ENVIRONMENTAL CONCERNS OF WATER RESOURCES PROJECTS – AN OVERVIEW

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Abstract *India has to support 15% of the world's population with only 2% of world's land and only 4% of the world's water supply. Preserving the quality and the availability of the freshwater resources is the most pressing of the many environmental challenges on the national horizon. Due to the large temporal variations in river flows in India, storage of water becomes inevitable. This articles highlights the adverse and beneficial environmental impacts of water resources projects in India citing numerous Indian examples. The assessment procedures and management practices have also been briefly included.*

INTRODUCTION

Water is central to human existence. A world without water is unthinkable. Its myriad uses are well known. But just as its abundance and efficient management enhance quality of life, its scarcity and wasteful use impact acutely on humanity. Water scarcity affects adversely on health, availability of food, and the conditions in which people live. The poor are particularly vulnerable when water is either unclean or in short supply.

Integrated water management is most vital for poverty reduction, environmental sustenance and sustainable economic development in India because water has the potential for both disease causation and prevention. While water is the medium for the transmission of water borne diseases; water is also a primary contributor to the control of infectious diseases through its use for personal and domestic hygiene. Availability of water in India is under tremendous stress due to growing population, rapid urbanization, increase in per-capita consumption, industrial growth and other demands for maintaining ecology. Due to the large temporal variations in river flows in India, storage of water becomes inevitable. The environmental impacts of water resources projects may be classified as beneficial or adverse. This paper presents some important facts about beneficial and adverse environmental impacts of water resources projects.

ADVERSE ENVIRONMENTAL IMPACTS

Rehabilitation and Resettlement

The crucial problem is that of physical and psychological suffering of the displaced people from the submerged area of reservoirs. There are full efforts for provisions for more liberal compensation, amenities, land and employment for the

displaced population while constructing river valley projects. Some projects have been shelved on this account alone. There is a strong need to formulate a strong monitoring group for dealing with rehabilitation of project affected persons. Many people argue that the tribal people should not be displaced at all, as they cannot live in different environment. This approach is not always correct specially when it results in perpetuation of their backwardness for times to come. No efforts should be spared to expedite the process of improving their lot. Experience in the North-Eastern region indicates that the tribal people definitely want water storage projects for bringing in overall economic prosperity to them. Awareness and persuasive approach are needed to tackle this problem. At the same time the rehabilitation packages with scope for more than one option should be made more attractive so that project affected people are induced to accept them.

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

There are many positive aspects noticed in the resettlement and 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.

Deforestation

It is said that large dams result in deforestation which is unavoidable in areas to be submerged under water; it would, however, be erroneous to regard Water Resources Development (WRD) Projects, as a major cause for deforestation. Even if all the dams in Ganges basin are constructed, the submerged areas of forest will be less than 2%. Similarly, the forest area submerged in Madhya Pradesh would not exceed 2% by construction of all the identified dams. In this connection it may also be noted that the supply of cheap electricity generated by hydro-projects would tend to reduce deforestation. Much of the greenery and the improved land cover that one notices in the developed countries is on account of effective restrictions placed on the free grazing by livestock particularly sheep and goats. There are obvious natural limitations on the cattle population that can be sustained on pastures and grass area in a given region.

It needs to be stressed that the deforestation on account of water resources projects has been limited to only 4% of the total forest area that has been lost during

the last 3 decades. Against this loss, the Water resources Projects have created biomass including tree crops and other plantations several times over the forest cover area lost. Availability of electricity from hydropower projects, in fact, checks demand of fuel and fire wood that greatly contributes 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 Sarover Projects, alternative lands for compensatory afforestation have been allocated and the cost of this has been included as part of the project cost.

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 made for siltation of reservoirs while planning the projects. It is a fact 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 in earlier projects. 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 the rivers such as soil conservation and watershed treatment have been taken up in a number of catchment areas of various projects.

If water resources projects are not built, silt gets transported unchecked and gets deposited towards the sea thereby gradually flattering the slopes of river in their lower reaches with a consequent tendency to diminish their flood discharging capacity. This, in turn, results in frequent and severe flooding of the lower aliuvial tracts. Reservoirs positively control both silt and flood. Several fears have been voiced regarding silting of the Indian reservoirs due to increased of sediment flow in the river. Siltation is a natural process and can be reduced but cannot be eliminated. The reservoirs by themselves have not accelerated the rate of silting. Due to very steep gradients in Himalayan rivers, the run of river and small dams get choked due to boulders as well as coarse sediments. On this account the high dams keeping exclusive provisions for dead storage have an advantage. For example, the Maneri Dam on Bhagirathi (39 m high) and Ichwari Dam (60 m high) on the River Tons–Yamuna were designed and filled up to crest by sediments during construction. The storage space for sediment is determined while computing the life of reservoirs, say 50 or 75 or 100 years on the basis of standard reservoir types ranging from lake to gorge. Sediment distribution is assessed to determine new zero elevations for positioning of the outlets for withdrawal of water for various uses. The statements on increased sedimentation in earlier constructed Indian reservoirs should be understood with the precaution that sedimentation rates in those design were based largely on assumptions and thumb rules in the absence of field observations. It is to be realised that the rate of sedimentation decreases with the age of the project and becomes asymptotic. Moreover soil conservation works, watershed treatment and afforestation are being undertaken in the catchments to reduce the sediment flow.

If sub-watershed in the Direct Draining Areas along the rim of the reservoir has very high category erodable areas, such areas need to be treated to reduce direct silt inflow into the reservoir and to improve the environment in the vicinity of the reservoir. Geographical diversity precludes precise definition of such watersheds and standardised package for their treatment. Such area and their treatment will necessarily be project specific. It is to be underlined that catchment area treatment and watershed management are development projects in their own right and should be planned and executed as such independently without putting undue financial burden on WRD projects. At best, treatment of only directly draining degraded sub-watersheds –watersheds up to 2500 ha, along the reservoir rim could be charged to the project cost.

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 to be taken for their rehabilitation. Similarly, if the project interferes with wild life migration, suitable arrangements are made for their habitat. In fact, protection of flora is a contentious issue. An extremely rare step for environmental protection would be to abandon a project, if it endangers rare species of plants or animals, in orer 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 favourable conditions, elsewhere, should be possible. Silent Valley project in Kerala, though a promising project planned to develop hydropower, was shelved, as it was projected as affecting prime virgin forest with rare species of plants. On a positive side Heran reservoir in Gujarat, which provided assured water enough for wild life, has actually helped in population growth of wild life and crocodiles which were on verge of extinction. 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 and fauna in its vicinity.

Mineral Deposits and Archaeological Heritage

At times mineral deposits, archaeological monuments or shrines are threatened by submergence due to reservoirs. Mineral wealth can be exploited to the possible extent before inundation. It is also possible to protect the mineral wealth and monuments falling in the shoreline zones by constructing ring bunds etc. Sometimes historical and cultural monuments may fall in the submerged area of a reservoir. The temple of Abu sibel in Egypt and the Nagarjunkonda in India are living examples of how ancient monuments have been saved and given a greater lease of life. Many temples have been successfully shifted with religious fervour in the Bargi, Srisailam and Sardar Sarovar projects. The Jyotirling temple has been preserved in the planning of the Omkareshwar Dam and improvement in the

approach roads and bridges would also be a part of the integrated project itself. 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. Srisailam, Narayanpur and Almatti reservoirs are shining examples of successful rehabilitation of historical monuments.

Seismic Impacts

International Symposium on "Earthquake and Dams" held in May, 1987 in China had concluded that "Dams designed by modern techniques and built according to the latest specifications have considerable reserve strength to resists severe earthquakes". They have been shown to resist earthquakes well as compared to other manmade structures. The World's highest Dam is NURECK of Russia which is a 305 m high earthen Dam. This dam is situated in a highly seismic region but has safely withstood a very high seismic shock of intensity over 7 on the Richter scale. There are thousands of dams in the world of over 150 m height but there is hardly any damaged to them due to earthquakes. It has been scientifically established that the dams using modern methods of design and construction can safely withstand high intensity earthquakes, while small dams not using such techniques can be damaged even with earthquakes of quite a low intensity.

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 its correctness. The mighty reservoir like Bhakra and Ramganga, although located in earthquake prone areas did shown that in case of 15 reservoirs only, the seismic forces were observed to have gone up than 5 on Richter scale. It is also a hypothesis that impounding of water in large reservoirs induces seismicity (RIC). There is however little proof of this hypothesis. The failure of large dams due to earthquake is only a fear, which is unnecessarily being projected manifold. Any way, RIS can never be larger than the magnitude of seismicity due to tectonic activities. India Meteorological Department, Central Water and Power Research Station at Pune and Dept. of Earthquake Engineering at IIT Roorkee, are continuously monitoring the seismic status of the area around selected reservoirs. National Committee on Dam (NCDS) and National committee on Seismic Design Parameters (NCSDP) for River Valley Projects continuously review and update the standards and procedures to ensure earthquake resistance and hydrologically safe construction of large dams.

Migration of Fish Species

One of the criticisms levelled against the water resources projects is that dams pose barriers across the rivers which 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 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 Kaveri 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 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 in this project area with encouraging results.

Water-logging and salinity

The growth of irrigation may subject certain tracts of lands to water logging, increased soil salinity and alkalinity. Water-logging can be easily avoided, except for chronic areas due to other topographical reasons, by providing adequate drainage measures right in the beginning of the irrigation project. The change in water table/salinity should also be closely monitored to check any adverse effect on crops and preventive/remedial measures taken. In waterlogged areas, the conjunctive use of surface and ground water, reduction of water allowance and bio-drainage could be useful. Drainage should be integral part of any irrigation project.

To identify the problem areas affected by waterlogging, salinity/alkalinity in existing irrigation projects, to undertake prioritisation of the problem areas for suggesting suitable remedial measures and also to suggest priorities in future plan allocations, a Working Group under MoWR was set up. The Working Group in their report of Dec.1991 have estimated the areas affected by waterlogging, soil salinity and alkalinity in various irrigated commands to be in the order of 2.46 mha, 3.06 mha and 0.24 mha, respectively.

Appreciable seepage from canal, obstruction in the natural/existing drainage system on account of developmental activities, inadequate support for maintenance, absence of realistic operational plan especially during the initial stages of cnstruction leading to over irrigation in the irrigation projects etc. has gradually led to the change in the ground water table resulting in waterlogging, salinity/alkalinity in a few command areas of irrigation projects. State authorities have been taking up necessary measures for controlling the drainage problems depending on their nature, extent and magnitude. Lining of canals, the surface drainage and sub-surface drainage are most widely employed interventions for relieving drainage problems. In some of the projects like Tawa Irrigation Project in Madhya Pradesh, adopted measures have tremendously removed earlier water logging.

Minimizing Adverse Environmental Impacts

In order to assess the likely changes in the environmental conditions due to taking up of the projects, it is already mandatory to carry out environmental impacts study and submission of Environmental Impacts Assessment (EIA) statement and Environmental Management Plan to obtain environment and forests clearness for the projects. EIA is a formal process to predict environmental consequences of development activity and to plan appropriate measures to eliminate adverse effect and augment the positive effects. It is advisable that environmental concerns should not be treated as an imposition from outside. It is essential that while carrying out

EIA, both adverse and beneficial aspects should be objectively evaluated, rather than the present system of suppressing/neglecting beneficial socio-environmental impacts of river valley projects.

Reservoirs create new conditions for the growth of organisms, and ultimately, as adjustments are made, faster grow new eco-systems. Some of the flooded organisms are also tolerant to inundation. Some new organisms emerge in the new eco-lake systems that may thrive leading to changes in land use pattern. Additional water is made available for the dry period of the year, when the environment earlier tended to be harsh, and make the area hospitable and supportive to the growth of life around, after construction of dams. These intangible benefits need to be accounted for in EIA.

POSITIVE ENVIRONMENTAL IMPACTS OF RIVER VALLEY PROJECTS

Health aspects

Almost half of the world's population suffers from diseases associated with insufficient or contaminated water. Safe water supplies and environmental sanitation are vital for health. Important water borne disease are hepatitis-A, cholera, typhoid, polio, diarrhoeal disease and amoebiasis. Important water associated diseases include malaria, filaris, dengu, polio myelitis, heiminthic and infectious hepatitis. Degradation of water quality from industrial and domestic pollution is another major cause of environment related illness. Release by industry of untreated toxic organic and inorganic waste water pollution into water courses is a widespread problem.

Water resources projects provide a dependable source of drinking water. People from the irrigated areas may therefore, enjoy better health and sanitation facilities, thus reducing the incidence of disease. A survey revealed that the Mula Irrigation Project had a substantial positive impact on the incidence of illness, leading to a significant reduction in sick days. With the Indira Gandhi Nehar Project, the percentage of the reported relative incidence of waterborne diseases to all diseases dropped considerably over 12 years in the areas that received continuous irrigation facilities. The increased incidence of malaria in some areas after irrigation may also occur in relatively wet areas. In contrast, health position in dry areas would improve due to the construction of WRD Projects. General decline in incidence of disease has been reported from some of the selected irrigation commands. It should be noted that the very availability of water leads to improvement in the level of sanitation. The improved economic status also makes people health conscious and capable of availing of requisite health care. The development of area due to irrigation also make available health care units, nearer to irrigated areas. This can be verified from development of villages in Punjab, Haryana and Western UP where many facilities, particularly 'Health Care Units' have become available in villages, along with other facilities like roads, electricity etc., particularly so, in irrigated areas.

Tourism and Recreation

Recreational facilities like boating, rowing and other facilities for water sports may be created in the river valley projects. Water resources projects lead to social and cultural improvements. Development of gardens and recreation areas have taken place around many reservoirs making the environment more pleasant and providing recreational facilities to the people. The gardens developed in water resources projects like Brindavan garden, Ukai garden, Ramanga garden, Kalindi Kunj, Dhyaneswar Udyan, Jaikwadi Garden, Matalila Garden, Pinjore Gardon; Bhakra garden, Mata Tila garden, Nagarjunasagar garden and Bagalkot New Township garden are great tourist attractions in India. Forests around reservoir created by Periyar dam are a very popular tourist spot to watch varieties of wildlife, while boating in the reservoir. Large reservoirs thus provide additional benefits; as these can be economically developed into tourist attractions for water skiing, fishing and recreational facilities.

Climatic changes

Moderate changes take place in temperature and humidity due to reservoir which are mostly beneficial. For example, the earlier prevailing intense heat in Punjab, Haryana and UP had subsided after construction of related reservoirs. In arid zones, evaporation from reservoir is high. If there is no wind, high temperature drops during the night and cools the large evaporated water mass, which creates fog on the lake perimeter. This causes mild changes in temperature. Changes in the micro-climate are sometimes beneficial in cold areas. Impact of additional evaporation due to creation of reservoir on the water cycle of the atmosphere, will be too small to effect any appreciable change in the precipitation. More scientific studies and research are needed to study climatic changes due to reservoirs in India.

Improvement in wildlife

Case Study for Ramganga Dam Project clearly shows that there has been substantial increase in the numbers of tigers, panthers, elephants, cheetals, crocodiles and ghariyals as per counting by Wildlife Preservation Organisation of UP Forest Deptt., in the famous National Corbett Park. Such increase has been due to continuous availability of green fodder, plentiful availability of clean water throughout the year and environmental security among animals and improved climatic conditions, after construction of the 127.5 m. high Ramganga Multipurpose Dam Project, even though 55 sq.km. of the Corbett Park has been either submerged or affected by this reservoir. It is also found that rare species of birds flock in and around Ramganga reservoir. This phenomenon of an increase in birds and wildlife has also been observed around Pong, Bhakra, Pandoh, Rihand and Matatila reservoirs. Some of the best tourist places of India like Ukai tourist resort, Periyar wild life sanctuary, Shalimar Garden, Brindavan Garden, Pinjore Garden, Kalindi-Kunj, Matatila Garden, Gyaneshwar Udyan, New Bagalkot Town Garden, Ramganga Udyan are some of the highly beneficial impacts of water resources

projects. Significant increase has also been reported in number of species of wild animals and aquatic life after construction of these water resources projects.

Multiplier Socio-economic Benefits

Large infrastuctural facilities including bridges, metalled roads, telecommunication and postal services, large scale employment opportunities, soil conservation and afforestation in very large areas, and assured power and water for agricultural and industrial purposes have resulted in tremendous direct and indirect socio-economic benefits, due to the multiplier chain effect of benefits by most of the water resources projects. Remganga, Pandoh, Pong, Bhakra, Hirakud and Beas dams, and Indira Gandhi Canal Project are shining examples in this regard. The headquarters of Ramganga Project, Kalagarh was being seriously considered for siting the capital of new Uttranchal State due to availability of all facilities and infrastucture by construction of this project.

COMPLEXITIES OF ENVIRONMENTAL IMPACTS

Following complexities should be kept in mind while discussing, assessing and managing environmental impacts of water resources projects:

(a) It is as important to identify the contributions of favourable environmental effects of a project, as it is to identify the negative ones and the constraints they may impose. Sometimes the same physical component may produce both benefits as well as some adverse impacts. For example, the creation of a dam may block a fish migration route. Thereby reducing fish stock and catch, at the same time, it may create a potential lake fishery as well as recreational benefits.

(b) Most of environmental impacts in water resources projects are interconnected. People displaced from the inundated area of the reservoir, or those whose movement is facilitated by the reservoir and dam construction activities, may move upstream into the watershed. Use of forests and cultivation by them may create additional erosion, leading to increased sedimentation in the present and future reservoirs thereby reducing storage capacity. Sediment, in turn, affects water quality, and may reduce the capacity for power generation, and provision of water supplied and other intended benefits for irrigation and water supply users.

(c) In general, the characteristics of water releases from the dam affect such factors as downstream river flow, stream-bed configuration, water quality, and associated cultivation. The dam can also affect conditions elsewhere in the river basin through changes in subsurface water levels, resettlement of displaced people, and land use patterns.

(d) As a major investment, a dam may have impact on regional development and induce growth of new population centres and industrial activity. The cumulative effects of such projects any be substantially different from the effect of individual projects. Consequently, consideration must also be given to other

projects, those under development in the basin, or those induced as a result of a particular project. It is to be noted that the combined adverse impacts of large number of small and medium projects in river basin may be many times more serious compared to a large projects.

(e) It is to be highlighted that poverty and low productivity levels in dryland areas themselves have tremendous social costs. Acute scarcity of water in these areas add on to the social and economic problem of the inhabitants.

(f) Well planned transfer of surface water can be a great boon in providing drinking water, removing or reducing water-brone diseases, raising agricultural productivity of the region and improving ecology.

(g) The design of development has to augment the sustaining capability of the environment and provide for a more active interaction between man, technology and available land and eco-resources.

(h) Water is essential to solve the social and economic problems of the inhabitants. Well planned transfer of surface water may be a boon by way of provision of drinking water, reduction in water borne diseases, increase in agricultural productivity of the region, availability of power to reduce deforestation and variety of benefits and improved ecology.

(i) Water resources project may really not induce significant adverse environmental impacts (for example Ramganga Project). Whether these exist or not, must be determined through the environmental impact assessment (EIA) at different stages of the project, considering both the positive and negative socio-environmental impacts.

(j) The effect of "induced growth" in an area, once it starts to get industrialized , is not easy to predict quantitatively; but this has a greater socio-economic effect in the long run through multiplier chain concept of benefits of river valley projects than many other items.

It is unfortunate that most of the NGOs and persons associated with environmental activism, in India, have neglected above complex aspects and 'does-response functions' of multi-disciplinary complicated environmental impacts, while creating abnormal time and cost overruns by blocking the progress of large number of highly beneficial river valley projects. It is desirable that environmental aspects and the process of planning and operation of water resources projects are rightly taught at different levels of education as well as to the experts of different disciplines. Another important fact remains that participation of people is a must in the management system. The community is to be made not only water conscious, but also to be integrated to participate in the planning and management of such projects.

The services of professional Societies like Indian Water Resources Society, The Institution of Engineers (India), Indian National Science Academy, Indian Water Works Association, Indian Association of Hydrologists, Indian Society of Hydraulics, Water Management Forum and Association of Hydrologists of India having vast network, good spread and pool of expertise, which may be channelised in debating, dissemination and documentation of reports and creating balanced scientific public awareness.

LEGAL FRAMEWORK AND ENVIRONMENT ACTS

In order to ensure sustainable development of water resources, Government of India have also 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 (CGWA).

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, 1997, both Central and State Governments have to provide funds to the Boards for implementing this act. The Forest Conservation Act, 1980 provides for compensatory afforestration to make up for the diversion of forest land to non-forest use.

The Environment (Protection) Act, 1986 was enacted for the protection and improvement of human environment. The EIA Notification of 1994 has made the environmental clearance mandatory for all the new projects as well as for expansion/modernisation of existing projects covering 29 disciplines including hydropower, major irrigation and flood control projects. Amended Notification of 1997 has made it mandatory to hold environmental public hearing before according environmental clearance to the listed category of projects.

ASSESSMENT AND MANAGEMENT OF ENVIRONMENTAL IMPACTS

Proper mechanism did not exist up to 1978, for assessing the environmental impacts of the river valley projects in India. CWC and Planning Commission had indicated broad guidelines for the preparation of Detailed Project Report and clearance of the Projects. Department of Environment and Forests (DoEF) prepared in 1978 guidelines for EIA of river valley projects. It was aimed in these guidelines that each river valley project should be subjected to rigorous assessment of their environment impacts so that necessary mitigative measures could be incorporated in the project right at its inception stage. These guidelines for site selection as well as incorporation of mitigative measures were prepared and circulated among the project authorities through the Planning Commission.

Later, in 1980, the Forest Conservation Act was passed by Indian Parliament. Under this Act all the proposed river valley projects are needed to be cleared by MoEF, before commencement of construction, in case any submergence or deforestation of forest land is involved. MoEF circulated a list of the type of data and basic information on the environmental impact studies in January 1985, along-with the guidelines for EIA of River Valley Projects.

Central Water Commission has published, "Detailed Guidelines for Sustainable Water Resources Development and Management", in September 1992, to meet the Indian requirement for data collection and analysis, impacts assessment and preparation of management plans. Together with EIA for water resources projects, Environmental Management Plan (EMP) is also essential to ensure sustainable development. Special attention has to be given for rehabilitation and resettlement of affected persons, compensatory afforestation and catchment area treatment of directly draining degraded areas. In the environment impact assessment, following types of information are required:

- A summary of positive and negative environmental impacts,
- Analysis of the economic implications of the impacts if these are quantified, and
- Qualitative statements on un-quantifiable impacts.

Recently, four prestigious publications have been brought out (Goel, 2000a; Goel, 2000b; Goel and Srivastava, 2000; Prasad and Goel, 2000), each containing over 30 state of art like articles on well focused subjects. The articles edited and compiled in the these publications were invited from eminent experts, chief executives of water and power development agencies, academicians, researchers, apex professional institutions and credible NGOs. The guidelines provided in these publications have been prepared for the study and management of environment impacts in various river valley projects to achieve rapid economic development on a sustained basis, with due care for safeguarding the environment. Sustainable development considers an equitable balance between the two prime goals of higher levels of economic development as well as environmental quality. It is with this objective that proper management plans are prepared for ensuring sustainable development.

ENVIRONMENTAL SAFEGUARDS

Minutes of meetings of Environmental Appraisal Committee bring out the nature and extent of scrutiny carried out by MOEF and the main observations, recommendations, etc. with regard to the environmental safeguards. Commonly suggested safeguards are summarised below:

- Drawing up and implementation of master plan for relief and resettlement
- Necessary arrangement for the supply of fuel wood for construction
- Restoration of land in the construction area
- Compensatory afforestation
- Identification of highly eroded areas in the catchment
- Catchment area treatment at project cost in directly draining degraded sub-watersheds
- Mechanism for free movements of fish

- Preparation of report on command area development
- Covering of river banks with a 10 m wide green belt
- Provision of drainage system in the irrigated areas
- Measures for prevention of endemic health problems
- Setting up of monitoring system for implementation of the suggested safeguards
- Alternatives in case of adverse effects on flora and fauna etc.

ENVIRONMENTAL MONITORING

Government of India has made it obligatory to get environmental clearance for all major irrigation, multipurpose and flood control projects from the Union Ministry of Environment and Forests (MoEF). The project is considered by the Environmental Appraisal Committee (EAC) from the environmental angle, stipulating certain environmental safeguards to be implemented along with the construction of the project.

Accordingly, three tier inter-disciplinary Environmental Monitoring Committees for River Valley Projects at National, States and Projects levels (NEMCRVP, SEMCs and PEMCs) were constituted, as per the decision of Union Ministry of Water Resources (MoWR) taken in 1990. These committees have been constituted for overseeing and ensuring the implementation of environmental safeguards, stipulated by MoEF in granting the environmental and forest clearances of multipurpose river valley, irrigation, flood control and hydropower projects. NEMCVRP is presently monitoring 85 river valley projects, geographically well distributed all over the country. Representatives of the Planning Commission and Union Ministries of Agriculture and Cooperation, Environment and Forests, Tribal Development, Water Resources and CWC regularly visit and participate in the meetings of NEMCRVP.

CONCLUSION

It is thus evident that the benefits accrued from large river valley projects are so immense that they substantially outweigh the costs of immediate human and environmental disruptions. On the other hand, long-term adverse effects of not utilising the water resources would be catastrophic, due to recurrence of floods, droughts and the resulting unemployment, which further increases the backwardness in highly populated developing countries like India. Prevailing controversy of the large versus small dams is highly unfortunate and irrelevant. Due to the large temporal variations in river flows, storage of water becomes inevitable. The recent Supreme Court Majority Judgement for Narmada Projects has also highlighted that against the utilisable storage of 690 cu.km. of surface water resources out of 1869 cu.km., so far storage capacity of all dams in India is only 174 cu.km., which is incidently less than the capacity of Kariba Dam in Zambia/Zimbabwe with capacity

of 180.6 cu.km. and only 12 cu.km. more than the Aswan High Dam of Egypt. The impact on environment should be seen in relation to the project as a whole.

In the planning, implementation and operation of projects, preservation of quality of environment and the ecological balance are primary considerations. Adverse impacts, if any, on the environment are minimised and off-set by adequate compensatory measures with built in mechanism for emergency preparedness. The focus by large number of critics, media and environmental activists as it is construed at present, concentrates on what it is not, and then tries to ameliorate the negative impacts. Maximisation of positive environmental impacts should be an equally important consideration.

Note: The views expressed in the paper are those of the author and not of the author's organisation.

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