CASE STUDY - ENVIRONMENTAL EVALUATION OF SALANDI WATER RESOURCES PROJECT, ORISSA

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ABSTRACT

During the past two decades efforts are being made for protecting the environment while implementing the river valley projects by insisting on formulation of a suitable Environmental Management Plan (EMP) after undertaking a detailed Environmental Impact Assessment (EIA) study before construction of the project. While formulating irrigation development projects, the Government of India has initiated suitable measures for implementation of the EMP as well as Resettlement and Rehabilitation (R&R) Plan. It is now essential to evaluate the implementation of the EMP in the completed project areas to assess the level of Environmental Impact and R&R and also to make suggestions for furthering the environmental improvement through suitable EMP redesigned for the project.

The basic objective of the study is to assess the environmental changes that have been occurred during construction and post construction phases of the project after a detailed review of the implementation of the Environmental Management Plan (EMP) leading to formulation of a redesigned EMP for the project. In light of the above, the present evaluation comprises the study of impact of the project on Resettlement and Rehabilitation, socio-economic status, agriculture, irrigation and drainage, bio-diversity, land environment, public health, water environment including groundwater, etc.

The paper deals with a case study on Environment Evaluation of SALANDI WATER RESOURCES PROJECT, Orissa.

1.0 OBJECTIVES OF STUDY

The objectives of the study is to assess:

i) The post impact due to the irrigation project compared with the pre-project situation on land environment including changes in cropping pattern.
ii) The impact of the project on water environment in the present scenario on surface and groundwater.
iii) The impacts on biological environment including forest area comprising of flora, fauna, aquatic life, endangered species, migratory birds etc when compared to the situation prevailed in the pre-project stage
iv) The public health hazards during pre and post project conditions including drinking water supplies, health status, health services, etc.
v) The impacts on agriculture such as changes in cropping pattern, cropping intensity, improvements in agricultural production, etc.
vi) The impacts on drainage including identification of waterlogged and saline areas.
vii) The impacts on socio-economic conditions such as changes in literacy, employment, improvements in quality of livestock and poultry, development of industries.
viii) Effects of rehabilitation including amenities, infrastructure facilities, sanitation status, and living standards compared to the pre-project baseline.

2.0 INTRODUCTION

Salandi river is a main tributary of Baitarani river basin in the state of Orissa. It originates from the Meghasani Hills of the Similipal pass in Keonjhar district. It is 144km long and has a catchment area of 1793 km². Droughts are not uncommon in the Salandi river sub basin. In the year 1949 the areas affected were Bonth, Basudevpur, Simulia, Soro and Khaira Blocks in Bhadrak sub division only affecting an area of 81,000 ha.
The Salandi Water Resources Project was envisaged in 1960 and was completed in 1982.The Dam on Salandi River is located near Hadgarh village in Keonjhar District of Orissa State which is 48 km north-west of Bhadrak

and is connected by road. The geographical location of the project is at a latitude of $21^{0}17^{1}$ North and longitude of $86^{0}18^{1}$ East. The dam site is about 200 km from Bhubaneswar, the state capital of Orissa. The dam was constructed with a view to release about 5.66 cumec of water to flow down the reservoir to the areas under cultivation in down stream reaches to protect the lower riparian rights. Initially the project also aims to irrigate an area of 45730 ha on the left side of the river and 55444 ha on the right side of the river including the areas under cultivation at that time. But, a later stage reduced the command area duly restricting it to left side of the river only. The project also envisages to release quantum of water for the command area from the dam into Salandi River which is picked up by "Bidyadharpur Barrage" constructed at 6.5 kms down stream of the river with canal network formed on both sides.

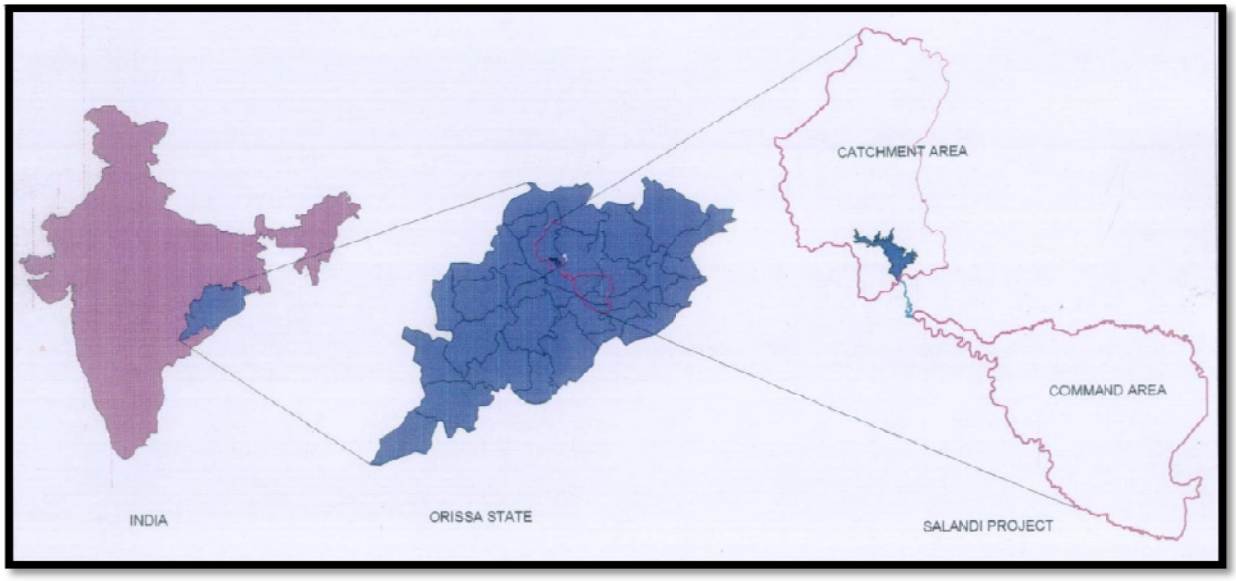

Figure 1 – Location Map

3.0 METHODOLOGY

The comprehensive study is made duly comparing with the baseline data i.e., prior to the construction or during the construction of the project. The baseline data has been collected to the extent of availability from the various departments of the Government of Orissa. The following environmental components are considered for the Impact assessment.

Sl. No.	*Component*	*Monitoring and Evaluation Indicators*
1	Effects of Rehabilitation	a) Details of rehabilitation sites where rehabilitation has been carried out.
		b) Actual photographs of rehabilitation sites and houses and details thereof.
		c) Environment and sanitation status.
		d) Details of amenities and infrastructure facilities provided to the rehabilitated families.
		e) Progress of economic rehabilitation programmes.
		f) Details of the occupational training programmes conducted for project affected persons.
		g) Details about health status and health services provided in the project area.
		h) Response of the oustees to the process of rehabilitation and constraints.
		i) Status and living standards of the oustees at new location.
2	Socio-Economic Impacts	a) Detail status of schools / teaching staff, student turnover.

Sl. No.	*Component*	*Monitoring and Evaluation Indicators*
		b) Improvement in male - female literacy, evaluation of adult education programmes, provided if any.
		c) Response to education provisions and assessment of constraints.
		d) List of post project occupational options that have arisen in the region and also make a statement what occupations are attributable to project benefits.
		e) List all the new educational , cultural, recreational and commercial (markets, banks, etc.) institutions accessed that have come up in the post project situation and state how much of it is attributable to the project.
		f) Compare the incidence of some important diseases in post and pre project situations.
		g) Compare the health care infrastructure in the post and pre project situation.
		h) Compare the Human Development Index (to the extent that the data is available) in the post and pre project situations.
3	Effects on Agriculture	a) Improvement in Production.
		b) Changes in Cropping Pattern and improvement in cropping intensity due to the project on agricultural / horticulture / animal husbandry.
		c) Improvement in quality of livestock and poultry.
		d) Assess agriculture cooperative and agriculture finance programmes if initiated.
		e) Details of the steps taken to prevent contamination of ground and surface water due to fertilisers, pesticides, runoff, etc.
		f) Development of industry in command area.
		g) Development in the command area.
4	Impact on Groundwater	a) Quality and quantity of groundwater.
		b) Changes in groundwater table in recharge zones.
5	Impact on archaeological monuments	a) List of the archeological monuments and places of worship that are restored as part of EMP, record their status and enlist reasons.
		b) List new places of worship and monuments that have come up during the post project period
		c) List the new recreational opportunities that have come up in post project situations.
		d) List the pre-project and post project status of economically important minerals and the means and activities of harnessing the same.
6	Impact on Forests, Flora, Fauna and Aquatic Life	a) Assess changes in the forest cover, forest types.
		b) Assessment of change in Importance Value Index (IVI) & Shannon-Wiener diversity index.
		c) Assess effectiveness of forestry programmes, contribution to sustaining local population needs (in eco development perspective).
		d) Contribution to economic activities related to medicinal plants in sustaining livelihoods of local population, if any.
		e) Status of endemic and endangered species, and evaluation of conservation programmes , if any.
		f) List terrestrial, avi and aquatic fauna.
		g) Assess changes in terrestrial fauna and their migratory patterns, if any.
		h) Assess changes in avi fauna and their migratory patterns, if any.

Sl. No.	*Component*	*Monitoring and Evaluation Indicators*
		i) Assess affectivity of wildlife conservation programmes, pisci-culture development programmes, and other activities contributing to sustaining local population livelihoods.
7	Impacts on public health, drinking water and Communication	a) Study the occurrences of diseases such as, typhoid, diarrhea, malaria, jaundice and other water borne & water related diseases in pre and post project implementation scenario.
		b) Ascertain impacts due to reservoir impoundment, water logging and spread of such diseases, if any.
		c) Improvements in water supply provisions in pre and post implementation scenario.
		d) Improvements in communication and transportation facilities in post implementation scenario.
8	Land Use and Land Cover	a)Using image processing carry out land use / land cover classification and map on GIS.
		b) Using overlays identify new development triggering land use changes.

4.0 RESULTS AND DISCUSSIONS

4.1 Effects of Rehabilitation

The rehabilitation and resettlement for Salandi Irrigation Project was undertaken between the year 1965 to 1972. The Salandi Project was the first project in the State to be funded by the IDA when the R&R was taken up. There was no clear-cut policy for R&R in the State or in the country at that time for the Project Affected Families. The total families affected by virtue of construction of this project were 945 spread over in 02 blocks and 05 villages. During the time, the total compensation given to the 945 PAFs in the displaced 05 villages was Rs.17.55 lakhs. Out of 945 displaced families, only 546 were officially rehabilitated in 07 Government sponsored colonies. The others being landless, service providers or artisans were not covered under rehabilitation. Some of the PAFs shifted back to upper reaches of submerged villages during 1968 due to poor conditions in government sponsored colonies and unsuitable agricultural land provided to 107 oustees. All the government rehabilitated colonies for oustees have been provided with the roads, tube wells and primary schools. The colonies are located between 3 to 20 kms from Hadgarh village. Economic rehabilitation for the displaced families was absent under the programme and Focussed Group Discussions (FGDs) with the PAFs revealed that families dealing with the sale of forest produce get very less price for the produce. Therefore, in the absence of any economic rehabilitation programme, it is but natural for families to get impoverished. Similarly, no economic training programmes were conducted for the PAFs. A proposed livelihood and rehabilitation plan as per provisions of government of India National Relief and Rehabilitation Package 2007 was assessed. Under this programme an amount of Rs.81.90 lakhs was provided for development of land, and Rs 20000/ per family were proposed for income generating group based activities.

4.2 Socio-Economic Impacts

The Salandi Major Irrigation Project (Hadgarh Dam) provided for implementation for environmental plan for both catchment and command areas. The command area of the left bank canal is 45730 Ha spread over 475 villages in 07 blocks falling in three districts of Orissa. The population in the command area was about three lakhs in the pre project while it has increased to four lakhs after the project. The total increase in the population is 38.28 per cent in males and 37.99 per cent in females. The sex ratio was 973 females for every 1000 males and there appears to be not much difference in the sex ratio in the pre and post project situation. The total Scheduled Caste population in pre-project period was 75052 while in post-project, it was 90298 and there is an increase of 25.32 per cent in the SC population. The total Scheduled Tribe population in pre-project period was 13685 while their number increased to 15477 in the post-project period. The overall percentage of increase of SC/ST population to total population in the command area is 21.51 and 3.68 respectively. The blocks in the command area are having a number of primary, middle and secondary schools. During the pre-project period total number of primary schools were 306 while they increased to 850 in the post-project period. Similarly, number of middle schools has increased from 165 to 446 and secondary schools from 89 to 285 and colleges from 05 to 26. There is a significant improvement in the provision of education in the command area villages. The male female literacy percentage in the pre-project situation was 40.59 per cent while in the post-project, the

male female literacy has increased to 72.09 per cent. It was observed, adult education programme was not organized in the pre and post project situation.

The total command area falls in seven blocks spread over in three districts. In the pre-project situation, the main occupation pattern was only cultivators, agriculture labour and other labourers while in the post project situation, there is a shift in the occupational pattern towards mining, household industrial labourers and other services mainly due to the development in mechanization, urbanization and industrilization. In the post-project occupational pattern, workers and other cultivators labour continues to occupy highest in terms of percentage i.e. 58, agriculture labour 30.17 while other agriculture labourers are 12.15 per cent. It is observed that involvement of women in hoeing/weeding and watching crops is higher in the project area while comparing outside the project area. There is also increase in the traditional artisans in the post project situation and the wages in the range of Rs.77.50 to Rs.100.00 in the year 2000-01 while currently these ranges from Rs.91.24 to 121.67. During the social mapping exercise in the command area, 55 per cent of the villages were found to have community centres or youth club houses, about 40 per cent were found to have cinema halls, community parks and social infrastructure like anganwari centres and tube wells were found in almost all the villages. In the command area districts, there are regulated markets. Farmers bring the produce to the regulated markets or sell locally to the agents. The prices offered to them were reported to be lucrative. In the command area villages, there is spurt in the increase of financial institutions. While making an analysis of human development index, the poverty analysis based upon household income of Rs.11000/- per year is a benchmark for the poverty line as per Government of Orissa (Economic Survey 2003). It is observed that at the time of survey from the available data, the 44 per cent households in the command area are below the poverty line. An analysis of the data also indicated that 73.5 per cent of the HHs in the non-project area were below poverty line (BPL). The poverty analysis based on the per capita monthly expenditure is fixed at Rs.246/- per month for defining the poverty line. It is observed that there is improvement in the income of HHs in the command area, increase in primary middle and high schools, availability of medical infrastructure, drinking water, and financial institutions. There has also been increase in the productivity and cropping intensity levels in the command area when compared to outside the project.

4.3 Effects on Agriculture

Prior to the construction of the project, the area was frequently affected due to droughts or floods causing reduction in the yield of crops. The average yields were 50 to 68 % and there is substantial increase in the yields due to the practice of latest agricultural techniques and usage of manures and improved pesticides during post-project period. The average consumption of fertilizers during the years 1999-2000 to 2005-06 in the command area under kharif is 92.10 kgs per Ha. while in rabi, it is 99.52 kg/Ha. The average consumption of fertilizers per Ha is 95.81 kgs. The principal crops grown under pre-project conditions were rice, pulses, oilseeds, fibre crops and sugarcane. Rice cultivation is a major crop with 96 % cropping intensity in the pre-project situation. While in the post project, it was totally paddy which accounts for 122 %. The cropping intensity has increased from 100% to 122% in the post project situation. The average area under irrigation in kharif is 37252 Ha while in Rabi it was 10,501 Ha and the total average area under irrigation from the year1996 to 2006 is 47753 Ha. The intensity of irrigation for paddy alone is reported to be 128%. There was also improvement in the increase of cattle's, buffaloes, sheep, goats, pigs as well as poultry birds. Overall the command area under the Salandi irrigation project is quite compact and served with irrigation water through vast canal network systems. The habitations in the command area are found to be well developed due to the improvement in productivity of agriculture produce, creation of employment and development of infrastructure facilities. Most of the main and branch canals and distributaries are provided with roads on the top of the bank facilitating the transportation of the residents of the command area, material and agricultural produce. The entire scenario in the command area appears to be quite satisfactory due to the construction of the project.

4.4 Impact on Groundwater

Surface water samples were collected in different locations from the reservoir, and also Salandi river during the hot weather period of 2007 and results show that pH values are within limits and have low EC value. The surface water pH value is quite suitable for irrigation in the command area. No negative impact on the quality of surface water is anticipated. Ground water samples were also collected at different parts in the command area and it is found to be most suited for irrigated agriculture and for drinking water purposes. There is no contamination of ground water and surface water due to the use of pesticides, manures, run-offs. There is considerable rise in the ground water tables in the recharge zones of the command area compared to pre-project conditions. The chemical analysis of the soils in the command area indicates that there is no salinity. Conjunctive use of ground water needs to be observed for preserving the precious water for the dry spells and

even in kharif.

4.5 Impact on Archaeological Monuments

No archaeological monuments or places of worship were affected by the project and hence restoration does not arise. Adequate recreational facilities were provided in the command area.

4.6 Impacts on Forests, Flora, Fauna and Aquatic Life

The Salandi reservoir is surrounded by thick dry deciduous hill forests on steep slopes of hills of the Satkosia reserve forest. But in the upper reaches, there are open rocky areas with huge boulders. Khumthan reserve forest is on the western side of the river Salandi. There is no information about the status of forests at the time of launching of the project since no EIA was made at that time. Hence a comparison could not be made to assess the changes that may have occurred in the forest cover and forest types.

Some of the thick forests may have become open forests and the open forests have become scrub forests etc. But the existing forests, the agro forests of Sal (*Shorea robusta*), Teak (*Tectona grandis*), *Eucalyptus* and Bamboo are quite productive and sustainable. Owing to rising income levels on account of irrigation facilities created by the project, the dependence on forests for fodder and fire wood have declined. Thus the project has reduced the pressure on forest resources. The forest area coming under submergence is to the extent of 3442 ha.

A comprehensive list of the plant species of the study area was made based on the plant species collected during different seasons by the survey teams. The species were further separated in to trees and shrubs (perennials), herbaceous species, medicinal plants and aquatic plants. The Shannon – Wiener Index of diversity of the catchment area of Salandi river is found to be in the range of 1.21to 3.21. The corresponding values of dominance and evenness were in the range of 0.23 to 0.54 and 0.47 to 0.78 respectively. The high value of 3.21 was due to species richness (S=141), low dominance (0.23) and high evenness (0.78). But different areas were dominated by different associations and hence the indices of diversity and evenness could be lower and dominance higher when each sample or formation was considered separately.

In the absence of any baseline data and biological setting of the area before the launching of the project, it is not possible to specifically pin point whether there were any real changes in the migratory patterns of the project area. However, the reservoir may have restricted the free movement of terrestrial animals from the right and left banks of the reservoir to some extent. But the reservoir is not really large enough to prohibit migrations of any species. At the same time, the reservoir might have attracted a number of wild animals for drinking water.

Most of the birds reported from the project area are either residents or local migrants. Very few exotic migrants have been spotted in and around the reservoir, the water body between the reservoir and the barrage, irrigation canals and paddy fields. But none of them was found to breed or nest in the area. The migration patterns of the exotic migratory species cannot be influenced by a small reservoir since they are capable of flying non-stop over several kilometers.

In order to assess the fish life, benthic ecology and primary productivity of the reservoir, professional fishermen were engaged for trapping /catching the fish and the benthic microbes. In spite of several attempts with different types of devices and gadgets, the fisherman could catch only a few cat fishes, major carps and Murrells.

The project may not have posed any threat to the biodiversity, flora and fauna of the catchment area. But all the terrestrial plants of the reservoir must have been lost on account of submergence. Irrigation facilities must have brought about a significant change in the land use and land cover of the command area. The terrestrial flora and fauna of the hills that get marooned by the reservoir water must have been isolated either permanently or temporarily. But all these changes are a part of the missing history.

4.7 Impact on Public Health, Drinking Water & Communication

An attempt has been made to study the prevailing water borne diseases before the project and the impact of the project on the water borne and other diseases in the area after the project. Considering water resource development projects vis-à-vis diseases there are two groups of water related diseases viz. water based and water related water borne diseases which are the most prevalent in the project area. Biological agents are implicated in most of the gastro-enteritis diseases, respiratory diseases and more importantly malaria, fileria, Japanese encephalitis and schistosomiasis etc. Preventive measures were taken by the Public Health Department during

their regular visits to the command area village. Adequate attention is given to sanitation, healthcare and health delivery systems. There is also increase in the Allopathy, Homeopathy and Ayurvedic institutions which is a positive sign. There is also tremendous improvement in the infrastructure levels during the post project period.

4.8 Land Use and Land Cover

The command area of the project was receiving irrigation as intended during the time of construction. The land use and land cover revealed that cropped land area increased (both single and double cropped area). The study highlighted that during the pre-project period the entire area of 19,642 hectares (34% of GCA) was almost rain fed. This area after the project has increased by 10.10 % to 21,626 hectares (38% of GCA) after receiving the benefit of full / supplemental irrigation. Besides, in a similar way there was increase in double crop area from 4478 ha to 5971 ha registering an increase of 33.34 % after the implementation of the project. It was also observed that there was reduction of area under agricultural plantation to an extent of 4,114 hectares (36.33%) and swampy area 1675 hectares (80.72%). The land use and land cover of the command as per the satellite imagery shows that there is marginal reduction in the area under agricultural plantations.

5.0 RECOMMENDATIONS

Since river valley projects are multi dimensional in nature, they encompass both positive and negative attributes. The objective of these studies is to minimize the negative attributes associated with the project. A few recommendations to further enhance the project value are listed as below-

(i) Since the lands allotted to PAFs in lieu of their submergence area are not fit for cultivation, it is recommended that the same may be developed under various land development programmes of the state and make them suitable for cultivation. Further, a special package for PAFs who have reverted back to old habitations may be provided. The wage employed PAF households may be provided necessary livelihood training, so that they can get self employed.

(ii) Further if the already allotted land cannot be converted to farm land through land development, the PAFs, may be allotted alternative lands which are fit for cultivation. The study team also found that the R & R colonies developed by the Government of Orissa have inadequate sanitary facilities and also medical & health facilities are inaccessible. Therefore, it is recommended that necessary sanitary and medical facilities may be provided in these colonies, so that the PAFs may start living in these colonies.

(iii) In spite of investments made in creating irrigation infrastructure, it is noted that in about 50 percent cases the canals and other structures are not functioning smoothly due to damage. This could lead to wastage of water and increase in salinity. NGO's may be contacted to facilitate/train WUA farmers to manage the scheme successfully.

(iv) Paddy is the main crop grown by the farmers both in kharif and rabi. The reason being that paddy can be stored and sold in the market whenever the farmer is in need of money and farmers are aware of cultural practices involved. The WUAs have been formed and could be motivated to collect farm produce from member farmers and sell it in the market. This would result in farmers getting better price for the crop. Common interest groups within the WUA could be encouraged to take up vegetable and other crops. It is suggested that NGO's be involved in assisting WUAs for identifying markets and providing support. The support group of NGO's can charge necessary fees from the farmers after first year of operation

(v) As 18 per cent of the area is under water logging which is likely to accrue salinity, field drainage and improvement of the natural drainage are most essential. Conjunctive use of surface & ground waters is also suggested.

(vi) Canal network is to be lined to arrest seepages from the banks which lead to water logging, salinity and cause adverse effects on public health system. Modernization of the canal system is suggested.

(vii) To compensate the loss of afforestation, reservoir rim treatment, canal bank plantations, developing landscapes by means of garden complexes may be taken up in consultation with Forest Department.

(viii) Convergence of all developmental schemes from Irrigation, agriculture and watershed treatment have to be introduced in the command area.

BRIEF PROFILE OF THE AUTHORS

W.M.Tembhurney graduated in Civil Engineering from VREC, Nagpur in the year 1980 and joined CWC in Jan, 1984 as Asstt. Director. Thereafter he has held important positions in the Ministry of Water Resources & Central Water Commission (CWC). He has very good experience in Techno-economic appraisal of water resources projects of the country, implementation of command area development programme in the northern states of the country and release of central assistance to the states under the programme, physical monitoring of water resources projects for timely completion of the projects, hydrological observations and implementation of World Bank assisted Hydrology Project for the Monitoring Central Organization of CWC, Nagpur etc. At present, he is working as Chief Engineer, Environment Management Organization, CWC. He is the Chairman for the Sectional Committee on WRD (24), BIS. He is also the Chairman for various committees carrying out Comprehensive EIA of Inter linking of River Projects, Basin Studies (Siang & Subansiri) of Hydro projects, Capacity surveys for assessment of sedimentation studies of the completed water resources projects of the country including Remote Sensing technology. His areas of expertise are policy matters on sustainable development of water resources projects including environmental aspects.

G. Naga Mohan graduated in Civil Engineering from the JNTU College of Engineering in the year 1990 and M.Tech (Transportation Engg) in 1992 from IIT Madras. Prior to joining Central Water Commission(CWC), he has held important positions in AP State R & B Department and Border Roads Organization (GREF). He has very good experience in hydrological observations and implementation of World Bank assisted Hydrology Project in Cauvery & Southern Rivers Organisation of CWC. He has held many key positions in CWC and National Water Development Agency(NWDA) and is presently working as Director, Environment Impact Assessment Directorate, CWC. He is also the Member Secretary for committees carrying out Environmental Evaluation of Completed Water Resources Projects of the country and Comprehensive EIA of Basin Studies (Siang & Subansiri) of Hydro projects.

Abhishek Gupta graduated in Civil Engineering from Malaviya Regional Engineering College in the year 2002 and obtained his M S (Buildings) from National University of Singapore in the year 2005. He has worked in establishments like BITS (Pilani) , Steel Authority of India Ltd and with GS Engineering & Construction Pvt Ltd (formerly LG Engineering) before joining as Assistant Director in Central Water Commission(CWC). He is currently working as Assistant Director, Environment Impact Assessment Directorate, CWC.