand to benefit, while those in proximity and upstream of a dam (in the catchment area) stand to lose. The gains for the upstream population are primarily from the construction activity (itself) and from enhanced economic activity around the reservoir. The losses for the community are: loss of agricultural and forest land, and increased salinity and waterlogging of the land around the reservoir. Also, upstream populations are more exposed to diseases caused by the large-scale impounding of water, such as malaria (Duflo and Pande 2005). The equity concerns need to be addressed in such projects so as the displaced population is not marginalised.[39] A sound Resettlement and Rehabilitation (R&R) package may aid in overcoming some of these losses. However, it needs to be highlighted that social costs are not always tangible. One can measure loss of a house, land, forest, etc. but there are intangibles like loss of heritage, culture, which cannot be easily measured in quantitative terms (Adams 2000).

The costs and benefits from dam projects are outlined in the table below.

Table 46 Direct and indirect benefits and costs

Direct benefits	Direct Costs	Indirect Costs and impacts
(a) Power generation benefits	(e) Total direct costs	(h) Resettlement indirect costs
(b) Irrigation benefits	(f) Direct investment costs	(i) Health indirect costs
(c) Urban water supply benefits	(g) Direct operation costs	(j) Fishery losses indirect costs
(d) Flood control benefits		(k) Natural habitat losses indirect costs
		(l) Downstream losses indirect costs

Source: Gutman (1999)

International experience

The experience on dams has been mixed at the international level. For instance, the Lugube power dam built on Huang Ni River in China has been reported as a success story. The project has an installed capacity of 600 MW. 2320 persons were displaced due to the project. There are no reported environmental impacts due to the project. The resettlement of the PAPs (Project Affected Person) has been satisfactory giving them several options: new irrigated farm plots, using water from the reservoir among other things. Also, social infrastructure was developed in the area after the project. Studies indicate that the livelihood of the PAPs have improved over the pre-project times. Another successful multi purpose dam is Chungju in Korea with the capacity of 412 MW. 38,670 persons were displaced due to the project, and have been fully compensated and relocated (Gutman 1999). However, the problem with Chungju dam has been that after the employment boom -due to the project activities- ended, the community was left with temporary joblessness.[40]
Three Gorges dam in China on the Yangtze River is world's largest power project, with widespread human rights abuse and have several resettlement problems. Up to 1.3 million people have been displaced due to the project.[41] The compensation

[39] A detailed discussion on social costs and benefits of dams has been done in Adams (2000).
[40]http://64.233.167.104/search?q=cache:UB_Ha9_x2kEJ:www.his.com/~mesas/irr_model/irr_page_5%2520major%2520risks.htm+Chungju+dam+in+Korea+displacement&hl=en&gl=in&ct=clnk&cd=1 accessed on September 1, 2006.
[41] http://english.sina.com/china/1/2006/0508/74985.html accessed on September 4, 2006.

offered is not adequate, as the oustees have bought property – alternative land- at a higher cost. Also, land and jobs that were offered/ promised to the oustees have not been available or have been of inferior quality. Also, there is no independent grievance mechanism to address communities' problems (IRN 2003). Other instances of dam project that have been shrouded with problems are Chioxy in Guatemala and Sobradinho dam in Brazil. Sobradinho dam is located on San Francisco River, also known as Paulo Alfonso IV and has a capacity of 3500 MW. The project created a reservoir of 4214 km^2, displacing 70,000 persons and permanently flooding 32,000 ha of rice fields. The planning for the resettlement of PAPs was poorly done and implemented. Hence, despite quintuple increase in the resettlement cost, the needs of the displaced people were not addressed. In case of Chixoy, the project planners failed to identify several geological problems. Besides very poor conception and planning to resettle approximately 2,500 Maya Indians was done (Gutman 1999). The dam was built in the midst of bitter army repression during Guatemala's 36-year civil war. There was bloodshed due to the project when 300 people from village of Rio Negro -upstream from the proposed dam- refused a relocation offer.[42]

The experience of Three Gorges project indicates that the resettlement process needs to be guided by lucid policy guidelines, compensation and implementation mechanism that are adhered to and not changed with time. For successful resettlement capacity and commitment from the public agencies/ organisations is critical. Economic rehabilitation of resellers is the weakest aspect of resettlement planning. Resettlement needs to be treated as a development opportunity as then only it would lead to most successful resettlement outcomes (OED 2000). For the purpose of the study design and implementation issues have been discussed which would facilitate in successfully rehabilitating the PAPs at the resettlement site.

Methodology

This section discusses the framework that has been used to understand the marginalisation of the community due to development-induced displacement. There is a structural incongruity in policies, which define improving/ restoring the livelihoods of the community solely based on compensation (Cernea 2003). There is a need to shift from calculation of 'economics of compensation to 'economics of resettlement and development' so as to take into account the inequity and losses

[42]http://www.downtoearth.org.in/full6.asp?foldername=20041015&filename=news&sec_id=4&sid=46 accessed on September 4, 2006

suffered by Project Affected Person (PAPs). According to Adams (2000):

"Economic assessments tend to overlook indirect and opportunity costs to riparian environments and people (eg. Flood plain environmental impacts, loss of natural resources, loss of production opportunities, forced resettlement, social dislocation, etc.), and they fail to deal adequately with non-quantifiable socio-cultural costs."

At present, there is a vast gap between the method used to arrive at compensation and the cumulative losses plus re-establishment costs incurred by displaced people as a result of expropriation and relocation. Cernea enunciates (several) risks that need to be mitigated by the compensation provided to the PAPs so as to extenuate impoverishment risks in displacement. The same have been listed below (Cernea and Kanbur 2002):

i. Landlessness
ii. Joblessness
iii. Homelessness
iv. Marginalisation
v. Increased morbidity and mortality
vi. Educational losses
vii. Food insecurity
viii. Loss of common property
ix. Social disarticulation

For the purpose of the study the above-mentioned risks have been assessed to indicate overall costs/ benefits from the project.

The following section delves into parameters[43] that are crucial to assess the overall social cost/ benefits from Bhakra Nangal Project (BNP) and Uri Hydroelectric Project (HEP). The cost/ benefits for the study have been evaluated by assessing whether the displaced persons have been re-established viably in the new sites/ areas. The key parameters to assess overall costs/ benefits from the project are:

Comparison of the R&R package provided to PAPs with the present norms

Compensation

The issue of compensation is crucial in the context of projects that require the population to be relocated elsewhere. Compensation provided should be such that it enables the PAPs to restart their lives in the new area, rather than creating a situation that leads to extended marginalisation. A crucial fact to be borne in mind in the context is that an individual receives compensation after being displaced, and development activities

[43] Based on type of risks discussed in the preceding section.

and land prices in the dam vicinity (often) decline as soon as a dam is planned, and the compensation rarely reflects/ takes this into account. Hence, in the context of the study it has been enquired whether the PAPs received compensation according to acceptable norms -for land price- at that time.

In addition, based on secondary data, compensation/ R&R norms have been compared with the current R&R guidelines, in case of Bhakra project. Moreover, it has been assessed whether all the PAPs received compensation. Also, was the compensation paid in accordance with the BRC guidelines? Did everybody avail the compensation or few did not? If not, reasons for non availment/payment of full compensation? What is the status of the support infrastructure, land and services provided to the PAPs? Also, as a consequence of the R&R package, were the risks of landlessness, homelessness, marginalisation and food insecurity mitigated for the community. There are no specific guidelines that were used in case of Uri HEP; hence a similar comparison cannot be done. Besides Uri HEP being a recent project, follows the present norms.

Qualitative issues

Livelihoods

Displacement affects a person/ household in diverse ways, livelihoods is one of the critical factors. In the context of the study the following has been assessed:

- In case of Bhakra Project livelihoods of PAPs prior to the project have been assessed in comparison to present livelihoods of the PAPs at the resettlement site in Haryana and in Himachal Pradesh[44] to assess the gains/ losses due to the project. In case of Uri HEP, the community was not resettled elsewhere. Hence, living conditions of the PAPs before and after the project have been assessed.
- Another critical question is that did the relocation result in marginalisation of the PAPs or were they reestablished comfortably at the resettlement sites? Also, did the prejudice/ discrimination faced by PAPs at the resettlement sites jeopardise their livelihoods?

Social disarticulation

Displacement and relocation changes the social dynamics of the population if the PAPs are resettled in a site where the social segregation is different from the original site/ home. This affects the livelihoods of the PAPs and also restricts their access to resources/ common land leading to (further) marginalisation of the PAPs, as also argued by Cernea that social disarticulation

[44] PAPs who stayed back in Himachal Pradesh

is a critical risk that needs to be mitigated to ensure sound resettlement of the community.

Health

Upstream population as a consequence of living near the reservoir are susceptible to diseases such as malaria, schistosomiasis, lariasis and river blindness, as the reservoir provides a natural ground for vector breeding (Duflo and Pande 2005). Effect of the reservoir on the health of the upstream population has been assessed based on field discussions.

Data sources

For assessing the social costs of the project the project team referred to various documents and data sets that include, but are not limited to:

- Documents collected from Bhakra Beas Management Board (BBMB)
    - Detailed Project report of BNP
    - Details on compensation
    - Infrastructure created
    - Revised booklet for instruction for resettlement
    - Minutes of BRC proceedings
    - Correspondence between BRC officials and state governments during the time of undertaking resettlement work
    - Responses to parliament questions on social aspects of Bhakra project
    - Resettlement and Rehabilitation issues of Bhakra dam, an article by Rajeev Bansal and Balbir Singh
    - Unravelling the ‘Unravelling of Bhakra’, a critique by Rangachari

- Documents collected from NHPC
    - Official correspondences, Land file
    - Status note on land acquisition, Land file
    - Minutes of the High Power Committee meeting
    - Notification, Government of Jammu and Kashmir, dated 4th December 1985
    - Compensation details, Barrage office, NHPC, Uri
    - Details on number of local OPD patients, NHPC hospital, Gingle
    - Details on infrastructure created
    - Rehabilitation plan Uri HEP

- National Policy on Resettlement and Rehabilitation (2003) and R&R plans of hydro-projects of NHPC

- Secondary literature on dams: the social and environmental effects of large dams, Unravelling Bhakra, Bhakra Nangal Project: social and environmental impacts, Report of the World Commission on Dams, etc.

Data Constraints

Due to unavailability of baseline data, it was not possible to give a monetary value to social costs from the projects. Moreover, some of the social costs like social disarticulation, marginalisation, loss of social networks, etc. cannot be given a value in any case. The social costs from the project have been assessed based on whether the PAPs were properly rehabilitated, and whether compensation was paid.

There is no baseline data available for Bhakra project. Hence, it was not possible to compare the livelihoods, living conditions of the project prior to the project with the current livelihoods, and living conditions of PAPs. The conditions of the PAPs have been assessed based on field discussions and available secondary data sets.

Bhakra Nangal Project

Fact sheet: Displacement, Resettlement and Rehabilitation

This section takes stock of number of people displaced because of Bhakra dam and gives an overview of the compensation provided as part of resettlement and rehabilitation (R&R) package for Bhakra project as per the guidelines of Bhakra Rehabilitation Committee (BRC)[45].

The number of displaced people from the Bhakra dam is 36,000, of which 34.76% are tribal (Patwardhan 2000). The PAPs as part of the resettlement package were resettled in Haryana in erstwhile Hissar district, which is now divided into three districts - Hissar, Sirsa and Fatehabad. In addition, Bilaspur town was submerged due to construction of the reservoir; a population of 4000 was resettled 3 km away – the new Bilaspur town. The details are evident from the table below.

[45] For resettlement of 2179 families a high-powered committee viz. Bhakra Rehabilitation Committee (BRC) was constituted under the chairmanship of Secretary of Government of Punjab, PWD, Capital Project, Chandigarh. Guidelines for payment of compensation for oustees were framed by BRC.

Table 47 Fact sheet: Bhakra Project

Bhakra dam	Project Affected person (PAPs)/ number of villages	Compensation
Land submerged	Bilaspur town (4000 people) 375 villages in four districts 6849 ha– govt land 11135 ha– privately owned 17984 ha– total land submerged[46]	People displaced from Bilaspur town, relocated in new Bilaspur town 30% of the oustees were resettled in Hissar, Sirsa and Fatehabad districts of Haryana
PAPs & Compensation	7209 families or (approx) 36000 PAPs. Total number of families affected in four districts are as under: » 3333 in Kangra (now part of Una district) » 3838 in Bilaspur district » 35 in Mandi district » 3 in Solan district	» 2635 (37%) families were given cash compensation [as per their own will to settle elsewhere] under Land Acquisition Act 1894. » 2395 (33%) resettled by the HP govt. » 2179 (30%) families opted for land [and cash] compensation: land allotted in command area. 5342 ha of land acquired in 30 villages in Haryana to resettle oustees

Source. Mathur, Subramaniam and Wahi (2005), Rangachari (2006), Status note on BNP & Detailed Project Report of BNP (unpublished, obtained from BBMB, Nangal).

Details of land acquisition and villages affected due to the Bhakra dam in four districts viz. Kangra[47], Bilaspur, Mandi and Solan in Himachal Pradesh are outlined in the table below.

Table 48 Details of land acquisition for submergence due to Bhakra dam

District	No of villages affected	Total land acquired (in ha)	Privately owned land (in ha)	No of private land owning families
Kangra (now part of Una district)	110	5483	5483	3333
Bilaspur	256	12313	5611	3838
Mandi	5	162	15	35
Solan	4	26	26	3
Total	375	17984	11135	7209

Source: Rangachari (2006)

Bilaspur district has the highest number of affected villages (256) in the state followed by Kangra (now Una), Mandi and Solan. 17984 ha of land were acquired for the project, affecting 7209 families.

[46] Of the total land submerged, 5747 ha was forest land.
[47] Now part of Una district

Compensation

R & R Policy

At the time of the project initiation, there was no national R&R policy that could be followed for giving compensation to the project affected. Hence, a committee –Bhakra Rehabilitation Committee (BRC)- was specially set up to look into the resettlement and rehabilitation aspects for the PAPs (Mathur, Subramaniam and Wahi 2005). Compensation was offered to PAPs based on the award given by BRC. Some salient features of the compensation package awarded by BRC is summarised in the table below:

Table 49 Salient features of the R&R package for Bhakra project

Compensation	Salient features	Remarks (based on field discussions)
Land	Land to be allotted in one place and no oustees to be allotted land less than his cultivated land	Only 30% households received/ opted for land compensation Land was allotted in three districts in Haryana: a spread of 250 km The climatic condition -environment- in Haryana was totally different from Himachal Pradesh. Hence, it was very difficult for PAPs to resettle in Haryana
	New abadi sites with model layout were planned	The layout plan of the resettlement colonies is okay
	For compensation upto Rs. 1000, only land was given to the PAPs	Land was acquired at a price lower than the market price
	For compensation above Rs. 1000 a scheme of graded cuts/ slab was there for the PAPs Compensation for submerged land has been provided at the rate of Rs. 800 & Rs. 250 per acre for cultivated and uncultivated land	Land acquisition rates mentioned could not be verified during the field discussions. Field discussions revealed a much lower rate of land acquisition
	Landless tenant were given land in accordance with their submerged tenancy; the price of land was to be recovered in 20 equal half yearly instalments	Landless were given few marlas, a very small piece of land Most of the landless did not come to Haryana as there was no livelihood support provided to them
Non-land based activities	License for fishing in the reservoir was provided to the oustees	Fishing cooperatives are there and have taken up fishing activity in the reservoir Not all PAPs availing fishing rights
Assistance in relocation	Rehabilitation grant at the rate of Rs. 250/- per family was given to the oustees shifting to Hissar including railway freight for transportation of animals	Provided as per field discussions
	For oustees that were resettled within 5 miles of their original residence, rehabilitation grant of Rs. 150/- was provided	Provided as per field discussions
	Allowance for transport	Provided as per field discussions
Basic facilities	Shelter accommodation and wells provided to PAPs at resettlement sites in Haryana	Shelter accommodations were provided. Wells provided much later The arrangements were not sufficient to meet the needs of PAPs at the resettlement site

Compensation	Salient features	Remarks (based on field discussions)
Drinking water supply (DWS)	DWS provided by BBMB to 6 villages near the Bhakra dam. However, not part of the original plan. A temporary scheme (1974) was started with the Himachal Pradesh government	DWS not functioning properly Apart from the six villages the community/ PAPs living next to the reservoir do not have - the most basic right - access to water for drinking as well as irrigation
Infrastructure created: New roads, village paths, etc.	Infrastructure was created in lieu of the bridges and roads that were submerged	Community is not aware of the details of the same

Source: Phoolka (1959) and based on FGDs

As per R&R norms set by BRC, oustees received compensation in lieu of the resources lost viz. land, *gharat*[48], trees, etc. The land was acquired from the PAPs under the Land Acquisition Act of 1894. The compensation was provided to the head of the household, mostly men in case of Himachal Pradesh, women were not entitled to compensation. However, if a woman was head of the household then she was eligible for compensation, otherwise not. The guidelines do not give any additional benefits to women. In this whole process the women and other vulnerable sections have been marginalised.

Only 30% of the Project Affected Person (PAPs) opted for land compensation and majority of the PAPs were given cash compensation. Reason for only 30% PAPs opting for land compensation was that the community was not keen on relocating in an area which had completely different climatic conditions and was far from Himachal Pradesh.

In addition, there is an anomaly in land rates given for acquisition under BRC guidelines -Rs. 250 to 800 per acre- from what was conveyed by BBMB during the course of the study: Rs. 20 to 850 per acre[49]. The above indicates that land rates were varying too much. Secondly, the minimum land rate for acquisition as per BRC guidelines was not adhered to.

Comparison of compensation package with the present norms

In this section, a comparison has been made between the R&R guidelines devised for Bhakra Nangal Project with the current R&R norms. Some of the features of BRC guidelines are relatively better in comparison to the norms enunciated in the present times; the same is evident from table below.

[48] Water mill
[49] The land rates of Rs. 20 to 850 per acre were calculated -on an average- based on the land acquisition records of 5 villages in Himachal Pradesh; personal communication BBMB, Nangal.

Table 50 Comparison of compensation package of Bhakra Project with the present norms

Features	Bhakra	SSP (Gujarat)	NR&R 2003[50]
Responsibility for implementation	BRC had the responsibility	Small cell created in SSNNL[51] to ensure that benefits of development scheme accrue to PAPs.	State government shall constitute a committee under the chairmanship of the chief administrator to monitor and review the progress
Who is eligible for compensation?	Head of the household, in case the husband is not alive than the women family member	Major sons as separate family (cut off date 1/1/87)	Land allotted is in joint names of husband and wife of project affected family
Land	Max 10 ha	2 ha (min)	1 ha of irrigated or 2 ha of un-irrigated land
Land development	Not mentioned	Rs. 600	Rs. 10,000 for wastelands Rs. 5000 per project affected family (PAF) for agricultural production
Gap in land prices	Enhancement can be claimed if the court awards the same, case specific (only host community of Haryana claimed enhancement)	Ex-gratia to cover the difference in price of land acquired and purchased	Not mentioned
Shelter accommodation	2 lakhs sanctioned for construction of mud house for allottees	Not mentioned	Not mentioned
Land allotment for house	500 sq. yards.	502 sq. yards. Free core houses costing Rs. 45,000	Not more than 150 sq.meter in rural areas and 75 sq. m. in urban areas
House construction	5 lakhs earmarked to be advanced as loans to allottees	Land is earmarked and Rs. 10,000 is paid to construct the plinth	Rs. 25,000 [only for BPL[52] household]
Temporary accommodation	Yes (Rs. 2 lakh earmarked for the same)	Yes	Not mentioned
Assistance for electrification	Not mentioned	Assistance for 1-1/2 point connection	Not mentioned
Trees	Rs. 25 per acre	Not mentioned	Not mentioned
Cattle shed	Not mentioned	Provision of land for cattle shelter	Rs. 3000
Transportation cost	Lump sum grant of Rs. 250. In addition, Rs 15	Free	Rs. 5000

50 NRR 2003 is applicable only for projects displacing 500 families or more enmasse in plain and 250 families enmasse in hilly areas (MoRD 2004).
51 Sardar Sarovar Narmada Nigam Limited.
52 Below Poverty Line

Features	Bhakra	SSP (Gujarat)	NR&R 2003[50]
	as railways/ bus fare and Rs 10 as transportation charge for cattle		
Landless/ agricultural labourer	Land was provided, artisans had to pay the compulsory land acquisition charges	Land was not provided. SC/ ST oustees will get Rs. 29,000/-. While others would get Rs. 19,500/-.	Not mentioned
Rural artisan	Half acre to each artisan free of cost. However, if there is any enhancement on the said plot, that would be claimed from the artisans	Non agriculturist family can avail financial assistance of Rs. 5000 to settle at new sites	500 days minimum wages
PAF whose entire agricultural land has not been acquired, thereby becoming a marginal farmer	Not mentioned	Not mentioned	375 days minimum wages
PAF owning agricultural land in the affected zone; consequently becoming a marginal farmer	Not mentioned	Not mentioned	625 days minimum wages
Agricultural labourer/ non-agricultural labourer	Not mentioned	Rs 15 per day for 25 days a month for a period of one year	20 days of minimum agricultural wages (MAW) per month for a period of one year upto 250 days of MAW
Each PAF will get monthly subsistence allowance	Not there	Rs 4,500 in three installments for a year	Yes
PAF will be provided necessary training facilities for development of entrepreneurship	Not there	Yes	Yes
SCs to enjoy reservation benefits in the resettlement zone	Not mentioned	Yes	Yes
Reservations in the project agency	Not there	Reservation in SSNNL	Not there
Responsibility for implementation	BRC had the responsibility	Small cell created in SSNNL to ensure that benefits of development scheme accrue to PAPs.	State government shall constitute a committee under the chairmanship of the chief administrator to monitor and review the progress

Source: Phoolka (1959), MoRD (2004)

The above table gives in detail a comparative picture of present R&R norms with the BRC guidelines. One critical issue that the BRC guidelines do not address is: providing livelihood options to PAPs, which is enunciated in the present R&R norms. However, BRC guidelines are way ahead as far as acreage to be given as compensation is concerned. But, even in context of Bhakra only 30% of the PAPs opted for land compensation as land was provided in a region, which was not conducive for PAPs to resettle.

Due recognition of the special status of certain oustees –the marginalised sections- is given in both NRR[53] and Gujarat's R&R policy. However, this clause is not mentioned in BRC guidelines, the PAPs lost the Dogra status after resettling in Haryana.

From the above table it is evident that R&R norms have provided few additional benefits in the last few decades. However, there are few limitations, which is true in case of both the present and earlier norms of compensation:

- Compensation package does not give actual value of land to the PAPs. Land acquisition from the PAPs was done at 1942-47 average prices.[54] In contrast allotment to PAPs was made at 1952-57 prices. Land prices in Haryana were much more competitive because of steep rise in the price of land after independence (1947) because of influx of migrants (TERI 1992). Thereby, the community got lesser money for their land in bargain because of difference in land prices. The above is in line with one of the widespread critique of large dams that the community does not get adequate price for the land that they lose. One of the reasons for the same according to Duflo and Pande (2005) being that project affected receive compensation after being displaced; however, developmental activities and land prices in the dam vicinity often decline as soon as a dam is planned, and the compensation amount rarely reflects this.

- Field discussions with the community revealed that the oustees have been allotted poor quality land in Haryana, though on land records it is marked as irrigated. This happened because the host community manipulated the land records. Secondary sources attest that the host community in Haryana fraudulently got the land type changed from '*Banjar*' to '*Nehri*' in the revenue records; resulting in oustees paying much more for the land acquired for them (TERI 1992).

[53] The SC/ST community according to NRR-2003 can avail reservation at the resettlement site as well. Also, there are some special benefits for the tribal project affected families.
[54] During the British regime land prices were much lower than the market price.

Social infrastructure created

The project authorities have rebuilt several bridges and roads that were submerged in Bilaspur district due to the Gobind Sagar Reservoir. Also, as part of the R&R process, the amenities provided at the resettlement site in Haryana included a grant of Rs. 2 lakh for construction of shelter accommodation. In addition, Rs. 2 lakh were sanctioned for the construction of new wells and for repairs of existing/ acquired wells at the resettlement site (Phoolka 1959).

Findings

Field visits were undertaken to build a perspective on the present status of the oustees due to Bhakra project. Focus Group Discussions (FGD) were undertaken with PAPs to assess the status of the oustees prior to the project in comparison to the present status. Discussions were also held with the project officials to understand the status of resettlement and problems in implementation, if any. Based on field assessment of the present conditions of oustees, and secondary data/ discussions with project officials an assessment of the implementation process has been done and issues have been highlighted that need to be borne in mind while planning such projects.

Village Selection

For conducting FGDs villages were selected from the region(s) where maximum number/ percentage of people were displaced. For instance maximum number of persons were ousted from Bilaspur district- 68%. Accordingly, 5 villages were selected from Bilaspur district for field survey, 3 villages were selected from Una district (earlier part of Kangra district), and 1 village from Solan district was selected, as is evident from the table below. Discussions were also held with few residents of New Bilaspur town.

Table 51 Sample villages for field discussion for Bhakra project

State	District/ town	Total affected villages [and percentage]	No of villages/ town where FGD was conducted	Name of villages/ town sampled
Himachal Pradesh	Bilaspur	256 (68%)	5	Saloha, Bhatei, Khadki, Makri, Khal
	Una	110 (30%)	3	Badgaon, Sorla, Nehri
	Solan	4 (1%)	1	Narle Brahmana
	New Bilaspur town	-	1	New Bilaspur town
Haryana	Fatehabad	17 (29.4%)	5	Nandei, Bhirdana, Ratta Tibba, Ahali Sadar, Kali Kankari

Source: Rangachari (2006) and TERI compilation

In Haryana, oustees were resettled in 30 villages in Hissar, Fatehbad and Sirsa districts. Of the 30 villages in Haryana, FGDs were conducted in 5 villages of Fatehabad district where the number of oustees relocated is highest.

The following sections discuss the gains and the losses for the PAPs since the Bhakra project came into place. First section, discusses the socio-economic conditions of the oustees settled in Haryana, and the following section discusses the condition of the oustees who received cash compensation and resettled on their own in Himachal Pradesh. The onus of resettlement for PAPs below RL[55] 1280 and above RL 1700 was with the Himachal Pradesh government; resettlement was done according to *Nautor* Land Rules of 1968.

Social economic status of the oustees relocated in Haryana

Bhakra oustees have been settled in 30 villages in 3 districts of Haryana -Sirsa, Fatehabad and Hissar- in an area spread over 250 km.

About the villages

Bhirdana

Bhiradana village falls in Fatehabad tehsil and district of Haryana. Villagers from Bel Bhamia, Saloh, Bhakra, Makri, Kunfara, Kharkari of Himachal Pradesh are now resettled in Bhirdana revenue village. Bhirdana has a population of 14,000 of which 3,000 is the oustee population.

Nanheri

Village Nanheri falls in tohana tehsil of Fatehabad district. Nanheri has two hamlets: Nanheri Kalan and Nanheri Khurd. Nanheri Kalan has 300 oustee households whereas Nanheri Khurd has 200 oustee households. The original allottees in the two hamlets were 80 and 60 respectively. The oustees are well settled in this village. The sarpanch of the village -Mr. Ramdas- is an oustee, reflecting the influence of oustees in the village.

Ratta Tibba

Ratta tibba is one of the hamlets of Hizrawa Khurd revenue village in Fatehabad tehsil and district. Ratta Tibba has 200 households out of which 150 households belong to oustees. Population of oustees in the village is around 800. This village comes under Nikahtia panchayat. Five members of the ward panchayat are oustees. The hamlet is very political and there are lot of conflicts amongst the oustees. 212 allotments were made for Ratta tibba, and 115 allottees came from Himachal Pradesh.

[55] Reservoir Level

Ahli Sadar

Ahli Sadar is one of the hamlets of Hizrawa Khurd revenue village in Fatehabad tehsil and district, and the panchayat is Ahli Sadar as well. It has 20 oustee families currently, though initially 100 families were allotted land. Most of the allottees sold their land to the local community and went back to Himachal Pradesh; reason cited for leaving is poor quality of land and non-availability of water for irrigation.

Field discussions in five villages with oustees in Haryana brought forth following issues mostly related to implementation process:

Basic services

One of the major contentions of the project affected has been that they were relocated in an area/ region, which has poor land quality, and no connectivity to nearby towns or villages. The oustee villages/ hamlets are less developed compared to habitations of the host community at the resettlement site. Initially, when the PAPs arrived at the resettlement site their living status was pitiable. Also, there was no arrangement for drinking water in the village. Wells as per the provision of BRC were dug much later; also they were far off from habitations (radius of 8 km) and not adequate in number.

Moreover as the PAPs were outsiders, they were especially vulnerable to dacoits and thugs who used to frequent the area; they were robbed of their valuables often. In addition, the link road and status of infrastructure in the oustee settlement was poor, and still remains poor in comparison to the habitations of the host community.

In addition, of the five villages where FGDs were conducted, drinking water was a problem in three. In Ahli sadar and Nanheri, drinking water is not a problem (at present). There are two tube wells of water works department that supply water in Nanheri.

According to the residents of Bhirdana and neighbouring villages, until 1995, the village used to be flooded every year affecting around 70% of the area and causing heavy economic losses. There has been no instance of flooding after 1995 after the drainage lines were laid. Also, average rainfall has gradually lessened in the past decade. Moreover, village Nanheri was severely affected by floods in 1962, 1988 and between the period from 1990-1995. During each flood (in the village) houses were damaged and crops completely wiped out. As part of flood relief, Haryana government gave oustees a compensation of Rs 5000 per household. Ahli Sadar was also prone to floods till mid

1990s, the condition has improved after the drainage lines were laid.

Artisans, labourers, landless and tenants

According to the R&R norms, there was a special provision for the artisans who lost their homestead land in Himachal Pradesh; they were allotted land in Haryana. Half an acre of land was made available to such artisans, labourers.
Also, for tenants there were special provisions depending on their status. For occupancy tenants, land was allotted against cash compensation as per the BRC norm (Phoolka 1959).

The Himachal Pradesh government according to the regulations of *Nau Tor* policy settled the landless upto RL 1280; the onus of resettling the rest of the PAPs was with the Bhakra officials according to BRC guidelines. Under BRC guidelines, land equal to submerged tenancy could be allotted to landless tenants. However, the money for this land allotted plus compulsory land acquisition charges at the rate of Rs 5.25% per annum was to be recovered from the oustees in 20 half-yearly equated instalments (Phoolka 1959).

Field discussions revealed that not many artisans and landless came to Haryana, as the land allotted to them was (very) little. Secondly, they were no alternative livelihood options for them in Haryana; hence, giving them no incentive to relocate. The BBMB records also corroborate the above as 108 *Kanals* and 13 *Marlas*[56] of agricultural land reserved for artisans is given on annual lease to other Bhakra oustees settled in Hissar district, as the artisans did not come forward to avail the allotment.[57]

Land

The PAPs got lesser compensation for their land because of the time lag between the land acquisition in Himachal Pradesh and land allotment in Haryana.[58] Another critical issue in allotment of land that community apprised is that there was an upper ceiling of land that could be allotted (25 acres) for agricultural purposes to an oustee, but there was no such lower ceiling.[59] Hence, villagers got land as less as two *marlas*.[60]

Enhancement on value of land

In Haryana the host community from whom the land was acquired by project authorities were not satisfied with land acquisition price given; therefore the host community

[56] 1 Kanal is equivalent to 20 Marlas and 8 Kanals make an Acre.
[57] Resettlement Policy document, BNP (Unpublished).
[58] The issue has been discussed in detail in the earlier section on compensation.
[59] According to BRC guidelines, no PAPs can be allotted land lesser than his earlier ownership (Phoolka 1959).
[60] 20 *marlas* make a *kanal* and 8 *kanal* make an acre.

demanded an enhancement on price of the land by going to the court.

This enhancement paid to the host community in Haryana was recovered from PAPs in certain case; an additional burden that the oustees faced. Enhancement from allottees owning less than 5 acres of land was not recovered. All other allottees had to pay the enhancement cost in lump sum in 60 days of issuance of demand slips. Failing the above the recovery was to be made in 20 half yearly equated instalments including interest at 5.25% per annum (for details see Phoolka 1959). Few PAPs paid a higher price for the alternative land that was given to them in Haryana, thereby resulting in lesser compensation for them. PAPs had to bear the burden of enhancement on value of land that was to be given to the host community in Haryana, though the PAPs did not demand enhancement on compensation money paid for their land (Dharmadhikari 2005). The above was corroborated during field discussions as well.

It has been widely acknowledged that compensation amount depends on organisational abilities and political power of the project affected (Duflo and Pande 2005). Field discussions revealed that the community was mostly illiterate and not aware of their rights; also did not have capacities to organise themselves to demand appropriate compensation in lieu of the land lost. The marginalisation and vulnerability of the community is also implicit from the fact that 34% of the PAPs belonged to ST. Also field discussions revealed that the community had approached project authorities several times to change the site of resettlement, but this request was not heeded to (Dharmadhikari 2005).

Proprietary rights

In addition, PAPs in Haryana have still not been conferred proprietary rights for the land that was allotted to them. PAPs apprised that the process was to start within ten years of relocation but it began only in 1980 (Dharmadhikari 2005). Data from BBMB corroborates that out of total 2285 agriculture plots allotted to the oustees, so far proprietary rights have been given for 2225. In case of residential plots, out of 2836 total plots, proprietary rights have been given only for 708 plots. Hence, even after the work started the progress has been slow. The present status of proprietary rights is apprised in the table below.

Table 52 Status of Proprietary Rights [for agricultural and *abadi* land]

Abadi [residential] land	Agricultural land
Registered: 708 (22.83%)	Conveyance deed executed: 2225 (97.37%)
Proprietary rights to be given: 2836 (77.17%)	Proprietary rights to be given: 60 (2.62%)

Source: BBMB office, Hissar

One of the fallback of the proprietary right not being given to the project affected has been that PAPs could not avail assistance for construction of house as enunciated by BRC guidelines (Phoolka 1959). Also, the community could not avail any loans for agricultural improvement -from elsewhere, as they did not have the proprietary rights for agricultural land. Field discussions revealed that the delay in conferring proprietary rights has been due to tardiness of few officials. The conferment process has gained speed only recently. However, project authorities claim that the progress has been slow because the community has not come forward after completing all the paper work to get the proprietary rights for their land. Also, oustees are not living at their allotted places, have left the place on their own will by selling agricultural/ abadi land plots to other people on *mukhtiarnama/ iktharnama*.[61] There would be claims and counterclaims in such instances but critical issue in the context is the need to ensure through requisite guidelines that the implementation process is smooth and speedy.

Effect on livelihoods

Derecognition of Dogra status in the resettlement site

PAPs in Himachal Pradesh were entitled to join the Indian Army -Dogra regiment[62]. However, after being relocated to Haryana as part of the R&R process the PAPs no longer were entitled to avail the special concession for Dogra regiment. In Haryana, the Dogra status is not recognised so the local administration cannot issue any letter regarding the same. Putting the above in monetary terms indicates, loss of a secure livelihood option for the PAPs and their children. The pay scale for the lower ranks –Sipahi to Subedar- in the Army varies from Rs. 3250 to 6000 per month. The monetary loss for the community is huge given the unemployment status in the country. In Ahli Sadar, only 2 persons are employed out of 20 oustee households in the village, highlighting the grim scenario for the oustees. While designing R&R norms, the above-mentioned issue was overlooked.

[61] Resettlement Policy, BBMB (unpublished).
[62] Only for inhabitants of the state of Himachal Pradesh and Jammu and Kashmir.

Agriculture

Primary livelihood of most of the oustees is cultivation. Oustees, who have access to water for irrigation from canal/ tube well, are better off, compared to oustee habitations that have no/ limited access to water supply for irrigation.

Village Nanheri is relatively better off compared to other oustee villages in Haryana and compared to those oustees who stayed back in Himachal Pradesh. 75% of households in the village have 5 or more acres of land. Mr Ramdas, also the sarpanch, has 50 acres of land while another villager Mr. Roshan lal Dhaliwal has 100 acres of land. The above oustees were better off than other sections of the population, even when they were in Himachal Pradesh: had large tracts of land. In Haryana, their progress has been better due to access to water for irrigation from canal and tube wells; and also the fact that they were more enterprising.

However, all PAPs do not have access to assured water for irrigation: a benefit assured to Bhakra oustees relocated in Haryana. There is lesser water available for irrigation from canals in oustee villages as they were resettled at the tail end of the canal in Haryana. Currently, in Ratta Tibba 60 oustee households have their own tube wells. These households sell water at Rs 30 per hour to other oustee families. In Ahli Sadar also sufficient water for irrigation through canals is not available; and the community has to use tube wells, which works out expensive for them. Also, with the groundwater going down and electricity supply being erratic, the cost of irrigation for the farmers in general has become high. Currently, the depth of ground water for installing a tube well in the village is 400 ft. Four oustee households have tube wells in the village; rest of the households buy water from them.

The oustees feel let down, as they had moved to Haryana with the hope/ assurance that they would get water for irrigation purposes from the canal. However, being the tail end of the canal there is very little water in the canal by the time it reaches the oustee villages. Hence, the oustees are disappointed as one of the promised benefit -irrigation water- is elusive.

Loss of forest rights

Prior to the dam, the community in Himachal Pradesh had principal rights in the protected forests for (Singh 1954):

- Taking timber for buildings for household use and not for commercial purpose
- Timber and wood for funeral, marriage, ceremonies, agriculture implements and fuel

- Access for subsistence needs
    - Grazing and grass cutting
    - Lopping for fodder and manure

To give indicative figures, according to the 1954 working plan in Bilaspur forest division 112.35 ha of land at any point was open for the right holding villages.[63] The right holding villages were of two kinds viz. villages having all rights including grazing and villages having only grazing rights. The community was entitled to the following forest rights, viz. (Singh 1954).

- Two good size trees per family for five years for construction of new houses or reconstruction of old houses
- One medium size tree per family annually for ordinary building repairs
- Fuel wood at the rate of 5 seers per family per day
- Grazing at the rate of one acre per animal

Total right holding villages in Bilaspur forest division were 783, of this 403 (51%) villages had only grazing rights. Total affected villages due to Bhakra dam in Bilaspur district are 256. The community around forestland were dependent on forest for the services it provide and for its socio-cultural value. After relocating in Haryana, the community lost the above-mentioned rights.

Loss of mutual help networks

The oustees feel disjointed from the mainstream population. Lack of mutual help network has made it difficult for the oustees to get any work done in the present bureaucratic system. PAPs are a small segment of the local population; they do not have much say or persons in higher positions to expedite their work, which was possible in Himachal Pradesh. Also, they do not have any political standing in the region due to which their children do not get jobs and they face step motherly treatment from the local administration. Although, now oustees are trying to fight against the odds, and there are few *sarpanch's* from the ousted community but mostly from villages where oustee population is in majority.

Oustees feel that they do not have same social status as locals in the region. They are called 'Bilaspurias';[64] the usage of the term has derogatory connotations attached to it and emphasises the prejudice and animosity that the host community has towards the oustees. The above has made it difficult for oustees to merge

[63] A total of 149.80 ha of land was submerged which was part of protection forest according to the 1954 working plan. Of this 37.45 ha of land is protected at any point and the rest is open to the right holding communities.
[64] Name given by the host community in Haryana, to Bhakra oustees.

with the host community in Haryana, even after 5 decades. As a consequence, the oustees prefer to marry off their children to relatives in Himachal Pradesh or amongst themselves in Haryana.

Also, oustees contend that they have been relocated over a long spread -around 250 km- on purpose, reducing their bargaining power and ability to negotiate (for their rights). The project officials contend that they had tried to resettle oustees in contiguous spaces; however finding land at one place is a problem.

Politics/ conflicts within and outside

Communities in peri-urban, slightly developed rural areas are much more political than those which are untouched or remote. The same is true for PAPs that were resettled in Haryana. The oustees in Haryana are highly political and a divided group with awareness on world happenings, and each group work for their own interest. At few places during the filed visit it was felt that PAPS [in Haryana] are not a united community, there are several small political groups in the villages.[65] For instance in Ratta Tibba, PAPs are engaged in legal battle among themselves due to a *nullah* emerging from the irrigation canal.[66] There have been similar such instances where there have been 2-3 sarpanch candidates from one oustee village for panchayat elections. Hence, the conflict within and lack of homogeneity amongst PAPs is affecting development interventions in the village. For instance, despite five oustee ward members from the village, there is no development work that has been undertaken in the village. Critical issue to be noted in the context is that development of a certain community has been affected not only by extraneous factors but also by elements that are intrinsic.

In Ahli Sadar there are not many oustees who have stayed back. Of the total 100 allotments made in the village, 35 allottees came to Haryana. From the 35 families that relocated in Ahli Sadar, 15 families have returned to Himachal Pradesh. There has been encroachment on common land of the oustees: 5 acre by the locals, and till now nothing has been done about it.

Institutional/ implementation issues

In every oustee village a ‘Pursharthi committee’ with eleven members has been constituted, to liaise and convey the problems of oustees to district administration as per the

[65] As per field discussions.
[66] This *nullah* passes through a village street and irrigates land of 15 households. The *nullah* has created excessive dampness and damage to houses on both sides of the street. The affected households are engaged in a legal tussle with the people whose land is being irrigated but the beneficiaries of irrigation water are not relenting. This has lead to animosity and acrimony amongst the PAPs.

government guidelines. PAPs perceive that district administration does not give due importance to these committees.[67]

In addition, in several cases there has been encroachment on oustee allotment by the locals. The oustees have gone to court for the same. Interestingly during the field discussions it was found out that the oustees can avail a lawyer from BBMB side, when the BBMB official who was facilitating the visit mentioned it. The community was not aware of the said option. It appears that there is a gap in information flow between PAPs and project authorities; the same needs to be bridged to ensure better communication.

According to Ajit Singh of village Ahli Sadar when asked about what was better: earlier situation or present. He said, *'zindagi wahan acchi thi'*. The oustees made similar remarks more often than not. The older generation reminisces the mountains and the peaceful life they had in Himachal Pradesh and are dissatisfied by the treatment met by the host community and apathy of the administration/ project authorities towards their problems. Box-1 dwells into the present condition of residents of Kali Kankari, a '*harizan*' hamlet, in Haryana.

[67] District administration could not be contacted to get their opinion on the same.

Case of harizan hamlet of oustees in Haryana

In Kali Kankari, a hamlet of Bhuthal Khurd village, 65 Harijan families were allotted land. Currently, only 5 oustee families are living in the village; rest have gone back to Himachal Pradesh. The community was not able to sustain themselves in harsh weather conditions of Haryana [almost close to Rajasthan] with land that was of poor quality and no basic services in vicinity.

Lack of access to basic services

Access to drinking water was a major problem for the oustees as the host community -upper caste- denied them water from their wells, thereby making their survival extremely difficult. Being from lower caste, they were ostracised and not allowed to draw water from upper caste community wells. Hence, to meet drinking water needs the community used to dig holes and collect rainwater. At times, water was infested with worms but the community did not have any option but to drink it. Having no access to one of the basic human needs the community the community had no option but to return to Himachal Pradesh.

Lack of alternative livelihoods

There were no livelihood avenues for the community in Haryana and they found themselves in no position to bargain for work and basic services in the hostile environment. Agriculture was also not a viable option for them because of lack of access to water for irrigation. There is no canal close to the hamlet. There is one small distributary, which does not have much water. The community does not get water for irrigation from Bhakra canal, a benefit promised to oustees to be settled in Haryana. One of the five-oustee families (remaining) owns a tube well with which he irrigates his land and also gives water to the other families for a price.

Marginalisation of the marginalised

Locals have encroached 5 bighas of common land, which belong to the oustees, nothing is being done about it till now. Harijan oustees are poor and weak, do not have the capacities to organise themselves to fight for their rights, and are not getting any support from the administration. Compared to the host community and oustees in other villages, the economic condition of the harizan oustees is poor. In addition, there is apparent discrimination even among the project affected toward the harizans, the oustees belonging to the upper caste do not like maintaining any social relations with them, and are treated lowly. In sum, PAPs feel disconnected from the mainstream. One finds that the most marginalised section of the community is worst hit amongst the project affected- in this case the harijans. The pursharthi committee of the village is dysfunctional.

To conclude, in absence of access to water – for drinking and irrigation, proprietary rights not conferred, hostile host community, the oustees did not have much to fall back on and returned to Himachal Pradesh to start life afresh. Most of the families sold their land at throwaway prices and returned to Himachal Pradesh two decades ago.
Source: FGD

Having discussed the conditions of the oustees in Haryana, the next section discusses the condition of oustees who stayed back in Himachal Pradesh.

Socio economic status of the oustees who stayed back in Himachal Pradesh

The Himachal Pradesh government had settled oustees under *Nau Tor* policy. Some PAPs were allotted land close to the reservoir that was notified as Naina Devi Wildlife Sanctuary in December 1962.[68] First the dam displaced the community and later the notification of the sanctuary further restricted

[68] According to forest department's records, the date of creation of Naina Devi Wildlife Sanctuary is December 1962 (Singh 1974).

communities' rights. The quality of land and the basic services like road, drinking water supply, heath services, etc. are very poor in the sanctuary area. The living conditions of the oustees in the sanctuary villages are quite harsh.

Livelihoods

Gains from construction activity for the up-stream population

One of the gains envisaged from large dam projects is the employment avenue that it opens for the up-stream population during the project construction activity. For BNP project, labour requirement during the project construction was in terms of skilled and unskilled labour.[69] According to Raj (1960), the villages close to the field of operations were affected by the fluctuation in employment offered, as they were mostly unskilled labour and were hired by contractors. According to Raj, this is not a big issue as the villagers had alternative sources of employment as well.

Another interesting fact highlighted by Raj is the discrepancy in the wage rate offered to men and women for the same work done. Also, most of the women employed were from Rajasthan, which comprised half of the workforce from the state. Labour from Himachal Pradesh and Uttar Pradesh did not have women folk as part of the work force. The unskilled labour was getting Rs 50-55 per month. At the peak of employment the total workforce was 122,000 (Raj 1960).

During field discussions the community apprised that they did not get any major employment benefit during the project construction. Most of the labour employed had come from outside. Field discussions suggest that 10% of the labour employed was from nearby villages. Moreover, only 2-3% of the labour [from the nearby villages] gained permanent employment with BNP, data on the above was not available with BBMB.

Loss of agricultural land

Field discussions revealed that prior to the dam being built, the primary occupation of most of the PAPs was agriculture. The villages were earlier in the valley on the banks of Sutlej and farmers were cultivating sugarcane, paddy, wheat, vegetables etc. Assured irrigation was available to the farmers then, and the land being fertile the productivity from land was high. After the community was ousted from their homes, majority moved higher up in the mountains, few were resettled in Haryana and

[69] Employment was given through contractors or labour was directly engaged on a departmental basis. The peak employment for the project was in the year 1954. The employment offered through the department was steadier and regular compared to the employment provided by the contractor.

there is no information available for others. The quality of the land higher up in the mountains was poor compared to the fertile land in the valley, which was lost in submergence.

Assessment of assets

The community apprised that compensation for the land, assets lost was paid; but actual/ market value of land, house, *gharat*, etc. was not given.[70] Also, while valuing the house the greater construction cost for building a house in hilly areas was not accounted for. Moreover, the compensation paid for *gharat's*, trees was meagre.[71] In addition, valuation of fruit bearing trees was not done properly, resulting in loss of income from fruit bearing trees. The compensation money that the oustees received was spent on buying land and building a house, in most cases.

Water

Access to one of the basic service: water is not readily available for PAPs in Himachal Pradesh. Prior to Bhakra dam community had access to the waters of Sutlej for meeting their needs. But post dam construction, there has been a reallocation of benefits from riparian users to beneficiaries in regions downstream. According to the BNP agreement (1959) and interstate agreement (dated 31 December 1981), Himachal Pradesh is not entitled to allocation of water from Sutlej and surplus of Ravi Beas waters. Hence, oustees are not allowed to lift water from the reservoir. The waters from Gobind Sagar reservoir are for fulfilment of irrigation and drinking water needs of the downstream population; ironically the upstream population has not received any benefit from the reservoir. Only once, a temporary scheme was evolved by BBMB to provide drinking water to villages around Bhakra Dam, six villages were covered under the scheme viz. Bhakra, Khulmi, Uttapar, Makri, Khal and Saloha. BBMB and Himachal Pradesh Government shared cost of the above scheme.[72] Field discussions revealed that at present the water supply scheme is not working properly and is not sufficient to meet the communities' water demand. Apart from the above-mentioned six villages the PAPs living around the reservoir have no claim to the waters. This is a design issue. A multipurpose project like Bhakra accrues irrigation, power and drinking water benefits to the beneficiary population, which the PAPs are deprived of.

[70] As discussed earlier.
[71] Rs. 1 for Gharat and Rs 25 for a tree.
[72] Response of BBMB to Lok Sabha question Dy. No. 1665 for answer on 13-7-2004 b y Suresh Chandel, M.P (Lok Sabha) regarding lift water scheme for potable water to the oustees of Bhakra dam, obtained BBMB office, Nangal.

Health

One adverse effect of dams is adverse health consequences for those living near the reservoir, given that it would provide a natural ground for vector breeding, and hence for diseases such as malaria, schistosomiasis, lariasis and river blindness (Duflo and Pande 2005). However, field discussion revealed that there has been no major outbreak in water borne diseases in the area because of the reservoir.

To conclude this section, the overall economic condition of the oustees in Haryana is relatively better off than of those PAPs living in Himachal Pradesh. However, one needs to bear in mind that when the oustee moved to Haryana the quality of land allocated to them was not good. The land was of poor quality [and bushy], and saline in several places, and the community has toiled for decades to reclaim the land and are now reaping the benefits (Dharmadhikari 2005). One cannot attribute the improved living conditions of the oustees in Haryana compared to Himachal Pradesh to the fact that resettlement of the PAPs was done well. The living conditions at the resettlement site were poor/ tough. Several oustees dissatisfied with the resettlement site returned to Himachal Pradesh. Those who have stayed back had no one to go back to[73], and in few cases it is the endurance and hard work of the oustees that resulted in their improved economic conditions.

Critical Issues

This section dwells into the implementation and design issues that came up in context of assessment of social costs from Bhakra dam. These issues are indicative by nature and would aid in averting the social costs from such projects. However, it needs to be indicated that for the purpose of analysis tangible costs have been emphasised more.

Implementation issues

A critical issue with development projects is that the work does not end by formulating R&R guidelines/ policy. It needs to be substantiated by successful implementation. Several issues that were found critical in context of implementation process for ensuring sound R&R are:

Proper R&R

The R&R guidelines are comprehensive, but during implementing them there have been several issues. As discussed in the earlier section of the report, of the total PAPs that came to Haryana, several went back, as the basic services were lacking at the resettlement site. Drinking water was a major problem; also the land selected for R&R was of poor quality. The community

[73] Entire family moved to Haryana.

had to face several hardships and all segments of the population could not bear it. Moreover, it is well known that PAPs are not a homogenous community; therefore social impacts of dams would have differential implications for the different segments of these communities (Adams 2000). Hence, it is critical that basic services are in place at the resettlement site and there are enough mechanisms to ensure smooth relocation of the PAPs. Besides, a pertinet question to ponder is why only 30% of the PAPs were resetlled in Haryana and what of the remaining 70%. R&R measures need to be adequate and should ensure that the entire project affected population avails the benefits.

Water for irrigation

Land for oustees in Haryana was selected bearing in mind the oustees desire to be resettled in an area close to Bhakra canal, so that they can avail irrigation benefits. However, the resettlement site that was selected for the oustees' -erstwhile Hissar district- was at the tail end of the canal and (some of the) oustee habitations do not receive much water from the canal; the same is also evident from the [50th] minutes of the BRC.[74] The command area of the oustee habitations is very poor, and few belts don't receive any water for irrigation the above was also corroborated from field discussions.

In case of Bhakra dam, reason for relocating the PAPs to Haryana was to avail irrigation benefits, but being relocated at the tail end of the canal the PAPs don't get much water from the canal. While selecting the resettlement site greater care needs to be taken to ensure that the oustees can avail the promised benefits.

Proprietary rights

The oustees resettled in Haryana have not yet been conferred proprietary rights for the land that was allotted to them. The community contends that the local administration has not been forthcoming in conferring the proprietary rights. Non-conferment of proprietary rights created a lot of uncertainty for the oustees, as they could not make any future investments at the resettlement site. The project authorities claim that the community has not come forward after completing all paperwork to avail their proprietary rights. This is an implementation issue and needs to be pondered, as there has been a delay that has curtailed growth of a community. Also, processes need to be made community friendly.

[74] Note on item no 3 for the agenda of 50th meeting of Bhakra Rehabilitation Committee, obtained from BBMB's Nangal office.

Design issues

If projects like BNP have to bring prosperity for all the stakeholders, it is crucial to internalise the cost and make the PAPs beneficiaries of the project. Some of the design issues that are apparent in context are:

Valuation of land/ assets

The process of valuation of land and assets is a critical issue. There has been an outcry in case of several dam projects in the country that the community has not received adequate compensation for the land, and other assets lost. The above happens because when a project is declared the market value of land in the area declines. The general procedure of assessing value of land is to take average value of land in the revenue records for the last five years. This process does not take into account the market value of land, given that the land prices in the revenue records are much lower than the actual market value. The community loses in this valuation process, and receives lesser compensation for their land. This is a design issue and valuation of land and assets needs to be done bearing in mind the market value so as it does not further alienate and marginalise the vulnerable section of the population.

Water for drinking and irrigation

As part of the project design it needs to be ensured that the community is not deprived of the services which the project creates for community at large – in this case water for drinking and irrigation. Being riparian users the community earlier had access to water for drinking and irrigation from Sutlej's water. Currently, there is an acute water problem in the region where the oustees are living. The water supply scheme started by project authorities is also not functioning well;[75] the storage is not enough to cater to the growing population. It is critical that during the formulation of guidelines/ policy the interest of the riparian users/ oustees are taken care of and they also get benefits from the project, which are available to the beneficiaries of the project.

Forest Rights

A critical issue in the context of displacement is that when a community is displaced they lose the rights they earlier had: over forest, common land. For instance PAPs resettled in Naina Devi Wildlife Sanctuary have restricted mobility and rights. Also, community that was relocated in Haryana lost forest rights that they had in Himachal Pradesh. The policy guidelines need to ensure that when a community is relocated, the rights over forest that the community had earlier are not curtailed by resettlement.

[75] As per field discussions

Livelihoods

A major loss for PAPs of Bhakra dam who were resettled in Haryana was the Dogra status, through which they could get employment in the Indian Army. If a project affects the livelihood of a community it needs to ensure that steps are taken to revive/ secure these livelihoods. The policy guidelines need to take this anomaly into consideration. Further initiating a policy dialogue would unfold the process of sensitisation and address such livelihood questions/ issues. Studies have indicated that weakest link in resettlement planning is the economic rehabilitation of the resettlers. Focus of the policy guidelines need to shift from income restoration to income improvement (OED 2000). This logic prompts to reflect on ways and means of entrepreneurship and alternate skill development. Such an approach would help reduce the dependence on the systems and promote self-reliance. However, synergies with government programmes, schemes of financial institutions and easy access to credit, etc. would create conducive climate for economic rehabilitation.

Uri Hydro Electric Project

Uri hydroelectric project (HEP) was completed in 1996 and has an annual installed capacity of 2663 million units of energy. It is a run of the river scheme located downstream of Jhelum Power Station. Uri reservoir has a capacity of 0.2316 mcm[76] (Varma and Jalota 1997).

Fact sheet: Resettlement and Rehabilitation

Uri HEP being a run of the river scheme on river Jhelum, there was not much displacement due to the project. After undertaking a site survey, land was acquired for the project under two heads:

Land acquired for the project components

Total 246 families were affected in ten villages by land acquisition for the project component. According to official estimates, of the total 246 families that were affected, 77 families were rendered homeless and were required to be resettled; the remaining (169) lost only land (NHPC 1992). The same is evident from the figure below.

76 MCM: million cubic metres.

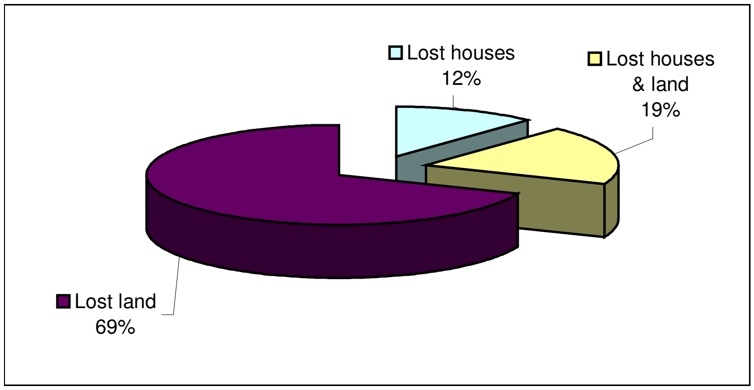


Figure 34. Families affecetd due to land acquisition for project component

Source: NHPC (1992)

Total land acquired for the project component is 235 ha. The land was acquired for:

- Barrage site
- Power house
- Dumping
- Administrative complexes
- Residential colonies

The villages most affected -in terms of land and house lost- are Boniyar, Gingle and Rajarwani.[77] The same is evident from the table below.

Table 53 Number of families affected due to land acquisition for project components[78]

Sl. No	Name of the village	No. of families		Total
		Losing house	Losing house and land	
1	Bonivar	15	17	32
2	Gingle	2	6	8
3	Pringle	-	3	3
4	Nowagran	-	4	4
5	Rajarwani	4	8	12
6	Bandi	-	1	1
7	Lagama	-	2	2
8	Mohura	-	4	4
9	Bela Salamabad	5	-	5
10	Helad Peernia	4	2	6
Total		30	47	77

Source: NHPC (1992)

[77] The barrage is in Boniyar village. The power house is in Rajarwani village, also land in Gingle was acquired to set up the NHPC colony.
[78] The table does not give village wise details of families who lost only land.

Land acquired for construction of parallel road

Apart from the families that were directly affected due to the project component, 20 ha of land was also acquired for construction of parallel road on the right bank of river Jhelum. In total 225 families were affected due to construction of parallel road.[79]

Table 54 Families losing house/ shop/ water mill due to land acquisition for construction of parallel road

Sl. No.	Name of village	No of families losing			Total
		House	Shop	Water Mill	
1	Dawaran	3	13	-	16
2	Gingle	3	-	2	5
3	Bangna Noorkhan	11	-	-	11
4	Kanchan	3	1	-	4
5	Azadpur	4	1	-	5
6	Iehtishampora	2	-	-	2
7	Tathamulla	1	-	-	1
	Total	27	15	2	44

Source: NHPC (1992)

Of the total 225 affected families, 12% lost their house and 16% lost their shops. Also, in village Kanchan a mosque was affected due to construction of parallel road.

Compensation

There are no R&R guidelines that NHPC follows for its (dam) projects to ensure smooth rehabilitation of PAPs.[80] For each dam project, R&R norms are decided. In case of Uri, there are no specific guidelines to ensure rehabilitation of PAPs.

Prior to the project construction, a socio-economic survey of the site was carried out, to understand the present socio-economic status of the community that was affected. Based on the socio-economic survey, a rehabilitation plan for Uri hydroelectric project was prepared (NHPC 1992 and Wilson 2005).

Assessment of land

The Chief Engineer of the project wanted to begin land acquisition proceedings in the financial year 1986-87; therefore, a need for a High Level Committee was felt to speed up the process.[81] The committee -headed by Divisional Commissioner- was set up to ensure speedy land acquisition through private

[79] The parallel road was constructed to ease the traffic on the national highway during the project construction period.
[80] Draft R&R policy has now been prepared and comments from various stakeholders are being incorporated.
[81] Official correspondence, Land File, NHPC project office, Uri.

negotiations[82]. After several meetings, High Level Committee proposed land rates for different category of land[83] ranging from Rs 45,000 to Rs 5,000 per kanal.

Graded compensation based on the quality of land was given. These rates were considered to be on higher side by the project authorities and the range was revised to Rs. 34,000 to Rs 5,000 per kanal; [84] since the project authorities felt that these rates would have long-term repercussions for future projects. The community did not agree to the proposed land acquisition rates initially, as they had demanded a land rate of Rs. 60,000 per kanal.

In addition, to speed up the acquisition process, project authorities provided allowance to people who agreed to voluntarily sell their land through private negotiations.[85] Land was acquired by private negotiations[86] and in few cases under State Land Acquisition Act, where the community did not readily agree to sell their land. For acquiring land in such cases help from local MLA, DC and influential people was sought to acquire land under Land Acquisition Act of 1970.[87]

All the land was acquired by the state government and transferred to NHPC on lease, on payment of token rent of Rs. 1 per kanal per annum for a period of ninety years extendable by mutual consent of both parties.[88]

[82] Reason for acquiring land under private negotiation was that if land were acquired under the Land Acquisition Act then, as mandatory community would have to be given land for land.
[83] The four land categories were:
Category A: Hotar awal, Lapara, Abi abi, Awal, Sagzar
Category A1: Mira Abi
Category B: Baghi Abi, Baghi Khushki, Lapara khushki, Meera Khushki, Maidani
Category C: Taki,Kaap, Banjari Qadeem, Banjari Jadid GaIRMUMKIN jungle (Proprietary)
Category D: Gairmumkin nallah, Gairmumkin pathar, Gairmumkin sanglakh, Gairmumkin jadh, Gairmumkin kuhl and all other gairmumkin excepting gairmumkin Bana which shall form the part of main classification of the khasri number concerned.
[84] Status note on land acquisition, Land file. NHPC project office, Uri.
[85] Official correspondence, land file, NHPC project office, Uri.
[86] Acquiring land under private negotiation has an advantage for the project authorities as the 30% of the market price, which needs to be paid as solatium for acquisition under the Act is saved. Also, the possibility of paying higher price subsequently as a result of decisions by the court is eliminated. http://punjabrevenue.nic.in/so28(3).htm accessed on August 31, 2006.
[87] Personal communication with ex land acquisition officer, NHPC project office, Uri.
[88] Minutes of the meeting held under the chairmanship of Shri. Musa Raza, chief secretary to J&K government regarding acquisition of land for Uri hydel project, dated 1st December 1988, obtained from NHPC project office, Uri.

Project authorities also needed land for dumping of excavated material; this was acquired separately from the above.

Assessment of house, trees, water mill

S.E. PWD[89] was made responsible for assessing compensation for house, shop, and water mill. District Horticulture officer did assessment of fruit trees. Other trees were assessed based on the fuel value. The compensation for trees was given on face value, and not potential value. To assess the value of trees, authentic annual income from the trees for the last three years was accepted as a reliable figure. If reliable annual income figures were not available, the assessment of trees was done based on the guidelines devised for the same. The guidelines discuss the value of trees based on its individual capacity to bear fruits for a given number of years.[90]

Compensation amount

Total compensation paid to the PAPs for the acquisition of land is Rs. 9,81,05,198. Of the above, Rs. 9,73,58,502 (99.24%) has been paid to the PAPs and Rs. 7,46,696 (0.76%) is remaining to be paid, this issue is discussed in detail in the subsequent section.[91]

Social infrastructure created and other benefits [as part of R&R]

Besides, cash compensation several other benefits that the PAPs received from the project authorities are indicated in the table below.

Table 55 Benefits provided to PAPs as part of rehabilitation package for Uri HEP

Type of benefit	Details	Remarks (based on Field discussions and secondary data)
Housing	» Payment made to the community for purchasing land for house construction (125 sq. m) » Also, logistic support for transport and settlement was provided	» All PAPs have received money for purchasing homestead
Educational facility	» 1 primary school was started in Gantamulla colony for project workers » 1 school has been started in Gingle colony for NHPC employees and central government staff	» Few students from outside (Project affected families) study in Kendriya Vidayalaya (KV) in Gingle colony » Percentage of local students studying in KV, Gingle is 16
Medical Facility	» About 1200 persons per month utilise the facility	» NHPC has provided medical facility to the local PAPs of Uri project from Gantmulla since

[89] PWD: Public Works department
[90] Notification, Government of Jammu and Kashmir, dated 4th December 1985, obtained from NHPC project office, Uri
[91] Compensation details, obtained from Barrage office, NHPC, Uri

Type of benefit	Details	Remarks (based on Field discussions and secondary data)
		the establishment of the medical centre. Later the hospital was shifted to Gingle. Moreover, medical facilities were extended to PAPs/ locals from the medical centre at Bandi. About 300 people were attended to. » After the hospital was shifted to Gingle, community apprised that initially they were not allowed to avail the medical facility because of security reasons. It's only for the past 4 years that outsiders have been allowed access to the medical facility in Gingle. » Number of local patients coming to OPD[92] has increased since the earthquake that had struck the region in October 2005 » Percentage of local patients going to OPD at the Uri power station hospital is 25.4 [between 1st July 2005 to 30th June 2006]
Employment	» 237 persons employed by NHPC » 2778 persons engaged by the contractor	» Community gained employment: contractual and on daily wages during the project construction. Also, the experience gained during the project construction opened avenues for other employment options. » Few have been permanently employment with NHPC
Reconstruction of religious places	» 1 mosque constructed in Kanchan village » 1 mosque renovated in Buniyar village	» Money and construction material (cement) for construction of mosque was given to the mosque committee » Still some money needs to be paid to the committee (around Rs. 26,000 as per field discussions)
Training	» Vocational training to 165 persons in the field of poultry farming	» NHPC officials apprised that the community however did not take much interest in poultry activity.
Water supply	» Money given to local PHED[93] for water supply scheme for Buniyar village	» The water supply scheme is functional in the village and is of 10,000 gallon capacity. The scheme is supplying water to 1000 families.
Communication facility	» Wielding of National highway 1A » Construction of roads in the vicinity of project » Construction of bridge across Jhelum » P&T microwave facility	» Community is benefiting from the social infrastructure created
Fuel arrangement	» Subsidised electricity, coal, kerosene and LPG provided by	» Financial details or any other details on this component are not available with the project

[92] OPD: Out Patient Department
[93] PHED: Public Health Engineering Department

Type of benefit	Details	Remarks (based on Field discussions and secondary data)
	project	office in Uri. Community also was not aware of any such fuel arrangement.
Pasture development	100 ha of pasture has been developed at a cost of Rs. 10 lakh	Pasture development was undertaken under CAT plan at various sub-watersheds. This was done at high altitude to provide fodder to the cattle of Gujjar community residing at high altitude so as to reduce the pressure of tree felling from the forest areas.

Source: Varma and Jalota (1997), NHPC (2006), Bhat and Khan (2003), data from Uri Power Station Hospital, NHPC project office, Nangal and field discussions.

The above table discusses in detail various benefits provided to the community. NHPC has spent considerable amount for creating social infrastructure in the region. The hospital in Gingle colony has been constructed at a cost of Rs 30,22,828. The villagers in Gingle informed that they use NHPC hospital in case of emergency. Also, after the earthquake, the number of people accessing the hospital has doubled. Currently, 20% of the OPD patients are from nearby villages.

The parallel road that has been constructed on the right bank of river Jhelum has been a boon for the community. Discussion with community in village Kanchan revealed that the parallel road has improved connectivity and provided access to health facilities and education to the community. Earlier patients used to succumb to their illness on the way to a hospital.

PAPs in Pringle also apprised that road and electricity have been two major benefits from the project. Besides that a children park has also been developed in Boniyar village. In addition, community in Boniyar apprised that one of the positive outcomes of the project is that they now have a grid station near the village and they get (almost) uninterrupted supply of electricity, and pay approximately Rs 250 per month. However, community is not satisfied with the maintenance of the children park in Boniyar. In addition, a bridge has been also constructed across Boniyar *Nala* at the cost of Rs 1758694.

The project authorities have invested in creating social infrastructure, but the community contends that everybody affected by the project have not benefited from the same. For instance, Boniyar and Rajarwani have the highest number of PAPs in the region. But no school has been provided in the village/ area. The school in Gingle colony has been primarily made to cater to the needs of the employees of NHPC. Given that the school is part of the Kendriya Vidyalaya *Sangathan* admission to the school is readily available to children of central government employees. For the rest of the community it is not easy to get admission in this school.

The cost of construction of Kendriya Vidyalaya was Rs 87,82,111. 16% of students attending school are from Gingle, Mohura, Datta Mandir and Chandanwari.

Field Findings

Village Selection

Field discussions were undertaken to assess the status of the oustees prior to the project in comparison to the present status. Secondary data and discussions with NHPC officials helped in substantiating field findings.

Being run of the river project, there are not many PAPs. In total, 17 villages were affected due to the project, 10 due to actual project construction and 7 for construction of parallel road. For field discussions villages from where maximum number/ percentage of people were affected was selected, as is evident from the table below.

Table 56 Sampled villages for field discussion

Type of villages	Total affected villages	Villages where FGD was conducted [and % of total]	Name of villages sampled
Villages affected due to project component	10	4 (40%)	Pringle, Boniyar, Rajarwani, Gingle
Villages affected due to construction of parallel road	7	1 (14%)	Kanchan

Source: NHPC (1992) and TERI compilation

Villages where field discussions were undertaken are in Baramulla district of Uri Tehsil.

The following section discusses present conditions of PAPs in comparison to their status prior to the project.

R&R of PAPs

PAPs who lost land and house [total landholdings] were offered resettlement in Sheeri Township. In Sheeri, land along with other civic amenities was offered. However, according to project documents, none of the PAPs indicated a desire to resettle in Sheeri.[94] Also, field discussions revealed that most of the PAPs were interested in cash compensation, and did not want to resettle elsewhere. As most of the PAPs were left with some landholding/ homestead in the area after losing land to the

[94] Minutes of the meeting held at Dak bungalow Baramulla on 13th October 1987, obtained from NHPC project office, Uri.

project; hence, did not want to resettle elsewhere. Few respondents apprised that they were not aware of any such resettlement offer. Most of the PAPs from Uri project, who lost their house, have constructed their new houses in the same region prior to the project commissioning. The community was provided cash compensation in lieu of the land acquired from them.

Partial payment

The compensation money was given to PAPs in two instalments. 80% was to be paid upfront and 20% paid later, after all liabilities were settled. During field discussions several respondents apprised that they have not yet received the full compensation for the land lost.[95] Discussions with NHPC officials confirmed the same. There is some anger in the community about this non-payment. The process has been slow because the person in the District Commissioner's office who was assigned responsibility during the project construction to facilitate speedy payment of compensation is no longer available for the given project.[96] Also, whether 20% remaining money would be provided at the earlier rate of land or the present rate is an issue with the community. Full compensation (money) for mosque in Kanchan is yet to be given to the community. Also, compensation for trees in Kanchan has not been given. Reasons cited by the project authorities for the delay in payment are several, ranging from PAPs having moved away elsewhere, to stoppage of work on parallel road, or non-availability of certain officials.

Living conditions: now and then

The PAPs affected due to the project are of four kinds in case of Uri hydroelectric project viz. those who lost land only, lost land and house, lost house only and those who lost employment as they were working as employed labourers on land, which was acquired for the project (NHPC 1992 and Scott Wilson 2005). The money received from the project authorities was primarily spent on marriage functions, construction of new house or general living expenses. Field discussions revealed that the compensation money was rarely invested to ensure sustainable income flow.

In Pringle and Boniyar community apprised that earlier they used to keep cattle, hence milk and butter was readily available. However, the livestock population in the region in general has been much lesser than other parts of the country because of the terrain. But with loss of land, keeping cattle has become expensive. Earlier agricultural residue partially fulfilled the

[95] Total money remaining: Rs. 7,46,696 (0.76% of the total compensation).
[96] Personal communication, land record officer, Barrage office, NHPC, Uri.

fodder requirement for cattle. But after the project, land holdings with the community has reduced drastically, this has lead to lesser livestock population as the community apprised that there is not enough fodder: agricultural residue (Scott Wilson 2005). In addition, purchasing fodder from the market is expensive: approximately Rs 25 for a bunch.

Moreover, during field discussions in Boniyar it was apprised that the trash from Jhelum is picked and dumped at the dumping site. The dumping site is aesthetically unappealing; also, the community fears that an epidemic may spread due to the unhygienic environment created because of the same. Also, due to the blasting operations during project construction, several natural springs have been affected.

Most of the PAPs have lost fruit bearing trees due to the project and apprised that it is a major loss as they had an additional assured income flow. The community mostly had walnut, pears, almond, and cherry trees. As compensation for trees was not given bearing in mind the potential income from trees over its fruit bearing life, the community feels cheated. However, a notification of Government of Jammu & Kashmir, revenue department indicates that valuation of trees can not be done for the entire life of the tree as then by the same rationale value of land would also have to be fixed bearing in mind the potential value of land based on all the crops that could be grown in future.[97]

In addition, few respondents apprised that land was not valued for its worth because in revenue records land that was of A category was entered as B & C by the PAPs forefathers to get a waiver/ pay lesser land fee to the revenue department. Change in land category not possible after 1971, and when the PAPs came to know the fact it was too late.

Basic services: drinking water

NHPC commissioned a drinking water supply through the local PHED in village Boniyar at the cost of Rs. 13 lakh. The water supply scheme caters to 1000 PAPs and has the capacity of 10,000 gallons.

Apart from the water supply scheme at Boniyar, tap stands have been installed in Rajarwani, Gingle and Pringle. However, community in these villages apprised that NHPC's DWS is only in areas from where there are NHPC employees. PAPs in Pringle apprised that during the project construction water supply from NHPC was available, but not any more. Most of the community

[97] Notification, Government of Jammu and Kashmir, dated 4th December 1985, obtained from NHPC project office, Uri.

in Rajarwani, Gingle and Pringle use water for drinking and irrigation purpose from natural spring.

Employment

The project construction started at the height of militancy. A critical issue that the community had in the context is that they did not get full time employment with NHPC. Villages where the militancy was high, formed pressure groups to get permanent job with NHPC, rest of the community did not get permanent jobs with NHPC.

Also, the PAPs claim that employment was promised to one family member prior to construction of the project by the project authorities, but this has not happened. It seems there is confusion whether the employment was promised during the project construction or after the project completion as well. Project authorities claim that they have no directive that requires giving permanent employment to all. Moreover, 237 people are permanently employed with NHPC and 2778 through contractors (Bhat and Khan 2003).
Field discussions revealed that skilled labour was employed for approximately Rs. 6000 per month and unskilled labour for Rs 3000 per month during the project construction. In Pringle, field discussions revealed that approximately 30 persons got employment due to the project. In addition, discussions in Boniyar revealed that the wages/ salaries paid by the Uri consortium during the project construction were much more lucrative than what NHPC was paying. Most of the people preferred working with the consortium rather than NHPC.[98] According to field discussions, those who worked with the consortium lost their jobs at the completion of construction work, while those who worked with NHPC during that time were made permanent. In village Rajarwani also there was some anger towards the project authorities, as they did not get permanent employment. PAPs however acknowledged that working for the project during construction was beneficial as it gave them valuable experience which could be used to get jobs elsewhere.

Critical issues

To conclude, previous sections have discussed in detail the condition of the PAPs prior to the project in comparison to their present status. The number of PAPs affected by the project is not many, also the community did not agree to resettle elsewhere; most of the PAPs are living in the same village or nearby villages. Most members of the community apprised that they are better off than earlier. Also, the parallel road created has been a great boon for the community. Some of the issues

[98] In 1990-92, NHPC was paying Rs 600 approximately per month.

that are critical and were brought forth by PAPs several times are regarding getting permanent employment with NHPC, delay in payment of compensation (remaining 20% amount) and lesser valuation of their land. Delay in payment of compensation money is an implementation issue, care needs to be taken that the payments to the community are made in time. Regarding employment, there is no official document that indicates that the community was promised permanent employment. However, the PAPs claim that they were 'promised' the same by the project authorities. As indicated earlier, 237 PAPs are permanently employed with NHPC and 2778 through contractors. Joblessness among PAPs surfaced after a time delay[99], in the short run the PAPs received employment in project-related jobs. This joblessness has led to some unrest amongst the community about the project authorities at present. Hence, it is critical that at the time of project initiation, the benefits and losses (including limitations of providing long term jobs to all) from the project need to be clearly indicated to the PAPs.

Another critical issue that needs to be borne in mind is the process undertaken to assess the value of land. One of the criticisms of dam projects has been that the community does not receive adequate compensation for the land, and other assets lost. In case of Uri, though most of the land was acquired through private negotiations, the land price fixed was lower than what the community initially demanded. This is clearly a design issue though the scope of the present study does not allow a detailed analysis of the degree to which land prices paid are fair. (Documents available with the study team and field discussions indicate a gap between the land price expected by communities and the land price actually paid. [100])

Conclusions

Several critical design and implementation issues in the context of Bhakra and Uri have been identified in the study: the manner in which compensation norms are set, providing/ improving access to basic services, involving community in planning of projects, securing forest rights (that are lost) to the community, and securing alternative livelihood options. The focus should not only be to give compensation for the land acquired but also to ensure that the PAPs are properly resettled and rehabilitated. For instance in case of Bhakra only 30% of the PAPs have been resettled in Haryana. Work on conferring the proprietary rights to the PAPs in Haryana is yet to be

[99] After the project construction work was completed.
[100] As discussed earlier. Moreover, field discussions also revealed that the community purchased land at a much higher price than what was given to them as compensation.

completed in case of Bhakra. Moreover, the compensation given to the PAPs was found to be less than what was initially demanded in case of both Bhakra and Uri projects. Also, the community does not have access to basic services, and infrastructure is in poor condition in their settlements; this is especially true in context of Bhakra oustees.

These social costs need to be accounted for in order to share the benefits from such project widely. The focus should not only be to give compensation for the land acquired but also to ensure that the PAPs are properly resettled and rehabilitated and alternative livelihood options are made available for the community.

Moreover, while planning such projects it needs to be borne in mind that there are practical limits to quantification of social costs - there are genuine intangible socio-cultural variables of importance. These need to be acknowledged and the appraisal methodology needs to give due weight in the decision making processes while project planning (Adams 2000).

CHAPTER 11 Conclusion

In this section, we provide the conclusions as they relate to the study objectives:

- **Inadequacies in the definition of forests in the Indian context:** The present system of charging payments for diversion of forest land, based on a notional definition of forests as per the Indian Forest Act 1927, is inadequate. This is because of the fact that the Act categorises certain land area as forest based on various notifications, irrespective of the kinds of vegetation present there. Thus, land which does not support any vegetation also gets counted as forest, just because the Act defines so. Hence, we need an ecological definition of forest – in terms of minimum land area (0.5 ha) and minimum canopy cover (10%) (as provided by FAO) – with further classification on the basis of end-uses.

- **Basis for classification of forestland:** Based on end-uses, forestland can be categorised into conservation forests (valued for ecological functions), production forests (valued for tangible products) and restoration forests (valued for reversing land degradation).

- **Parameters for estimating values of forestland:** Based on the above classification scheme, we have identified a set of goods and services that are most relevant for each category. These have been explained in detail in the report. For example, for production forests, key values would be based on timber, NTFPs, grasses etc, and for conservation forets, they will be based on services like watershed and biodiversity.

- **Estimation of net benefits of two selected projects:** The two selected projects – Bhakra and Uri – were evaluated in terms of the net benefits generated through irrigation, hydropower, drinking water, fisheries, employment, tourism, (avoided) GHG emissions, groundwater and flood control. (In case of Uri - a run-of-the-river scheme – only hydropower and employment are relevant). The values are in the range of Rs 280,237 crore (Bhakra) to Rs 207,412 (Uri). The costs in terms of diverted forest land are Rs 65 crore and Rs 10 lakh for the two projects respectively. These do not take into account loss of intangible forest services, and social costs, since these are difficult to quantify within the scope of the exercise. The challenges regarding monetisation of these have been elaborated in the report, and detailed qualitative assessment has been provided in case of social costs.

The implications for the payments regime can be summarised as follows:

- The relevant land-use category should be 'ecologically defined forests' rather than 'historically notified' forests. Thus, areas that do not have any vegetation cover, but are treated as forests as per IFA 1927 should not attract the provisions of FCA for the purpose of payments for diversion.

  In case of conservation forests, the services provided are irreplaceable and of infinite value. Hence, diversion of such land should not normally be done, unless there is an overriding national interest. In any case, this will then be a public policy decision based on careful evaluation of competing national interests, rather than comparison of monetary values of benefits. In case of other forests, reasonable replacement of the goods lost is possible. In either case (conservation forests and production/ restoration forests), **existing arrangements for paying for CA and CAT should continue.** However, the institutional mechanism for implementing these should be strengthened so that these measures achieve the intended result. In case of diversion of forestland, the user agency needs to set up appropriate implementation systems, and the Forest Department can play a monitoring role.

- At times, social costs from such projects are very high and need to be taken care of, even if they cannot be monetised. While planning such projects it needs to be borne in mind that there are practical limits to quantification: everything cannot be quantified and there are genuinely intangible socio-cultural variables of importance. This needs to be acknowledged and the appraisal methodology needs to give due weightage to the same in the decision making processes while project planning.

- In addition, if social costs are too high, then the very decision to go ahead with the project would again be a public policy decision, much like diversion of conservation forests, rather than one based on monetary valuation. In addition, when such projects are planned, then care should be taken that R&R measures are made as per the accepted norms and do not lead to further marginalisation of the PAPs. [The World Commission on Dams (WCD)[101] provides a framework for addressing the socio-economic and environmental issues surrounding large dams. The commission addresses a rights and risk approach for identifying stakeholders in negotiating development choices and agreements (WCD 2000).]

- **NPV based on value of forest land diverted should not be the basis of payments. What is relevant is a comparison of the NPV of the project and NPV of forest land diverted. The study shows that the former is higher than the latter by orders of magnitude. Hence, there is no basis for charging of NPV based on value of forest land diverted.**

[101] The WCD was an independent, international, multi-stakeholder process, which addressed the controversial issues associated with large dams. The five core values that the commission promotes are equity, efficiency, participation, sustainability and accountability.

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