

Environmental Management In Hydro Power Projects

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KEYWORDS

Hydro-power, Environmental, Social, Impacts, Management

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ABSTRACT

Various hydro power projects taken up in India, particularly during the post-independence era, have provided clean energy, contributing to socio-economic development. However, all developmental activities have certain environmental impacts, both beneficial and adverse, and hydro power projects are no exception. The possible adverse impacts of these projects include submergence of forests, impact on water quality, flora & fauna and socio-economic impacts like displacement of people, the last one being particularly sensitive. Lately, the concerns about minimum flows downstream of the dams and emission of green house gases from reservoirs have also emerged. The objective of environmental management is to optimize the benefits while minimizing the adverse impacts.

Integration of environmental concerns into the development process has been a regular feature of India's traditions and policies. India is one of the few countries where specific provisions exist in the constitution for environmental conservation. A number of Acts and Legislations have been enacted for the purpose. The National Water Policy of India, 2012 also emphasizes the environmental aspect *"Being inter-disciplinary in nature, water resources projects should be planned considering social and environmental aspects also in addition to techno-economic considerations in consultation with project affected and beneficiary families."* Environmental and forest clearance has been made mandatory and various management measures are insisted, while granting environmental clearance, for reducing the adverse impacts of projects.

An elaborate procedure is followed for according environmental clearance to hydro power projects to ensure that the implementation of the projects leads to improvement of the ecosystem rather than its degradation. The procedure has even been amended, making it mandatory to consider the public opinion regarding the project.

Before 1994, it was an administrative requirement to get environmental clearance for the projects from the Union Ministry of Environment and Forests. In order to assess the impact of the developmental projects/activities on the environment, the Ministry of Environment and forests (MOEF), Govt. of India issued a gazette notification on the Environmental Impact Assessment (EIA) on January 27, 1994 (as amended on May 4, 1994) and made environmental clearance statutory for all the projects located in ecologically sensitive/fragile areas as notified by the Govt. of India from time to time besides 29 categories of the projects as specified in the Schedule 1 of the notification. These also include river valley projects. The notification was further amended in 1997, making a public hearing also necessary to get environmental clearance. The notification has since been superseded by EIA Notification of 2006.

The paper presents the creation of environmental awareness at national and international level, environmental legislations and policies. It also describes environmental impact assessment, procedure for environmental clearance in India, environmental management of river valley projects and environmental monitoring.

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1.PROLOGUE

Various hydro power projects taken up in India, particularly during the post-independence era, have provided clean energy, contributing to socio-economic development. However, all developmental activities have certain environmental impacts, both beneficial and adverse, and hydro power projects are no exception. The possible adverse impacts of these projects include submergence of forests, impact on water quality, flora & fauna and socio-economic impacts like displacement of people, the last one being particularly sensitive. Lately, the concerns about minimum flows downstream of the dams and emission of green house gases from reservoirs have also emerged. The objective of environmental management is to optimize the benefits while minimizing the adverse impacts.

2.WHAT IS ENVIRONMENT

Environment is the current catchword. As it happens with many of the catchwords, people tend to use it without appreciating its meaning. Simply stated, the environment can be defined as one's surroundings. However, a more specific definition is needed to appreciate the issues involved.

The Environment (Protection) Act, 1986 states "environment includes water, air and land and the inter-relationship which exists among and between water, air and land, and human beings, other living, creatures, plants, micro-organism and property". Here we are basically concerned with water and environment and its environmentally sustainable development.

3.WHAT IS SUSTAINABLE DEVELOPMENT

Another current catchword is Sustainable Development. It has got many connotations. However, the most common definition is the one given in the famous report of World Commission on Environment and Development viz. "Our Common Future". It states "Sustainable development is defined as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs".

4.WATER AND ENVIRONMENT

Water is a major component of that environment in which man occupies the centre-stage. Apart from the need for drinking, water is needed for producing food and fibre; in process industries and manufacturing and to produce energy – hydro, thermal and nuclear. This great need for water has brought into focus the fragility of environment associated with fulfilment of these needs and the need to guard against it. All great civilizations had grown around water and many had perished with or without water, perhaps not having realised the importance of its sustainable development.

The status of water in the environment is unique. Ever since the birth of earth, from day one, the need for water is always on the increase, not just because of increase in human population but because all living beings are multiplying at a fast rate. The increase in demand has brought tremendous pressure on resource development. This has tended to disturb the status of water in the overall environment. The disturbance, if not contained, may seriously impair the capacity of the resource to meet the demands of future generations and

the present civilization may have to go the same way as its predecessors. Hence the need for sustainable development of water resources.

5.ENVIRONMENTAL AWARENESS IN INDIA

A good environmental sense has been one of the fundamental features of India's ancient philosophy. The earth was called "mother earth" and water, air and sun were considered to be gods. Major rivers like the Ganga and the Yamuna were also treated as mothers. The environmental concerns were integrated into various religious and social customs in such a manner that these were automatically taken care of by the people.

6.LEGAL FRAMEWORK

Adequate provisions for protection of environment and forest are made in the Constitution of India. Article 47 provides for protection and improvement of health. Article 48A is directed towards protection and improvement of environment and protection of forest and wildlife. Article 51 (A) says it is the duty of every citizen to protect and improve natural environment. Following the UN Conference on Human Environment (Stockholm, 1972), a constitutional amendment (42, 1976) inserted relevant provisions for environment protection in Constitution in Part IV-Directive Principles and Part IV A- Fundamental Duties.

7.ENVIRONMENTAL ACTS

In order to ensure sustainable development from water resources angle the Government of India have enacted various Acts and Legislations. Prominent among these is the Environment (Protection) Act, 1986 through which the Government has acquired wide powers for protecting the environment. Some other Acts related to Water and Environment are Water (Prevention and Control) of Pollution Act, 1974 (amended in 1988), Water (Prevention and Control) of Pollution (Cess) Act, 1977 (amended in 1991), Forest Conservation Act, 1980 and Environmental Impact Assessment Notification of 1994 (amended in 1997) and the Ministry of Environment & Forest's Notification of Jan. 1997, constituting the Central Ground Water Authority.

The Water (Prevention and Control of Pollution) Act, 1974 seeks to maintain or restore "wholesomeness of Water" and the Central and state Pollution Control Boards have been established under this Act. According to the Water Cess Act, 1977, both Central and State Governments have to provide funds to the Boards for implementing this act. The Forest Conservation Act, 1980 provides for compensatory afforestation to make up for the diversion of forestland to non-forest use. The Environment (Protection), 1986 was enacted in 1986 for the protection and improvement of human environment. The EIA Notification of 1994 made the environmental clearance mandatory for all new projects and expansion/modernisation of existing projects covering 29 disciplines which include hydro-power, major irrigation and flood control projects. Its amendment in 1997 made it mandatory to hold environmental public hearing before according environmental clearance. It was later superseded by EIA Notification of September 2006.

8.WHAT IS EIA

EIA is an "anticipatory, participatory, integrative environmental management tool, which has the ultimate objective of providing decision makers with an indication of the likely consequences of their decisions relating to new projects or new programmes, plans or policies."

EIA helps the decision makers to identify the likely effects at an early stage and to improve the quality of project planning and decision making. It is a process used to predict the

environmental consequences of proposed major development projects, to identify and plan for appropriate measures to reduce adverse impacts.

An EIA attempts to answer the following questions:

- 1 What will happen as a result of the project?
- 2 What will be the extent of the changes?
- 3 Do the changes matter?
- 4 What can be done about them?
- 5 How can decision makers be informed of what needs to be done?

Answers to these five questions is through five steps:

1. Identification of impacts.
2. Prediction of significance of causes and effects of impacts
3. Evaluation of the predicted adverse impacts to determine whether they are significant enough to warrant mitigation
4. Suggesting a wide range of measures to prevent, reduce or remedy those adverse impacts which warrant mitigation
5. Documentation of the process and conclusion.

9.NEED FOR EIA

It is now necessary to have an idea of possible impacts of any developmental plan it is going to have on our environment. Fortunately, adequate legislation could be brought into force to make proper assessment of all such environmental impacts. The objective of Environmental Impact Assessment (EIA) is to ensure that development is sustained with minimal environmental degradation. EIA refers to the evaluation of the effects of major projects on a man-made natural environmental. It is the basic tool for the sound assessment of development proposal.

EIA was introduced in the USA following the enactment of the National Environmental Policy Act (NEPA) by the United States Congress in 1969. Since then, many countries have included EIA in their environmental legislation. Today EIA has evolved as a management tool a planning aid that helps in identifying, predicting, assessing impacts on environment from proposed development projects. It is valuable mechanism that aids in promoting sustainable development.

10.ENVIRONMENTAL IMPACTS OF WATER RESOURCES PROJECTS

Water Resources Projects cause beneficial as well as adverse impacts both during the construction and the operational phases.

10.1Construction Phase

10.11Beneficial Impacts

The beneficial impacts during the construction phase are as under:

Socio Economic

- a) Employment
- b) Better Housing/Land
- c) Infrastructure Development
- d) Communication Improvement

Biotic

- a) Compensatory afforestation
- b) Improvement of degraded forest
- c) Green belt on periphery of reservoir

10.12 Adverse Impacts

The adverse impacts during the construction phase are as under:

Socio Economic

- a) Displacement of People
- b) Loss of monument, if any

Biotic

- a) Submergence of forest land
- b) Effects on flora & fauna

10.2 Operation Phase

10.21 Beneficial Impacts

The beneficial impacts during the operation phase are as under:

Socio-economic

- a) Increased/improved crop production
- b) Power generation
- c) Water supply
- d) Ground water recharge
- e) Flood moderation
- f) Agro industry
- g) Tourism

Biotic

- a) Increased aquatic life
- b) Afforestation
- c) Migratory birds

10.22 Adverse Impacts

The adverse impacts during the operation phase are as under:

Physical

- a) Water logging & Salinity
- b) Change in water quality and sediment load d/s

Biotic

- a) Increased aquatic weeds
- b) Spread of water borne diseases

- c) Deterioration of water quality

11.EIA REGIME

The EIA regime is as under:

- a) Physical
- b) Ecological
- c) Socio economic

12.PURPOSE OF EIA

The EIA serves one or more of the following purposes:

- a) Decision making
- b) Choosing among various alternatives
- c) Integrating env. cost into project cost.

13.STEPS IN EIA

The steps carried out in Environmental Impact Assessment are as under:

- a) Identification – This involves assessing of the magnitude of impacts, geographical extent, significance to decision makers etc.
- b) Prediction – This quantifies the impacts through mathematical models, physical models, socio-cultural models, economic models and experiments.
- c) Evaluation – This predicts adverse impacts by comparing it with laws, regulations or expected standards or by reference to present criteria or on the basis of acceptance to local community or public in general.
- d) Mitigation - Steps may be suggested for restoration of ecological balance.
- e) Communication – This involves communication of the results of EIA to the concerned agencies.

14.EIA PROCESS

The EIA process comprises of the following:

a) Screening

The screening can be either project related or site related. These are briefly described as under:

- i) *Project related* – This would determine the threshold value of cost, size and pollution levels
- ii) *Site related* – This is based on the assimilative capacity of the project area. The following factors are kept in view while carrying out site related screening:
 - A) Avoid environmentally sensitive areas
 - B) Avoid conflict with existing policies, plans & legislation.
 - C) Avoid conflict with desirable land use e.g. prime agricultural land

b) Scoping

Scoping is carried out with the following objectives:

- a) To determine depth of analysis
- b) To formulate Terms of Reference
- c) To identify prima facie major/minor environmental issues involved
- d) To determine geographical boundaries of the study
- e) Gives idea about format for Environmental Impact Statement

c) Rapid & Comprehensive EIA

The EIA can either be rapid or comprehensive as under:

i) *Rapid EIA* – This is the first level indication of the environmental issues of the readily available data as utilised for this purpose.

ii) *Comprehensive EIA* – This uses inputs from the rapid EIA. Steps involving are: identification, prediction, evaluation of the possible environmental impacts.

d) Mitigative measures

It comprises of a strategy devised to prevent, reduce and compensate the impacts of the project. The monetary assessment of the mitigative measures is also to be carried out to include into the project cost.

e) Environmental Management Plan (EMP)

This contains details of the Management measures to be adopted. It narrates the key agencies/persons, which would be responsible for the implementation of the plan. It also includes disaster management plan.

f) Environmental Impact Statement (EIS)

It is a gist of the whole exercise for getting environmental clearance and also for information of the general public.

g) Post Project Monitoring (PPM)

This is carried with a view to ensure the effective implementation of the mitigative measures.

15.RESOURCES NEEDED FOR EIA

The following resources are needed for carrying out the proper and effective environmental impact assessment.

- i) Qualified multi disciplinary team
- ii) Data about project and surrounding eco system
- iii) Analytical instruments – models
- iv) Institutional arrangements

16.ENVIRONMENTAL CLEARANCE OF PROJECTS

Before January 1994, it was an administrative requirement for the mega projects to obtain environmental clearance from the MOEF, Govt. of India. In order to assess the impact of the developmental projects/activities on the environment, the Ministry of Environment and forests (MOEF), Govt. of India has issued a gazette notification on the EIA on January 27, 1994 (as amended on May 4, 1994) and made environmental clearance statutory for all the projects located in ecologically sensitive/fragile areas as notified by the Govt. of India from time to time besides 29 categories of the projects as specified in the Schedule 1 of the notification . These also included River Valley projects.

The above notification was superseded by EIA Notification of 14th September 2006. The relevant extracts of the Notification are given as Annexure I.

16.1Procedure for seeking environmental clearance of projects

Any person who desires to establish a project of any category mentioned in Schedule of EIA Notification, 2006 shall submit an application to the Department of Environment/ State Government dealing with the environment.

All projects as mentioned in Schedule of EIA notification, 2006 including River Valley projects have to go through the process of public hearing. Ten sets of executive summary containing the salient features are to be submitted to the State Pollution Control Board (SPCB) both in English as well as local language. A notice for environmental public hearing is issued by the State Pollution Control Board in atleast two newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned. Date, time and place of public hearing shall be mentioned clearly by the State Pollution Control Board.

The participation in public hearing is open to the bonafide residents, environmental groups and other located at the project site/sites of displacement/sites likely to be affected. Oral/written suggestions can also be made by the public to the concerned State Pollution Control Board.

The composition of Public Hearing Panel consists of the following viz.

- (i) District Collector or his nominee. - Chairman
- (ii) Representative of the State Pollution Control Board.
- (iii) Representative of the State Government dealing with the subject.

- (iv) Representative of the Department of the State Government dealing with the Environment.
- (v) Not more than three representatives of the local bodies such as Municipalities or Panchayats.
- (vi) Not more than three senior citizens of the area nominated by the District Collector.

The concerned person (s) are provided access to the Executive Summary of the project at the following places viz.

- (i) District Collector Office.
- (ii) District Industry Centre.
- (iii) Zila Parishad or Commissioner of the Municipal Corporation
- (iv) Concerned Regional Office of MOEF

16.2 Post-clearance monitoring

Six Regional Offices of the MOEF located at Lucknow, Chandigarh, Bhopal, Bhuvaneshwar, Shillong and Bangalore have been assigned the job of post-clearance monitoring of all the cleared projects. All the recommendations/conditions stipulated by the Expert Committee (EC) have to be complied with by the project proponents. Submission of six monthly reports is mandatory after commissioning the project. Subject to the public interest, IAA can make "compliance report" available to the public. Case of the non-compliance of the stipulated environmental conditions/ recommendations of the cleared projects are brought to the notice of Ministry of Environment & Forests and Central/State Pollution Control Boards which initiate action against the project proponents under various legislations promulgated by the Govt. of India.

A National Level Environmental Monitoring Committee has also been constituted by the Union Ministry of Water Resources to oversee the implementation of the environmental safeguards. It is headed by the Member (Water Planning & Projects), CWC and comprises of members from the Ministries of Environment & Forests, Agriculture, Welfare and Water Resources, besides Planning Commission. It is assisted by State Level Environmental Monitoring Committees and Project Level Environmental Management Committees.

16.3 Environmental safeguards stipulated for river valley projects

Following are the general environmental safeguards /conditions stipulated by the Govt. of India for implementation by the project proponents for maintaining the environmental and ecological balance in the concerned area:

- (i) Proper resettlement and rehabilitation (R&R) of the displaced people.
- (ii) Free fuel wood supply to be provided to the labourforce at the project cost.

- (iii) Restoration of construction area ensured by leveling, filling of borrow pits and land escaping. Necessary soil conservation measures during construction of roads.
- (iv) Afforestation/compensatory afforestation.
- (v) Catchment area treatment as per the scheduled plan and completed before filling up the reservoir.
- (vi) Adequate arrangement to prevent incidence of any endemic health problems due to water/soil borne diseases.
- (vii) A multidisciplinary Environmental Management Cell to be constituted by the State Govt. in consultation with the MOEF with inclusion of experts from the disciplines such as forestry, ecology, wildlife, social science etc. Fto oversee the effective implementation of suggested environmental measures.
- (viii) Adequate and separate budget for the environmental management.

17. MANAGEMENT OF MAJOR ENVIRONMENTAL IMPACTS

Various environmental impacts of water resources projects and their management is discussed thereafter.

17.1 Resettlement and rehabilitation (R&R)

As the sites of these projects are located mostly in remote and hilly terrain, the submergence involves flora and fauna in addition to affecting socially and economically backward people living in such areas. The resettlement & rehabilitation (R&R) off these families is undoubtedly a very delicate and sensitive issue. It is essentially a human problem. By and large people have a deep attachment to their land, tradition, culture and way of life and do not want to part with them. However, the water resources planners have been aware of these issues and various measures have been taken for R&R of the affected people, even in the earlier river valley projects.

Initially, the compensation was paid to the displaced persons mainly under the Land Acquisition Act of 1894 and the formal rehabilitation guidelines did not exist. Efforts made for resettlement of the displaced persons varied from state to state and project to project. There were no clear-cut guidelines for defining the project affected people (PAPs). Later, some of the State Governments started formulating policies for resettlement of PAPs within their jurisdiction.

Meanwhile, the construction of multi-purpose projects like Sardar Sarover and Tehri Dam attracted the attention of a large number of Non Governmental Organisations (NGOs) both in India and abroad, mainly on the issue of R&R. There has been an adverse publicity regarding these projects, particularly relating to the problems in proper implementation of the resettlement and rehabilitation of PAPs. Considering the need for broad guidelines on R&R of PAPs to help the State/Project authorities in formulating their policies, the Government of India have formulated the draft National Policy for R&R of persons affected by reservoir projects.

The objective of R&R is that the oustees should enjoy a better quality of life at the place of resettlement than that enjoyed by them at the original habitat. For this purpose, master plans should be drawn based on the State/Project R&R Policy. In the absence of any such policy, the work of R&R should be carried out according to the norms adopted for other nearby projects.

There are many positive aspects noticed in the resettlement & rehabilitation of oustees. One such encouraging factor is the involvement of voluntary agencies or NGOs in this work in a constructive manner. In the Upper Krishna Project in Karnataka State, a reputed NGO, Maryada, was associated in preparing the Action Plan for the rehabilitation of PAPs. Similarly, in the Upper Indravati Project, in Orissa State, a voluntary agency viz. M/S Agragamy was entrusted with the work of preparation of rehabilitation master plan for the oustees. NGOs by adopting a constructive approach can play an important role in proper rehabilitation & resettlement of displaced persons.

17.2 Submergence of forest : Compensatory Afforestation

The country is reported to be losing forest cover at an alarming rate of 1.5 million ha per year. However, it needs to be stressed that the deforestation on account of water resources projects has been limited to only 4% of the total forest that has been lost during the last 3 decades. Against this loss the Water resources Projects have created biomass including tree crops & other plantations several times over the forest lost. Availability of electricity from hydro-power projects, in fact, checks demand of fuel & fire wood that greatly contribute to deforestation. Nevertheless, compensatory forestry has become an essential and integral part of all the new water resources projects. In several large projects like Narmada Sagar and Sardar Sarovar Projects, alternative lands for compensatory afforestation have been allocated and the cost of this has been included as part of the project cost. Considering the importance of forestry, the environmental safeguard pertaining to compensatory afforestation is next in importance only to rehabilitation.

The Department of Environment of the Government of India has issued detailed guidelines for the diversion of forest land for non-forest uses.

17.3 Water-logging

Water logging is generally projected as a major negative environmental impact of the water resources projects. Apprehensions have often been expressed that canal irrigation leads to severe water logging and soil salinity in the command areas of large number of projects. Water logging results from the excess moisture due to frequent flooding of the irrigated land, overflow of runoff, seepage from canal, over-irrigation, artesian water and impeded subsurface drainage conditions. Number of statistics are paraded in respect of water logging which are of questionable magnitude and relevance. Quite often the statistics that are cited are for the entire land area suffering from water logging and salinity without any separation of the area affected due to canal irrigation and due to other natural causes. In flat areas receiving high rainfall, lot of land is waterlogged during rainy season even without irrigation water. The Problem in this area is further aggravated by the construction of roads and railways with poor provision for cross drainage.

Water logging is not new to the Indian water resources planners. This was faced in some of the older projects like the Western Yamuna Canal and the Eastern Yamuna Canal. Western

Yamuna Canal which was constructed in the 14th century faced water logging problem as no checks were imposed on irrigation and due to inadequate cross drainage works. This canal was remodeled in 1873 and the alignment was improved and drainage works introduced. These measures resulted in significant improvements and reclaiming of land. The canal remains in service even today. Number of Acts were also enacted in the past for providing drainage and anti-water logging measures.

It is true that in the recent years, some of the projects faced water logging conditions but the area of land waterlogged is generally small as compared to the irrigated area. The percentage of waterlogged land has been found to vary from 1.5% of the benefited area in the various projects.

17.4 Sedimentation

Sediment flow in rivers is a natural process and water resources development projects do not contribute to increase in the sediment inflow in the rivers. Provision is kept in all reservoirs in the form of dead storage for trapping of sediments. It is a fact that in some of the projects constructed earlier the rate of inflow of sediments have been observed to be more than the anticipated values. This may be due to the empirical relationships used for assessment of the silt load in the absence of adequate observed silt data. Now, with the advent of modern technology and equipment, rate of siltation can be estimated more accurately. Further, remedial steps to reduce the sediment flow in rivers such as soil conservation and watershed treatment have been taken up in a number of catchment areas of various projects.

17.5 Flora and fauna

In case some unique or endangered species of flora and fauna are likely to be threatened by the project, suitable measures are required to be taken for their rehabilitation. Similarly, if the project interferes with wild life migration, suitable arrangements are to be made for their habitat.

In fact, protection of flora is a contentious issue. Merits and demerits of a reservoir with reference to loss of flora have been debated extensively but no standard solutions have been arrived at. An extremely rare step for environmental protection would be to abandon a project, if it endangers rare species of plants or animals, in order to preserve the natural heritage. However, as the project submerges only a small fraction of forest land, it is difficult to comprehend that the particular endangered species of plants or animals cannot be preserved in the vicinity of the project in the same watershed. Gene banks to preserve Species and to regenerate them in favorable conditions, elsewhere, is very much possible. Silent Valley project in Kerala, though a promising project planned to develop hydro-power, was shelved, as it was projected as affecting prime virgin forest with rare species of plants. The submergence of wildlife can be taken care of by relocating the sanctuaries at suitable places and by carrying out wild life rescue operations as was done at Dudhganga Reservoir (Maharashtra). The positive aspect of water resources development is the assured water supply for wild life in all the seasons. After construction of Heran reservoir in Gujrat, population of wild life has shown a trend of increase and crocodiles which were on verge of

extinction are now abundant in the reservoir. Periyar wild life sanctuary on fringes of Idukki lake and Sloth Bear Sanctuary proposed at Sardar Sarovar Project are some the examples of steps to protect the wild life. Pong reservoir is now acting as a resting place for migratory birds and number of rare species of birds have now been sighted in these areas. Water reservoir projects have in general enhanced the natural environment for development of flora & fauna in its vicinity.

17.6 Mineral Deposits and Historical Monuments

At times mineral deposits, archaeological monuments or shrines are threatened by submergence due to reservoirs. It is possible to protect the mineral wealth and monuments falling in the shoreline zones by constructing ring bunds etc. or even by exploiting the resources to the possible extent before inundation. Koteswar lime stone deposits likely to be submerged to some extent by the Bansagar lake (Madhya Pradesh) are being protected by providing a protecting bund around the quarries at a cost of about Rs. 180 million.

Due to the construction of Nagarjunasagar dam on the river Krishna in Andhra Pradesh, valuable historical monuments were to come under submergence. These were excavated well before impoundment and shifted to a museum on the top of a nearby hill coming within the reservoir. Similarly, Dargah at Galiakot which would have come under submergence of Kadana reservoir on the river Mahi in Gujarat, was protected from submergence by constructing a ring bund. Srisailem and Narayanpur reservoirs are other examples where historical monuments have been rehabilitated successfully. In Singur project of Andhra Pradesh, the Archaeological Department shifted the stone sculptures from different villages of submergence to a safe place.

17.7 Fish/Aquatic Life

One of the criticism leveled against the water resources projects is that dams pose barriers across the rivers to affect the migration of fish species like salmon and trout. The provision of fish ladders has successfully taken care of these problems in number of projects such as Farakka, Kosi and Hathnikund barrages. The reduction in the river fisheries can be compensated by rearing fish in the reservoirs. Many new species have taken firm hold in the newly created environment. The striking examples in this regard are fast growing gangetic carp in the reservoirs of Krishna and Cauvery in the peninsular India and in the Gobind Sagar in north west Himalayan region. Ukai project can be cited as an instance of improvement of fish production where no commercial fisheries existed in the river before impoundment. Now two fish farms with breeding, hatching and spawning units, artificially controlled climatic and physio-chemical conditions, have been established with encouraging results.

17.8 Health Aspects

Water related disease, such as Malaria, Typhoid, Diarrhea and Filariasis can be spread through unsanitary water or by presence of stagnant or slow moving water.

Surveys in selected irrigated commands also reveal that there is a general decline in incidence of diseases in these areas. Firstly, the very availability of water has led to improvement in level of sanitation. Secondly, the improved economic status has made people health conscious and capable of availing requisite health care. Vectoral risks can be substantially reduced by removing sources of stagnant or slow moving water and by ensuring continued maintenance of drains and canals and efficient water management.

17.9 Reservoir Induced Seismicity

It is often claimed that the impoundment of water in a large reservoir triggers earthquakes with their epicentres below or near reservoir. Koyna dam in Maharashtra is very often cited in this connection but there is no conclusive evidence about the correctness. The mighty reservoir like Bhakra and Ramganga, although located in earthquake prone areas did not influence seismicity since their impoundment. A study of 425 large dams in the world has shown that in case of 15 reservoirs only, the seismic forces were observed to have gone up after construction of reservoirs. In 10 of these 15 cases, the magnitude of earthquakes was less than 5 on Rkichter scale. There is thus a need for more data collection in this respect before conclusions can be drawn. In India, this is being done by India Meteriological Department, Central Water and Power Research Station at Pune and School of Earthquake Engineering, Roorkee, who continuously monitor the seismic status of the area around some reservoirs.

17.10 Water Quality

Integrated development of water resources invariably involves planning the projects for diverse uses. Therefore, the preservation of water quality becomes a very important factor in the planning of multipurpose water resources projects. For this purpose, pollution of the river courses from industrial and municipal effluents will have to be controlled. In the context of water quality, significant problem is eutrification which results from the excessive levels of nutrients in municipal, industrial and irrigation drainage effluents. Strong legal and administrative measures are required to ensure that the industrial and municipal wastewaters are treated to an acceptable standard before being discharged into the rivers. Emphasis has to shift to non-chemical organic fertilisers in irrigated agriculture.

17.11 Minimum Flows in the River

Dams create reservoirs to conserve flood flows for use during lean season. They also result in the drying up to the river down stream of the dam affecting river in ecology, pisciculture and human habitations. In a year of sub-normal rainfall there may be no releases at all from the dam which accentuates the problems. In all new dams low level outlets shall be provided to ensure minimum flows required for sustainable ecology. Such minimum flow may not be less than 10% of the virgin minimum flow of the river as a general policy. Efforts need to be made to provide such outlets in existing dams also if technically possible.

17.12 Impact on Climate

Water resources projects do have an impact on the climate in their vicinity. Irrigation increases the moisture content in the surrounding air, leading to a slight increase in the humidity but decrease in temperature due to evaporation from irrigated area. However, these impacts are not very significant.

17.13 Tourism and Sports

Development of gardens and recreation areas have taken place around many reservoirs making the environment more pleasant and providing recreational facilities to the people. Some examples are Brindavan Gardens (Krishnarajsagar) and Sant Dyaneswar Udyan (Jayakwadi). Government of Gujarat has developed area around Ukai reservoir as a tourist spot. Similarly, a nice garden has been developed around Ravisankar dam in Madhya Pradesh. The forests around reservoir created by Periyar dam is a very popular tourist spot where people can see varieties of wildlife while boating in the reservoir. Reservoirs can be developed into tourist attractions for skiing and fishing and to provide cheap and pleasant recreational facilities.

18. FUTURE PERSPECTIVES

The main challenge to the water resources development in the near future comes from environmental and social issues. Some important aspects are discussed here.

18.1 Large Vs Small Dams

An unsubstantiated argument is that submergence due to a single large reservoir is more than that which results from a number of small reservoirs created for the same storage. In a study of Jonk sub-basin of Mahanadi two alternatives were considered. The first alternative was Girina dam, with a storage of 603 m.m³. The second alternative was to reduce the storage at Girina to 185 m.m³ with eight other small dams to store the balance 418 m.m³. It was found that the second alternative was 150% costlier than the first, and also involved 60% more submergence.

Further, submerged area for major project generally varies from 2.87 to 10% of culturable command area, whereas for medium projects it varies from 10 to 25%.

To replace a single large dam irrigating 1,00,000 ha, 50 small dams each irrigating 2,000 ha. would be needed in either the upper or the lower reaches of a watershed. Such a large number of alternative sites is rarely available in practice, necessitating a curtailment in the envisaged development. Construction of dams in upper reaches submerges rich forest land. Construction of dams in lower reaches involves submergence of cultivated land.

Large volumes of water will be lost by evaporation in small reservoirs because of their relatively shallow depths compared to large reservoirs with significant water depths.

The adverse impacts associated with big dams are displacement of people, submergence of forests and cultivable lands, water logging, incidence of water borne diseases, etc. The benefits of large dams are designed to have carry over capacities and, therefore, they serve as insurance in cases of droughts. Further, the benefits such as pollution free hydropower and mitigation against floods are added attractions favouring big dams. At certain places, site conditions may not be favourable for constructing large dams. What is required is a discrete combination of large and small dams to maximise utilisation of waters in a basin.

18.2 Surface Vs. Ground Water

Though a large portion of the groundwater resources remain untapped, over-exploitation of the resources is a matter of concern in both rural and urban areas. Such over-exploitation needs to be regulated through legal provisions and their strict enforcement. A model Groundwater Bill has been formulated by the Ministry of Water Resources to help the State Governments in enacting suitable legislation for regulation and control of groundwater development in the country. The Central Groundwater Authority has also been constituted, consequent upon a Supreme Court Judgement, for the regulation of the exploitation of groundwater.

18.3 Legal Provisions

While the clearance to water resources projects is accorded by the Central Government, the implementation of the environmental safeguards rests with the State Governments. In many cases, due care is not taken by the project authorities in this regard. Although the Ministry of Environment and Forests has got the right to withdraw clearance in case of non-implementation of the safeguards, it is seldom resorted to.

18.4 Inter- Institutional Collaboration

At present the subject of "Water" is being dealt by many Ministries. While the Ministry of Water Resources is dealing with the multi-purpose, irrigation and flood management projects, the urban and rural water supply is being dealt by the Ministries of Urban Affairs & Employment and Rural Development respectively. The Ministry of Environment & Forests is dealing with the environmental and forest clearance of water resources projects. It is also implementing several schemes like the National River Conservation Plan, National Lake Conservation Plan, Conservation and Management of Wetlands etc. However, there is no effective co-ordinating agency with regard to these schemes and in many cases, one Ministry is not even aware of the work being done by the other Ministries. An empowered co-ordination mechanism needs to be set up immediately.

18.41 Possible areas of collaboration –Add min flows, CC & GHG emissions.

18.411 Role of NGOs

Until now, the Government has held exclusive responsibility for all decision making and management in the water sector. However, more and more NGOs are now getting associated with the sector. They can play an effective role in tackling various environmental issues like R&R of displaced persons, social forestry, catchment area treatment, watershed development, education and mass awareness, etc. Many NGOs have done commendable work in these areas. While Government should ensure effective involvement of NGOs, the latter, on their part should adopt a pragmatic approach.

18.412 Data Collection

Adequate data regarding the environmental impacts of various projects is unfortunately, not available at present. The available data has also not been documented properly. There is a need for systematic data collection on the environmental impacts, both beneficial and adverse, of completed water resources projects.

18.413 Research and Education

Research and development programmes are needed in order to reduce pollution of water bodies. Scientific and technical personnel should be encouraged to undertake specific research projects. There is a need to upgrade the technology so that water consumption is reduced without affecting productivity. This will also lead to reduction in wastewater quantity to be treated and the pollutants entering the water bodies.

A lot of research has already been taken up on environmental aspects by various institutes such as the Indira Gandhi Institute of Development Research, Bombay, Indian Institute of Public Administration, New Delhi, IITs etc. There is a need to co-ordinate all such work.

18.414 Role of Women

As 83% of the water resources are used for irrigated agriculture in which women play a major role, women have a significant role to play in "Water and Environment". There is a need to make the role of women more direct, visible and recognised. The role of women in sustainable development of water resources has also been highlighted in the modified National Water Policy.

18.415 Pollution Control

"Polluter pays" or "Polluter gets punished". The polluting agency should be made responsible to meet the costs of cleaning the polluted waters. Recycling and reuse of industrial and municipal wastewater after treatment would reduce pollution of water bodies.

18.416 Development of City Water Fronts

From time immemorial human civilizations thrived along water fronts. Majority of the population depends on the streams, rivers and lakes for fresh water supplies. But unfortunately, the same streams, rivers and lakes have also been convenient, inexpensive and apparently inexhaustible dumping areas for human and animal wastes and residues from industrial production. Sustaining the environment along water bodies calls for monitoring of the water quality. There is an urgent need for development of the city water fronts and lakes in an environmentally sustainable manner.

18.417 Some other concerns

A lot of concern is being shown about the environmental and social issues related to water resources development. While some of it is genuine most of it arises out of misinformation or exaggeration in reporting the impacts of water resources projects. Here a distinction would have to be made between the genuine and pseudo issues. No doubt the genuine issues have to be managed properly and effectively. Equally important is that the pseudo issues should be exposed by launching an awareness campaign.

The concern about the environmental issues is being expressed through the media and even through literature. Some of the major issues raised in this regard are as under:-

- a) Dam oustees –While expressing concern about the dam oustees, it is stated in a recent book that 40 million people in India have been displaced due to dams in the last fifty years. Considering that the population of the country has just crossed the one billion mark, it implies that out of every twenty five people in the country, one(in fact, even more than one) has been displaced due to dams. This is obviously unbelievable. Nevertheless, as per the broad assessment made by Central Water Commission, the indications are that the total affected persons may range between 6 to 7 million (This assesment is based on review of the relevant data of 2784 large dams in 14 states). Thus there is a need to make a realistic and accurate assessment of the dam oustees for which the states should provide the relevant data to Central Water Commission.
- b) Irrigation Efficiency – It is generally stated that the irrigation efficiency in India is around 35%. It implies that the irrigation efficiency in other countries is much more. However, according to a publication of USIS, " probably half of that amount (of water) is wasted before it reaches the intended crop....." Thus the efficiency of irrigation systems, worldwide, is around 50%. The discussion of the reasons for this low efficiency would be beyond the scope of

this paper . However, what is needed are steps for improvement of the irrigation efficiency rather than abandon the dams and projects.

c) Potential creation vs utilisation-

Another aspect inviting criticism of water resources projects is the low utilisation of irrigation potential already created. In this connection various steps are being taken for increasing the utilisation of the created potential under the Centrally sponsored Command Area Development Programme.

There is a need to take up detailed studies regarding various controversial impacts related to water resources projects so that things can be seen in the right perspective.

19 EPILOGUE

The water requirements of the country would continue to grow partly due to the rise in population and partly as a result of the improvement in the quality of life. As the developmental efforts to meet the water requirements take shape, simultaneously the environmental issues gain importance. Although less evident than the more obvious quantity related problems, these are critically important and need to be addressed to ensure sustainable development which is a formidable challenge, but one which can be accepted and negotiated successfully. However, what is more difficult to negotiate is the challenge posed by environmental activism, which if not contained may throw up remedies that may prove to be worse than the disease.

SCHEDULE**(Extracts)**

Project or Activity	Category with threshold limit	
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LIST OF PROJECTS OR ACTIVITIES REQUIRING PRIOR ENVIRONMENTAL CLEARANCE

1	Mining, extraction of natural resources and power generation (for a specified prod			
(1)	(2)	(3)	(4)	
1(a)	Mining of minerals	≥ 50 ha. of mining lease area Asbestos mining irrespective of mining area	<50 ha ≥ 5 ha .of mining lease area.	General Conditio <u>Note</u> Mineral prospec exempted provid previous clearan
1(b)	Offshore and onshore oil and gas exploration, development & production	All projects		<u>Note</u> Exploration Sur exempted provid previous clearanc
1(c)	River projects Valley	(i) ≥ 50 MW hydroelectric power generation; (ii) ≥ 10,000 ha. of culturable command area	(i) < 50 MW ≥ 25 MW hydroelectric power generation; (ii) < 10,000 ha. of culturable command area	General Condition
1(d)	Thermal Power Plants	≥ 500 MW (coal/lignite/naphta & gas based); ≥ 50 MW (Pet coke diesel and all other fuels -)	< 500 MW (coal/lignite/naptha & gas based); <50 MW ≥ 5MW (Pet coke ,diesel and all other fuels)	General Condition

