# EIA AS APPLIED TO WATER RESOURCES DEVELOPMENT PROJECTS

## A DISSERTATION

*Submitted in partial fulfillment of the requirements for the award of the degree of*

**MASTER OF TECHNOLOGY**

**in**

**WATER RESOURCES DEVELOPMENT**

**By**

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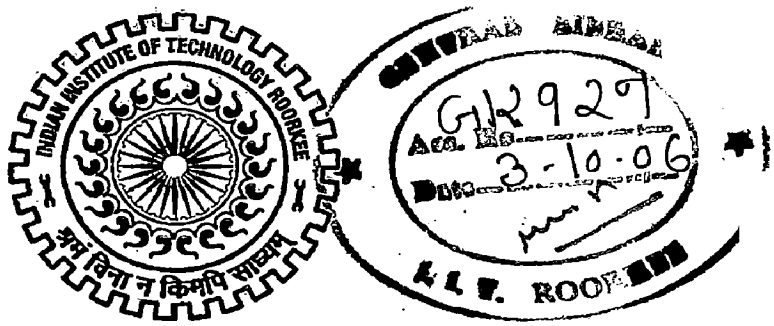


**DEPARTMENT OF WATER RESOURCES DEVELOPMENT AND MANAGEMENT**
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# EIA as Applied to Water Resources Development Projects

## CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the dissertation entitled: **"EIA as APPLIED to WATER RESOURCES DEVELOPMENT PROJECTS,"** in the partial fulfillment of the requirement for the award of the degree in Master of Technology in *Water Resources Development*, submitted in Water Resources Development and Management Department, Indian Institute of Technology Roorkee, is an authentic record of my own work carried out during the period from July 2005 to June 2006, under the supervision and guidance of Dr. M. L. Kansal and Dr Aman Sharma.

The matter embodied in this Dissertation has not been submitted by me for the award of any other degree.

Date : June 24 , 2006

Place : Roorkee

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Certified that the above declaration given by the candidate is correct to the best of my knowledge.

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# Contents

## ABSTRACTS

The urge for economic progress is common to any developing nation. Massive developmental activities are being undertaken in countries like India in the field of water resources to meet and satisfy the demands for higher standards of living of an ever increasing population. Developing countries are seized of planning and practice of steps towards achieving sustainable development. Sustainable development attempts to balance the often conflicting ideals of economic growth and protection of environmental quality. Present environmental crisis is due to paradigms of scientific materialism and economic determination due to consideration of quantitative growth as a major instrument of social policy. Guidelines for sustainable development involve adaptation of good strategies of utilization of non-renewable resources without restricting the options of the future generations, within the capacity of regeneration, applying precautionary principles by using Environmental Impact Assessment (EIA) and analyzing costs and benefits of development.

Present dissertation work is aimed to understand the role of Environmental Impact Assessment (EIA) of Water Resources Projects to maintain socio-cultural and ecological environment of the project affected area, intact.

The dissertation is structured into two parts. In the first part the first seven chapters deals with various components of EIA methodologies like identification, prediction and assessment of direct and indirect Environmental Impacts, Environmental Management Plan and Monitoring, Methods of EIA, Catchment area treatment plan, and audit trail.

In part II, a case study has been taken titled EIA study for Tapoban Vishnugad hydroelectric project, District Chamoli, Uttranchal, Conclusions of the dissertation, scope of further study and Annexure containing questionnaire for environmental appraisal for river valley and hydroelectric projects as per Ministry of Environment and Forest (MOEF).

## 1.1 Introduction

EIA is an exercise to be carried out before any project or major activity is undertaken to ensure that it will not in any way harm the environment on a short-term or long-term basis. Often the results of manually-produced changes cause degradation in the surrounding environment. Although the proposed project or plan has a good intent and addresses an identified problem, or solves it, the ramifications of the project may be serious. For instance, it may result in degradation of the human environment offsetting the possible benefits of the proposed project or plan. This is the purpose of environmental impact assessment (EIA). Thus the aim of EIA is to assess the overall impact of development project on the environment. *EIA may be defined as* "an activity designed to identify and predict the impact of a project on biogeo-physico-chemical environment and on human health so as to recommend appropriate legislative measures, programs, and operational procedures to minimize the impact." Environmental impact is any change to the environment, whether *adverse or beneficial* wholly or partially resulting from a project activities. *In other words* EIA can also be defined as "a systematic identification and evaluation of the potential impacts (effects) of proposed projects, plans, programs or actions relative to the physical-chemical, biological, cultural, and socioeconomic components of the total environment." The "physical-chemical environment" includes such major areas as soils, geology, topography, surface-water and ground-water resources, water quality, air quality, and climatology. The "biological environment" refers to the flora and fauna of the area including species of trees, grasses, fish, herpetofauna, birds and mammals. The "cultural environment" includes historic and archaeological sites. The "socioeconomic environment" refers to a range of considerations related to humans in the environment including population trends and population distributions, economic indicators of human welfare, educational systems,

transportation networks and other infrastructure concerns such as water supply, waste water disposal and many others.

EIA has found wide utility both in developed and developing countries in achieving development in an environmentally sound manner, either at national or regional scale or at the level of individual development project. Considerable research has been carried out on procedural and methodological issues related to EIA in past, and an acceptable standard of practice against which EIA can be reviewed has not emerged.

Professionals involved in the EIA process include engineers, planners, biologists, geographers, landscape architects, and archaeologists.

## 1.2 The Need for EIA

The purpose of EIA is to assist the decision making process and to ensure that the project options under consideration are environmentally sound and sustainable. EIA identifies the ways of improving project environmentally by preventing, minimizing, mitigating or compensating for adverse impacts.

Water resources projects are among the most sensitive of all development projects in terms of pervasivity of their influence in altering environmental resources. Since they cause a major alteration in the hydrologic regime of the watershed involved, they often result in marked alteration of the project and these effects may continue for d/s to the area of final discharge of the stream and beyond. Such projects usually result in establishment of new access routes and acceleration of encroachment into u/s areas in the watershed, resulting in impacts on various facets of environment.

Environmental impact assessment is one of the tools to achieve *sustainable development* but it is necessary to ensure complete integration of environmental management in the entire project cycle.

The major environmental issues associated with the development of water resources projects are:

- Submergence of sizable area due to creation of reservoir/ impoundment of water
- Impact on flora and fauna due to destruction of the habitat
- Rehabilitation and Resettlement
- Health aspects
- De-stabilization of slopes in higher reaches due to associated road construction activities
- Management of watersheds for ensuring envisaged benefits
- Reduction in river flow in the downstream stretches due to diversion of water for power generation and its impact on aquatic eco-system as well as riparian rights of villages/ habitations.
- Water logging due to seepage through canal
- Increased salinity of fertile land

Keeping above issues under considerations an EIA study is conducted which incorporates into development & planning process, a plan for environmental protection and conservation. The procedure identifies the possible positive and negative impacts on the environment likely to emanate as a result of construction and operation of a project. The EIA thus provides for a plan which upon implementation will reduce or offset the negative impacts of a project resulting in a minimum level of environmental degradation. This minimization may be a result of implementation of a project alternative or project modification or environmental protection measures which simply reduces the severity or number or magnitude of negative impacts. The plan may also result in utilization of positive impacts for enhancement measures which offset negative impacts. To measure the level of plan implementation and degree of effectiveness of the above environmental protection

provisions, the EIA provides a monitoring programme. This programme is so designed that it identifies the parameters of uncertainty and measures the related impacts.

Environmental Protection and Sustainable Development have been the cornerstones of the policies and procedures governing the industrial and other developmental activities in India. Ministry of Environment & Forests has taken several policy initiatives and enacted environmental and pollution control legislations to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concerns in developmental projects. One such initiative is the Notification on Environmental Impact Assessment (EIA) of developmental projects issued on 27.1.1994 under the provisions of Environment (Protection) Act, 1986 making EIA mandatory for 29 categories of developmental projects. One more item was added to the list in January, 2000.

EIA is a planning tool that is now generally accepted as an integral component of sound decision-making. The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design. EIA/EMP should assist planners and government authorities in the decision making process by identifying the key impacts/issues and formulating mitigation measures. Ministry had issued sectoral guidelines some time ago. A compendium of the procedures and questionnaires entitled "Application Form and Questionnaire for Environmental Clearance was published in September, 1999 in association with the Confederation of Indian Industry.

As part of the continued efforts to ensure transparency in the procedures of environmental clearance and to assist the project authorities in improving the quality of EIA documents, this Manual is now being brought out by the Ministry. The Manual has been designed to cover the whole gamut of issues like regulatory requirements, the EIA methodology including baseline studies, identification of key issues and consideration of alternatives, impact analysis and remedial measures in a systematic way. It also delineates the

process of reviewing the adequacy of EIA and EMP reports and post-project monitoring. To make the Manual comprehensive and self-contained, information pertaining to legislative regime, base line data generation and monitoring, thumb rules for pollution control measures etc. have been annexed to the main text.

Every anthropogenic activity has some impact on the environment. More often it is harmful to the environment than benign. However, mankind as it is developed today cannot live without taking up these activities for his food, security and other needs. Consequently, there is a need to harmonize developmental activities with the environmental concerns. Environmental impact assessment (EIA) is one of the tools available with the planners to achieve the above-mentioned goal.

Key information needed in applying the EIA process to a proposed project includes following items:

- A description of the type of project and how it functions or operates in a technical context.
- The proposed location for the project and why it was chosen.
- The time period required for project construction.
- The potential environmental requirements from the project during its operational phase, including land requirements, air pollution emissions, water use and water pollutant emissions, and waste generation and disposal needs.
- The identified current need for the proposed project in the location where it is proposed. Need could be flood control, irrigation, hydro-power, drinking water. Project need must be addressed as part of the environmental documentation.
- Any alternative which has been considered should be clearly delineated.

## 1.3 Indian Policies Requiring EIA

The environmental impact assessment in India was started in 1976-77 when the Planning Commission asked the then Department of Science and Technology to examine the river-valley projects from environmental angle. This was subsequently extended to cover those projects, which required approval of the Public Investment Board. These were administrative decisions, and lacked the legislative support. The Government of India enacted the Environment (Protection) Act on 23rd May 1986. To achieve the objectives of the Act, one of the decisions that were taken is to make environmental impact assessment statutory. After following the legal procedure, a notification was issued on 27th January 1994 and subsequently amended on 4th May 1994, 10th April 1997 and 27th January 2000 making environmental impact assessment statutory for 30 activities. This is the principal piece of legislation governing environmental impact assessment.

Besides this the Government of India under Environment (Protection) Act 1986 issued a number of other notifications, which are related to environmental impact assessment. These are limited to specific geographical areas. These are listed below:

- Prohibiting location of industries except those related to Tourism in a belt of 1 km from high tide mark from the Revdanda Creek up to Devgarh Point (near Shrivardhan) as well as in 1 km belt along the banks of Rajpuri Creek in Murud Janjira area in the Raigarh district of Maharashtra (6th January 1989)
- Restricting location of industries, mining operations and regulating other activities in Doon Valley (1st February 1989)
- Regulating activities in the coastal stretches of the country by classifying them as coastal regulation zone and prohibiting certain activities (19th February 1991)
- Restricting location of industries and regulating other activities in Dahanu Taluka in Maharashtra (6th June 91)

- Restricting certain activities in specified areas of Aravalli Range in the Gurgaon district of Haryana and Alwar district of Rajasthan (7th May 1992)
- Regulating industrial and other activities, which could lead to pollution and congestion in an area north west of Numaligarh in Assam (5th July 1996)

## 1.4 Complexities in Assessing the Environmental Impacts

The following points have to be kept in mind while assessing the environmental impacts of WRD projects:

a) it is important to identify the contributions of favorable environmental effects of a project as it is to identify the negative ones and the constraints they may impose.

b) Most of the environmental factors involved in dam construction and operation are interconnected. People displaced from the inundated area of the reservoir may move u/s 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. At the same time sediment trapped in a reservoir can improve d/s water quality and thereby provide economic benefits for irrigation and water supply users.

c) As a major investment a dam may have impact on regional development and induce growth of new population centers and industrial activity. The cumulative effects of such projects may be substantially different from the effects of individual projects. Consequently consideration must be given to other projects those under development in the basin or those induced as a result of a particular project.

d) It is to be highlighted that poverty and low productivity levels in dryland areas themselves have tremendous social costs. The acute scarcity of water in these area

adds on to the social and economic problems of the inhabitants. Well planned out transfer of surface water can be a great boon in providing drinking water, removing or reducing water-borne diseases, raising agricultural productivity of the region and improving ecology. The design of development has to augment the sustaining capability of the environment and to provide for a more active interaction between man, technology and the available land and eco-resources.

e) All the WRD projects need not induce significant adverse environmental impacts whether these exist or not, must be determined through the environmental impact assessment at different stages of the project.

## 1.5 Adverse Environmental Effects of WRD Projects

These can be classified into the following categories:

1. Deforestation
2. Displacement of people
3. Effects on wild life
4. Effects on monuments
5. Soil erosion and silting of reservoirs
6. Seismic impacts
7. Water-pollution
8. Climatic changes
9. Adverse impacts of irrigation
10. Tourism and recreation
11. Health impacts

**Deforestation**: It is said that large dams result in deforestation which is unavoidable in areas to be submerged under water. However it is erroneous to regard WRD projects as a major cause for deforestation. There is so much lime-light on the forest area lost due to

submergence and relatively much less on other factors like illegal felling and due to population pressure.

**Displacement of people**: The crucial problem is that of physical and psychological suffering of the displaced people from the submerged area of reservoirs. Earlier the provisions for rehabilitation and resettlement were quite inadequate in India. There is now trend of provisions for more liberal compensation, amenities, land and employment for the displaced population while constructing river valley projects.

**Effects on wild life**: Almost all reservoirs are located in hilly and forest areas which are the habitat of wildlife. The disturbance to wildlife from water resources development projects is quite common. Mitigative measures therefore need to be taken. If the submergence of forest area poses a danger to wild life, arrangements can always be made to shift the animals to safer area.

**Effects on monuments**: Sometimes historical and cultural monuments may fall in the submerged area of a reservoir. The Jyotirling temple has been preserved in the planning of the Omkareshwar dam on river Narmada. Improvement in the approach roads and bridges would also be a part of the integrated project.

**Soil erosion and silting of reservoirs**: It is estimated that in India out of total geographical area of 328 mHa about 175 mHa ( 53% ) is subject to soil erosion and degradation due to monsoon, waterlogging, salinity, jhum cultivation, etc. Himalayas being the world's youngest mountains have fragile rocks and prone of mass warfing. Landslides and slips are common in this region. Uncontrolled falling of trees, heavy pressure of grazing and faulty methods of cultivation also increases soil erosion. The river valley projects do not cause any soil erosion as such. In fact such projects themselves act as major check-dams where excessive silt gets trapped. Reservoirs control both silt and flood. It is to be realized that the rate of sedimentation decreases with the age of the project and becomes asymptotic. Catchment area

treatment (CAT) like soil conservation works, watershed treatment, and afforestation are being undertaken in the catchment to reduce the sediment flow.

**Seismic impacts**: Doubts have been raised about the safety of large dams due to seismic forces. There is however little proof of this hypothesis. Dams have been shown to resist earthquake well compared to other manmade structures. It is also said hypothesis that impounding of water in large reservoirs induces seismicity (RIS). There is however little proof of this hypothesis.

**Water pollution**: The riverine system plays an important role in transport of waste water to sea. Several trace elements including some dangerous heavy metals like lead, cadmium, mercury, arsenic, zinc and iron besides residues of pesticides and fertilizers washed from fields are found in the river. The nature of impact of waste water on the river water quality depends upon its characteristics and pattern of travel.

**Climatic changes**: The micro climatic changes due to reservoirs are not significant. Moderate changes take place in temperature and humidity which are mostly beneficial.

**Adverse impacts of irrigation**: The growth of irrigation may subject certain tracts of lands to water logging, increased soil salinity and alkalinity. An area is said to be waterlogged when water table rises to such an extent that soil pores in the root zone of the crops becomes saturated resulting in restriction of the normal circulation of the air, the decline in the level of oxygen and increase in the level of carbon-dioxide. As per Ministry of Water Resources (MOWR) Working Group-91 following norms are used to identify the water logged area for the irrigated land:

a) Water logged areas- Water table within 2 m of land surface

b) Potential areas for water logging- Water table between 2 to 3 m of land surface.

c) Safe area- Water table below 3 m of land surface.

The soil salinity and alkalinity are related to the concentration of chlorides and sulphates of sodium, calcium and magnesium in soil which affect the plant growth. Soil salinity resulting from water logging may arise due to upward movement of soluble salts in the soil. Saline land can be utilized for raising crops having higher salt tolerance like barley, sugarcane, cotton etc. A suitable chemical fertilizer usually nitrogen as well as organic manure may be added to saline soils along with chemical treatment for reclamation.

**Tourism and recreation**: Recreational facilities like boating, rowing and other facilities for water sports may be created in the river valley projects. The WR projects lead to social and cultural improvements.

**Health impacts**: It is believed that the water impoundments and irrigation projects give rise to increasing scope for breeding of mosquitoes. Incidence of malaria and other mosquito-borne diseases may escalate.

## 1.6 Objectives of the Dissertation

Present dissertation has following objectives:

1. To understand the role of EIA in Water Resources (WR) projects.
2. To identify what are the key issues (i.e. environmental parameters) in a particular WR Project.
3. To understand various methods of EIA.
4. To understand how impacts on environmental parameters are predicted.
5. To understand the Environmental Management Plan (EMP) and Environmental Monitoring
6. To understand Catchment Area Treatment Plan for environment protection.
7. To understand Audit Trail in EIA.
8. To understand the complexities associated in EIA of WR Projects.

## 1.7 Outlines of the Thesis

The contents of the study are arranged as follows:

**Chapter 1:** The chapter gives an overview of the objective, introduction, background, definition, scope, objective of the present study, how these objectives are achieved and need for EIA. The policy, legal and administrative framework for environmental clearance has been summarized.

**Chapter 2:** Pre-project environmental baseline conditions including physical, biological and socio-economic parameters, resource base and infrastructure. Before the start of the project, it is essential to ascertain the baseline conditions of appropriate environmental parameters which could be significantly affected by the implementation of the project.

**Chapter 3:** Anticipated positive and negative impacts as a result of the construction and operation of the project. It is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the construction and operation of the project.

**Chapter 4:** Environmental Management Plan (EMP) for amelioration of anticipated adverse impacts likely to accrue as a result of the project. The approach for formulation of an EMP is to maximize the positive environmental impacts and minimize the negative ones. The aim is to keep the stress/load on the ecosystem within its carrying capacity.

**Chapter 5:** Each of different methodologies for the assessment of environmental impacts of development projects has their advantages and disadvantages and their utility for a particular application is largely a matter of choice and judgment of the analyst.

**Chapter 6:** Catchment Area Treatment (CAT) plan for directly draining catchments area is outlined in this chapter. Silt Yield Index method has been used for categorization of sub-watersheds into erodible classes. Treatment measures for erosion of watersheds have been formulated.

**Chapter 7:** Environmental audit (EA) is a technique for integrating the interest of the industry and the environment so that these could be mutually supportive. An environmental audit is a routine evaluation of company's environmental control. EA is one of MIS.

**Case Studies:** EIA study for Tapoban Vishnugad Hydroelectric project, District Chamoli, Uttanchal.

## Conclusions of the dissertation

## Scope of further study

**Annexure-I** questionnaire for environmental appraisal
(For river valley and hydroelectric projects)

## References

## 1.7 Conclusion

EIA has a profound effect on project planning and decision making. Aim of EIA is to enhance positive effect and to reduce negative effect of the project. The conduction of environmental impact studies in India has improved the project considerably. The scientific and technical validity of EIA has improved. EIA requires interdisciplinary team formation.

# Ch-2 - Identification of Key Issues (Description of Environmental Setting)

## 2.1 Introduction

The description of the environmental setting (also referred to as "baseline," "existing," "background," or "affected environment") is an integral part of an environmental impact study. There are two major purposes of describing the environmental setting of the proposed project area in an impact study namely:

1. To assess existing environmental quality as well as the environmental impacts of the alternatives being studied including the no-action or no-project alternative, and
2. To identify environmentally significant factors or geographical areas that could preclude the development of a given alternatives. This could be referred to as "identifying any fatal laws in the proposed project setting". Examples of environmentally significant factors or areas include the presence of stream segments with poor water quality, geographical areas with "marginal" air quality, habitat for threatened or endangered plant or animal species, and significant historical or archaeological sites.

This chapter describes a conceptual framework for preparing a description of the environmental setting.

## 2.2 Key Elements of an Initial Project Description and Scoping

Specific information that must be covered by the Initial Project Description (IPD) includes:

- Location/current land use along with contours and whether it conforms to the development plans proposed for that area
- Details of proposed project activity including the project cost
- Outlining the key project elements during the pre-construction, the construction and the operation phases etc. as per the list of documents to be attached with the questionnaire
- The IPD may also include.
  - Off-site activities

- Associated activities
- Expected project induced activities
- Project activities as PERT chart and process as a flow chart delineating unit processes with input-output.

**Project Location(s)**

The site(s) selection can be an effective approach in minimizing the requirement of mitigation measures. Project location should be reviewed in relation to the following salient issues:

- Ambient air, water and noise quality standards
- Critically polluted areas
- Natural disaster prone areas
- Ecologically sensitive areas
- Availability of water and other critical infrastructures like electricity, roads with adequate width and capacity

While considering EIA we use the term ***significant impact***. Significant impact includes both ***context and intensity***. Following should be considered in evaluating *context*:

- The Society as a whole ( human, national )
- The affected region.
- The affected interests.
- The locality.
- Whether the effects are short or long term.

*Intensity* refers to the severity of impact. The following should be considered in evaluating *intensity*:

- Impacts that may be both beneficial and adverse.
- The degree to which the proposed project affects public health and safety.

- Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers or ecologically critical areas.
- The degree to which the effects on the quality of the human environment are likely to be controversial.
- The degree to which the possible effects on the human environment are uncertain or involve unique or unknown risks.
- The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
- Whether the action is related to other actions with individually insignificant but cumulatively significant impacts.
- The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historic resources.
- The degree to which the action may adversely affect an endangered or threatened species or its habitant that has been determined to be critical under the Endangered Species Act of 1973.
- Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment.

It is desirable to ensure that the development options under consideration are sustainable. In doing so, environmental consequences must be characterized early in the project cycle and accounted for in the project design.

Impacts resulting from proposed actions can be considered in one or more of the following categories:

- Beneficial or detrimental
- Naturally reversible or irreversible
- Reparable via management practices or irreparable
- Short term or long term
- Temporary or continuous
- Construction or operational phase
- Local, regional, national or global
- Accidental or planned ( recognized beforehand )
- Direct or primary, or indirect or secondary
- Cumulative or single

Sustainable development considers an equitable balance between two prime goals of higher levels of economic development as well as environmental quality. It is with this objective that proper management plans are essential for ensuring sustainable development. The management plan should ensure that stress/ load on the system is within its carrying capacity. While deciding carrying capacity the supporting and assimilative capacity should be considered.

The objective of EIA is to foresee the potential environmental problems that would arise out of a proposed development and address them in the project's planning and design stage. The EIA process should then allow for the communication of this information to:

(a) the project proponent;

(b) the regulatory agencies; and,

(c) all stakeholders and interest groups.

EIA integrates the environmental concerns in the developmental activities right at the

time of initiating for preparing the feasibility report. In doing so it can enable the integration of environmental concerns and mitigation measures in project development. EIA can often prevent future liabilities or expensive alterations in project design.

## 2.3 Components of EIA

Depending on nature, location and scale of the project EIA report should contain all or some of the following components.

***Air Environment***

- Determination of impact zone (through a screening model) and developing a monitoring network
- Monitoring the existing status of ambient air quality within the impacted region (7-10 km from the periphery) of the proposed project site
- Monitoring the site-specific meteorological data, viz. wind speed and direction, humidity, ambient temperature and environmental lapse rate
- Estimation of quantities of air emissions including fugitive emissions from the proposed project
- Identification, quantification and evaluation of other potential emissions (including those of vehicular traffic) within the impact zone and estimation of cumulative of all the emissions/impacts
- Prediction of changes in the ambient air quality due to point, line and areas source emissions through appropriate air quality models
- Evaluation of the adequacy of the proposed pollution control devices to meet gaseous emission and ambient air quality standards
- Delineation of mitigation measures at source, path ways and receptor

***Noise Environment***

- Monitoring the present status of noise levels within the impact zone, and prediction of

future noise levels resulting from the proposed project and related activities including increase in vehicular movement

- Identification of impacts due to any anticipated rise in noise levels on the surrounding environment
- Recommendations on mitigation measures for noise pollution

***Water Environment***

- Study of existing ground and surface water resources with respect to quantity and quality within the impact zone of the proposed project
- Prediction of impacts on water resources due to the proposed water use/pumping on account of the project
- Quantification and characterization of waste water including toxic organic, from the proposed activity
- Evaluation of the proposed pollution prevention and wastewater treatment system and suggestions on modification, if required
- Prediction of impacts of effluent discharge on the quality of the receiving water body using appropriate mathematical/simulation models
- Assessment of the feasibility of water recycling and reuse and delineation of detailed plan in this regard

***Biological Environment***

- Survey of flora and fauna clearly delineating season and duration.
- Assessment of flora and fauna present within the impact zone of the project
- Assessment of potential damage to terrestrial and aquatic flora and fauna due to discharge of effluents and gaseous emissions from the project
- Assessment of damage to terrestrial flora and fauna due to air pollution, and land use and landscape changes

- Assessment of damage to aquatic and marine flora and fauna (including commercial fishing) due to physical disturbances and alterations
- Prediction of biological stresses within the impact zone of the proposed project
- Delineation of mitigation measures to prevent and / or reduce the damage.

***Land Environment***

- Studies on soil characteristics, existing land use and topography, landscape and drainage patterns within the impact zone
- Estimation of impacts of project on land use, landscape, topography, drainage and hydrology
- Identification of potential utility of treated effluent in land application and subsequent impacts
- Estimation and Characterization of solid wastes and delineation of management options for minimization of waste and environmentally compatible disposal

***Socio-economic and Health Environment***

- Collection of demographic and related socio-economic data
- Collection of epidemiological data, including studies on prominent endemic diseases (e.g. fluorosis, malaria, fileria, malnutrition) and morbidity rates among the population within the impact zone
- Projection of anticipated changes in the socio-economic and health due to the project and related activities including traffic congestion and delineation of measures to minimize adverse impacts
- Assessment of impact on significant historical, cultural and archaeological sites/places in the area
- Assessment of economic benefits arising out of the project
- Assessment of rehabilitation requirements with special emphasis on scheduled areas, if

any.

***Risk Assessment***

- Hazard identification taking recourse to hazard indices, inventory analysis, dam break probability, Natural Hazard Probability etc.
- Maximum Credible Accident (MCA) analysis to identify potential hazardous scenarios
- Consequence analysis of failures and accidents resulting in fire, explosion, hazardous releases and dam breaks etc.
- Hazard & Operability (HAZOP) studies
- Assessment of risk on the basis of the above evaluations
- Preparation of an onsite and off site (project affected area) Disaster Management Plan

***Environment Management Plan***

- Delineation of mitigation measures including prevention and control for each environmental component and rehabilitation and resettlement plan.
- Delineation of monitoring scheme for compliance of conditions
- Delineation of implementation plan including scheduling and resource allocation

## 2.4 Roles in the EIA Process

EIA involves many parties, grouped by their role definition within the process. The following section outlines the basic responsibilities of various bodies:

- The Project Proponent
- The Environmental Consultants
- The State Pollution Control Board / Pollution Control Committees (PCCs)
- The Public
- The Impact Assessment Agency

***The Role of the Project Proponent***

The project proponent during the project planning stage decides the type of projects i.e. new

establishment, expansion or modernization. Later the project proponent needs to prepare the Detailed Project Report/Feasibility Report and submits the Executive Summary, which shall incorporate the project details, and findings of EIA study, which is to be made available to concerned public.

The proponent has to approach the concerned SPCB for NOC and holding the public hearing. After the public hearing the proponent submits application to IAA for environmental clearance.

***Role of Environment Consultant***

Environmental consultant should be conversant with the existing legal and procedural requirements of obtaining environmental clearance for proposed project. The consultant should guide the proponent through initial screening of the project and establish whether EIA studies are required to be conducted and if so finalize the scope of such study. The consultant should also be fully equipped with required instruments and infrastructure for conducting EIA studies. The environmental consultant is responsible for supplying all the environment-related information required by the SPCB and IAA through the proponent. The consultant is also required to justify the findings in the EIA and EMP during the meeting with the expert groups at IAA.

***The Role of the State Pollution Control Board (PCB) /Pollution Control Committee*** **(PCC)**

The State PCBs/PCCs are responsible for assessing the compatibility of a proposed development with current operational and prescribed standards. If the development is in compliance, the PCB will then issue its NOC. They shall also hold the public hearing as per the provisions of EIA notification. The details of public hearing shall be forwarded to IAA.

***The Role of the Public***

The public also has an important role to play in EIA. The concerned persons will be invited through press advertisement to review information and provide their views on the

proposed development requiring environmental clearance.

***The Role of the Impact Assessment Agency (IAA)***

Where a proponent is required to obtain environmental clearance, the IAA will evaluate and assess the EIA report. In this process the project proponent will be given a chance to present his proposal. If a project is accepted the IAA will also prepare a set of recommendations and conditions for its implementation based on this assessment. Environmental clearance conditions and recommendations of IAA are made available to the public on request through SPCB and through web site at http://envfor.nic.in. During the implementation and operation of the project, the IAA will also be responsible for the environmental monitoring process.

## 2.5 The EIA Cycle and Procedures

The EIA process in India is made up of the following phases:

- Screening
- Scoping and consideration of alternatives
- Baseline data collection
- impact prediction
- Assessment of alternatives, delineation of mitigation measures and environmental impact statement
- Public hearing
- Environment Management Plan
- Decision making
- Monitoring the clearance conditions
- Catchment area treatment
- Audit trail

**Screening**

Screening is done to see whether a project requires environmental clearance as per the statutory notifications. Screening Criteria are based upon:

- Scales of investment;
- Type of development; and,
- Location of development.

**Scoping and consideration of alternatives**

Scoping is a process of detailing the terms of reference of EIA. It has to be done by the consultant in consultation with the project proponent and guidance, if need be, from Impact Assessment Agency.

The Ministry of Environment and Forests has published guidelines for different sectors, which outline the significant issues to be addressed in the EIA studies. Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration and non-quantifiable impacts (such as aesthetic or recreational value), significance is commonly determined through the socio-economic criteria. After the areas, where the project could have significant impact, are identified, the baseline status of these should be monitored and then the likely changes in these on account of the construction and operation of the proposed project should be predicted. An exhaustive list of all likely impacts is prepared. Manageable numbers of attributes which may have significant implication are selected. Various criteria applied for selection of the important impacts are:

a. magnitude
b. extent
c. significance
d. special sensitivity

**Baseline Data collection**

Baseline data describes the existing environmental status of the identified study area. The site-specific primary data should be monitored for the identified parameters and supplemented by secondary data if available.

**Impact Prediction**

Impact prediction is a way of 'mapping' the environmental consequences of the significant aspects of the project and its alternatives. Environmental impact can never be predicted with absolute certainty and this is all the more reason to consider all possible factors and take all possible precautions for reducing the degree of uncertainty.

The following impacts of the project should be assessed:

- Air
  - changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources
  - effects on soils, materials, vegetation, and human health
- Noise
  - changes in ambient levels due to noise generated from equipment and movement of vehicles
  - effect on fauna and human health
- Water
  - availability to competing users
  - changes in quality
  - sediment transport
  - ingress of saline water
- Land
  - changes in land use and drainage pattern

- changes in land quality including effects of waste disposal
- changes in shoreline/riverbank and their stability

- Biological
  - deforestation/tree-cutting and shrinkage of animal habitat.
  - impact on fauna and flora (including aquatic species if any) due to contaminants/pollutants
  - impact on rare and endangered species, endemic species, and migratory path/route of animals.
  - Impact on breeding and nesting grounds
- Socio-Economic
  - impact on the local community including demographic changes.
  - Impact on economic status
  - impact on human health.
  - impact of increased traffic

**Assessment of Alternatives, Delineation of Mitigation Measures and Environmental Impact Statement**

For every project, possible alternatives should be identified and environmental attributes compared. Alternatives should cover both project location and process technologies. Alternatives should consider 'no project' option also. Alternatives should then be ranked for selection of the best environmental option for optimum economic benefits to the community at large.

Once alternatives have been reviewed, a mitigation plan should be drawn up for the selected option and is supplemented with an Environmental Management Plan (EMP) to guide the proponent towards environmental improvements. The EMP is a crucial input to monitoring the clearance conditions and therefore details of monitoring should be included in the EMP.

An EIA report should provide clear information to the decision-maker on the different environmental scenarios without the project, with the project and with project alternatives. Uncertainties should be clearly reflected in the EIA report.

**Public Hearing**

Law requires that the public must be informed and consulted on a proposed development after the completion of EIA report.

Any one likely to be affected by the proposed project is entitled to have access to the Executive Summary of the EIA. The affected persons may include:

- bonafide local residents;
- local associations;
- environmental groups: active in the area
- any other person located at the project site / sites of displacement

They are to be given an opportunity to make oral/written suggestions to the State Pollution Control Board.

**Environmental Management plan**

EMP enumerates set of measures to be adopted to minimize the adverse impacts.

**Decision Making**

Decision making process involve consultation between the project proponent (assisted by a consultant) and the impact assessment authority (assisted by an expert group if necessary)

The decision on environmental clearance is arrived at through a number of steps including evaluation of EIA and EMP.

**Monitoring the Clearance Conditions**

Monitoring should be done during both construction and operation phases of a project. This is not only to ensure that the commitments made are complied with but also to observe whether the predictions made in the EIA reports were correct or not. Where the impacts exceed

the predicted levels, corrective action should be taken. Monitoring will enable the regulatory agency to review the validity of predictions and the conditions of implementation of the Environmental Management Plan (EMP).

**Catchments Area Treatment**

The CAT plan pertains to preparation of a management plan for the treatment of erosion prone areas in the catchments area of a WR Project.

**Audit trail**

Audit trail is a management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental management system and equipment are performing. Environmental audit (EA) is one of the management information system (MIS) that provide management with specific information on how the project is performing the environmental requirements and the internally established environmental objectives and policies. EA is a productivity linked concept.

A sequenced approach for impact significance determination is appropriate. A sequenced approach considers several levels in determining the potential significance of impacts from a proposed action. A sequenced approach is achieved by applying the following questions in order shown (the answer to any question can be used to determine if an EIS should be prepared):

1. Does the proposed project, plan, program, or policy cause impacts that exceed the definition of significant impacts as contained in pertinent laws, regulations, or executive orders?
2. Is a quantitative threshold criterion exceeded in terms of project, plan, or program type, size, or cost?

3. Is the project, plan, or program located in a protected habitat or land-use zone, or within an exclusionary zone relative to land usage? Is the environmental resource to be affected a significant resource?
4. Is the proposed project, plan, program, or policy in compliance with environmental laws, regulations, policies, and executive orders?
5. What is the anticipated percentage change in environmental factors from the proposed project and will the change be within the normal variability of the factors? What is the sensitivity of the environment to the anticipated changes, or is the environment susceptible or resilient to changes? Will the carrying capacity of the resource be exceeded?
6. Are there sensitive human, living, or inanimate receptors to the environment impacts (stresses) from the proposed project?
7. Can the anticipated negative impacts be mitigated in a cost-effective manner?
8. What is the professional judgment of experts in the substantive areas, such as water quality, ecology, planning, landscape architecture, and archaeology?
9. Are there public concerns due to the impact risks of the proposed project?
10. Are there cumulative impacts which should be considered, or impacts related to future phases of the proposed action and associated cumulative impacts?

Detailed specific questions related to these ten groups of questions can be developed. One thing that can be done in conjunction with identified significant negative impacts is to consider appropriate mitigation measures to reduce negative impacts within reasonable environmental and economic constraints. Mitigation includes (as per Council on Environmental Quality 1987):

1. Avoiding the impact altogether by not taking a certain action or parts of an action

2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation
3. Rectifying the impact by repairing, rehabilitating, or restoring the affected environment
4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the project/ action
5. Compensating for the impact by replacing or providing substitute resources or environments

These measures should be used in sequence or ease of application, beginning with avoiding the impact. Negative impact has three categories:

- ✓ Insignificant
- ✓ Significant but mitigable
- ✓ Significant but not mitigable

When potentially significant negative impacts are identified, and if they can be reduced via mitigation to something of lesser concern, a mitigated FONSI (finding of no significant impact) can be prepared following an EA (Environmental Assessment) and without doing a comprehensive study leading to an EIS (Environmental Impact Statement).

Environmental Impact Statement (EIS)

Before putting up proposals for project/scheme located in either rural/urban areas analysis of cost-benefits, cause-effect and environmental impact analysis should be carried out. The EIS should be comprehensive, the main purpose is to ensure that impacts of alternative action are evaluated and considered in project planning. The sequence of EIS will be:

i) Major objectives of the project

ii) The technological possibilities of achieving the objective

iii) Specify one or two alternatives for achieving the objectives

iv) evaluate the characteristics and conditions of the existing environment

v) analyze the likely impact of the actions on the existing environment

vi) recommend a suitable way of action

## 2.6 Environmental Baseline Status

Before start of any EIA study it is necessary to identify the baseline levels of relevant environmental parameters which are likely to be affected as a result of the construction and operation of the proposed project. A scoping matrix is formulated to identify various issues likely to be affected as a result of the proposed project.

Based on the specific inputs likely to accrue in the proposed project, aspects to be covered in the EIA study were identified. The other issues as outlined in the scoping matrix were then discarded. Thus planning of baseline survey commenced with the short listing of impacts and identification of parameters for which the data needs to be collected.

**Scoping Matrix for EIA study**

| Aspect of Environment | Likely Impacts |
|---|---|
| A. Land Environment | |
| Construction phase | - increase in soil erosion<br>- Pollution by construction spoils<br>- Use of land for labour colonies<br>- Problems due to muck disposal<br>- Solid waste from labour colonies<br>- Acquisition of land for various project appurtenances |
| B. Water resources & water quality | |
| Construction phase | - Increase in turbidity of nearby receiving water bodies<br>- Degradation of water quality due to disposal of waste from labour colony and construction sites |
| Operation phase | - Disruption of hydraulic regime<br>- Sedimentation & siltation risks<br>- Impacts on D.O. due to increased residence time in reservoir<br>- Eutrophication risks |

| | |
|---|---|
| C. Aquatic Ecology | |
| Construction phase | - Increased pressure on aquatic ecology as a result of indiscriminate fishing.<br>- Reduced productivity due to increase in turbidity |
| Operation phase | - Impacts on migratory fish species<br>- Impacts on spawning & breeding grounds<br>- Degradation of riverine ecology<br>- Increased potential for reservoir fisheries |
| D. Terrestrial Ecology | |
| Construction phase | - Increased pressure on nearby forests due to labour force to meet their fuel wood & timber requirements<br>- Adverse impacts due to migration of labour population |
| Operation phase | - Impacts on terrestrial flora<br>- Impacts on nature reserves due to various project appurtenances<br>- Impacts on wildlife movement<br>- Impacts on wildlife habitats<br>- Impacts on diversity and productivity of flora<br>- Impacts on economically/ genetically/biologically important plant species |
| E. Socio-Economics | |
| Construction phase | - Acquisition of land and private properties<br>- Impacts on archaeological & cultural monuments<br>- Impacts on mineral reserves<br>- Improved employment potential during the project construction phase<br>- Development of allied sectors leading to greater employment<br>- Pressure on existing infrastructure facilities<br>- Friction between guest and host community |
| Operation phase | - Increased revenue from power generation |
| F. Air Pollution | |

| | |
|---|---|
| Construction phase | - Impacts due to emissions generated by crushers and other equipment.<br>- Impacts due to increased vehicular movement<br>- Fugitive emissions from various sources. |
| G. Noise Pollution | |
| Construction phase | - Noise due to operation of various equipment<br>- Noise due to increased vehicular movement<br>- Noise due to blasting activities |
| H. Public Health | |
| Construction phase | - Transmission of disease by immigrant labor population<br>- Increased incidence of water related diseases |
| Operation phase | - Increased incidence of vector borne diseases |

**Summary of data collection from various sources**

| **Aspect** | **Mode of Data Collection** | **Parameters monitored** | **Frequency** | **Source(s)** |
|---|---|---|---|---|
| Meteorology | Secondary | Temperature, humidity, rainfall | - | India Meteorological Department |
| Water Resources | Secondary | Flow, Design hydrograph and design flood hydrograph | - | Hydrological Report |
| Water quality | Primary | Physico-chemical & biological parameters | Two seasons | Field studies |
| Ambient air quality | Primary | RPM, SPM, $SO_2$, $NO_x$ | Three seasons | Field studies |
| Noise | Primary | Hourly noise and equivalent noise level | Two seasons | Field studies |
| Land use | Primary and secondary | Land use pattern | - | NRSA & Ground truth studies |
| Geology | Secondary Geological characteristics of study area | - | - | Geological survey being conducted for the project as a |

| | | | | |
|---|---|---|---|---|
| | | | | part of DPR preparation |
| Soils | Primary | Physico-chemical parameters | Two seasons | Field studies |
| Terrestrial Ecology | Primary and secondary field survey | Floral & faunal diversity | Two seasons | Field studies, Forest Department and literature |
| Aquatic Ecology | Primary and secondary | Presence and abundance of various species | Two seasons | Field studies, Forest Department and literature review |
| Socio-economic aspects | Primary and secondary | Demographic & socio-economic, Public health cultural | - | Field studies, Revenue Department and literature review. |

Primary data = data obtained from field survey

Secondary data = data obtained from other department, literature review etc.

## 2.7 Conclusion

The preparation of an appropriate description of the environmental setting is one of the key steps in the EIA process. Proper delineation of a list of environmental factors to be addressed as well as documentation of information and data utilized is a necessary component of this phase. A summary of detailed technical information and data should be provided with the referenced information appropriately contained in tables, maps, footnotes and appendices. Several approaches can be used for developing a list of pertinent environmental factors for a given project. No single approach is universal and utilization of a combination of approaches leads to the best results. The information and data sources for relevant environmental factors are manifold, however these can generally be narrowed to a minimal number of key sources.

## 3.1 Introduction

Environmental index is a numerical or descriptive categorization of a large quantity of environmental data or information with the primary purpose to simplify such data and information so as to make it useful to decision makers and various publics. Objectives of environmental indices are:

- To summarize existing environmental data
- To communicate information on the quality of the affected (baseline) environment
- To evaluate the vulnerability of environmental category to pollution
- To focus attention on key environmental factors
- To forecast difference between the pertinent index with the project and without the project

The following ratios yield relative indices that can be useful in EIA:

a) Existing quality/Environmental quality standard

b) Emission quantity or quality/Emission standard

c) Existing quality/Temporal average

d) Existing quality/Spatial (geographical) average

## 3.2 Typical Impacts of Dams and Reservoirs

1. Change in quality of impounded water (seasonal).
2. Water loss due to evaporation (seasonal).
3. Downstream effects; decreased (and more uniform) flow into estuaries, thus causing changes in saltwater intrusion patterns and changes in estuarine fisheries.
4. Increased cultivated lands and agricultural produce.
5. Hydropower generation, cleaner energy production.
6. Changes in local groundwater levels and quality.

7. In-reservoir landslides, increased regional seismic activity due to water pressure.
8. Changes in microclimate of area-more wind, humidity, and/or precipitation.
9. Inundation of mineral resources.
10. Flood control.
11. Drought management.
12. Changes in number and types of fish-from cold water to warm water fishery.
13. Preclusion of movement of migratory fish.
14. Fish destruction in turbines and pumps (use protective screens).
15. Possible creation of "new reservoir fishery" as positive impact.
16. Increase areas or breeding of mosquitoes and related insects – and their public health implications (e.g., malaria and schistosomiasis).
17. Promote growth of aquatic weeds such as water hyacinths.
18. Changes to habitat in inundated area and wildlife associated with habitat.
19. Changes to waterfowl habitat from shallow, flowing habitat to deeper lakes; possible impact on migratory birds.
20. Impacts on rare, threatened, endangered, unique flora and fauna.
21. Decrease in waste assimilative capacity of river segment.
22. Inundation of historical, cultural, archaeological, or religious resources.
23. People relocation-resettlement (and possible change in style of life).
24. Influx of construction workers associated social, infrastructure, health impacts.
25. Increased tourism around reservoir.
26. Downstream effects on traditional floodplain cultivation; reduced flood delivery of nutrients to downstream fields.
27. Developments in catchment area resulting from roads and from other associated increases in sediment and nutrients into reservoir.

28. Grazing land capacity and livestock breeding.

29. Reduction of energy generated from fossil fuel.

30. Transboundary impacts.

31. Direct and indirect effects on GDP.

## 3.3 Air Quality

PSI (Pollution Standard Index) is used in describing air quality in an air impact study. Five pollutants (total suspended particulates, sulfur dioxide, carbon monoxide, oxidants and nitrogen dioxide) are considered individually in the PSI.

PSI (Subindex$_{i)}$ = (concentration of pollutant / short-term primary standard) * 100

These short term (24 hours or less) primary standards represent the concentration below which adverse health effects have not been observed. The reported daily PSI is the maximum subindex for the five pollutants.

Ambient air quality standard

| pollutant | Primary (health related) | | Secondary (welfare related) | |
|---|---|---|---|---|
| | Type of average | Standard level concentration | Type of average | Standard level concentration |
| CO | 8-hour | 9 ppm | | |
| $NO_2$ | Annual arithmetic Mean | 35 ppm | Same as primary standard | |
| $SO_2$ | Annual arithmetic Mean | 80 $\mu g/m^3$ | 3-hour | 1300 $\mu g/m^3$ |
| | 24-hour | 365 $\mu g/m^3$ | | |

## 3.4 Conceptual approach for addressing Air environment impacts

To provide a basis for addressing air environment impacts a six step model is suggested:

Step 1 – Identification of air quality impacts of proposed project

Step 2 – Description of existing air environment conditions

Step 3 – Procurement of relevant air quality standards and/or guidelines

Step 4 – Impact prediction

Step 5 – Assessment of impact significance

Step 6 – Identification and incorporation of mitigation measures

In water resources project air pollution occurs mainly during project construction phase. The major sources of air pollution during construction phase are:

- Fuel combustion in various construction equipments, e.g. crushers, drillers, rock bolters, diesel generators, vehicles, etc.
- Fugitive emissions from crushers
- Impact due to vehicular movement

Pollution due to fuel combustion in various equipments

The operation of various construction equipments requires combustion of fuel. Normally diesel is used in such equipment. The major pollutant which gets emitted as a result of combustion of diesel is $SO_2$. The SPM (Suspended Particulate Matter) emissions are minimal due to low ash content.

Based on past experience in similar projects, the increase in SPM and $SO_2$ is not expected to increase significantly due to combustion of fuel in various construction equipments.

Emission from various crushers

The operation of crusher during the construction phase is likely to generate fugitive emissions comprising of suspended particulate, which can move even upto 1 km in predominant wind direction. There could be marginal impacts to settlements close to the sites at which crushers are commissioned. However based on past experience, adverse impacts on this account are not anticipated. However during finalizing the project layout it should be

ensured that the labour camps, colonies, etc. are located on the leeward side and outside the impact zone (about 1.5 to 2.0 km) of the crushers.

Impact due to vehicular movement

During construction phase there will be increased vehicular movement for transportation of various construction materials to the project site. Large quantity of dust is likely to be entrained due to the movement of trucks and other heavy vehicles. However such ground level emissions do not travel for long distances. Thus no major adverse impacts are anticipated on this account.

## 3.5 Conceptual approach for addressing surface water environment impacts

To provide a basis for addressing surface water environment impacts a six step model is suggested:

Step 1 – Identification of surface water quantity/quality impacts of proposed project

Step 2 – Preparation of description of existing surface water resource conditions

Step 3 – Procurement of relevant surface water quantity/quality standards

Step 4 – Impact prediction

Step 5 – Assessment of impact significance

Step 6 – Identification and incorporation of mitigation measures

The various aspects covered under water environment are:

- water resources
- water quality
- sediments

Water resources

The construction of dam/barrage leads to formation of water spread area. The passage of flood through a water spread area leads to the reduction in peak flow. The dry season flow

in the river too is regulated. The river stretch d/s of the dam/barrage site will have reduced flow.

Water quality

(a) Construction phase

The major sources of surface water pollution during project construction phase are as follows:

- Sewage from labour camps/colonies
- Effluent from crushers
- Effluents from other sources

(b) Operation phase

The major sources of water pollution during project operation phase include:

- Effluent from project colony
- Impacts on water quality
- Eutrophication risks

The flooding of previously forest and agricultural land in the submergence area will increase the availability of nutrients resulting from decomposition of vegetative matter. Enrichment of water with organic and inorganic nutrients will be the main water quality problem immediately on commencement of the operation. However this phenomenon is likely to last for short duration of few years from the filling up of the reservoir.

Another significant impact observed in the reservoir/water spread area is the problem of eutrophication which occurs mainly due to the disposal of nutrient rich effluents from the agricultural fields.

Sediments

When river flows along a steep gradient, it could carry a significant amount of sediment load, depending on the degradation status of the catchments. When a hydraulic structure is

built across the river, it creates a water spread area which tends to accumulate the sediment, as the suspended load settles down due to decrease in flow velocity.

## 3.6 Conceptual approach for addressing land and ground water environment impacts

To provide a basis for addressing soil and/or ground water environment impacts a six step model is suggested for the planning and conduction of impact studies.

Step 1 – Identification of soil and/or ground water quantity-quality impacts of proposed project

Step 2 – Preparation of description of existing soil and/or ground water resource condition

Step 3 – Procurement of relevant soil and/or ground water quality standards

Step 4 – Impact prediction for soil and/or ground water environment

Step 5 – Assessment of impact significance

Step 6 – Identification and incorporation of mitigation measures

The major impacts anticipated on land environment are as follows:

- Quarrying operations
- Operation of construction equipment
- Soil erosion
- Muck disposal
- Impacts due to construction of roads
- Acquisition of land

Quarrying operations

Any major WR Projects requires significant amount of construction material. A part of requirement can be met by using the muck generated during excavation of foundation, tunnel, power house and other project appurtenances, by crushing it into required size. The quantum of muck generated to be used as construction material would depend upon the

engineering properties of the muck and its suitability for construction. The balance requirement of construction material would be met by quarrying from appropriate locations. The quarrying operations are semi-mechanized in nature. Normally in a hilly terrain like Uttaranchal, H.P., quarrying is normally done by cutting a face of the hill. A permanent scar is likely to be left, once quarrying activities are over. With the passage of time rock from the exposed face of the quarry under the action of wind and other erosional forces, get slowly weathered and after some time they become a potential source of landslide. Thus it is necessary to implement appropriate slope stabilization measures to prevent the possibility of soil erosion and landslides in the quarry sites. Efforts must be made to select suitable quarry sites so that the adverse environmental impacts are minimized to the extent possible.

Operation of construction equipment

During construction phase various types of equipments will be brought to the site. These include crushers, batching plant, drillers, earth movers, rock bolters, etc. The siting of these construction equipment would require significant amount of space. In addition land will also be required for storing the construction materials. The various criteria for selection of these sites would be:

- proximity to the site of use
- sensitivity of forests in the nearby areas
- proximity from habitations

Efforts are made that the adverse impacts on environment are minimal i.e. locate the construction equipments in such a way that impacts on human and faunal population is minimal.

**Soil erosion**

Runoff from construction sites entering small rivers would have significant adverse impact on their water quality. The runoff would increase the turbidity levels with

corresponding adverse impacts on photosynthetic action and biological productivity. Adequate measures need to be implemented as a part of EMP to ameliorate this adverse impact to the extent possible.

**Muck disposal**

A large quantity of muck is generated during construction. Based on geological nature of the rocks and engineering properties of the soil, a part of the muck can be used as construction material, the balance requires to be suitably disposed. Normally muck is disposed in low lying areas or depressions. Trees if any are cut before muck disposal, however shrubs, grass or other types of undergrowths in the muck disposable sites perish. A part of muck can be disposed by landfilling the sites where many of the project appurtenances are likely to come up and require landfilling. Similarly a part of the muck can be used for restoration of the construction sites. Adequate measures need to be implemented as a part of EMP to ameliorate this adverse impact to the extent possible.

**Construction of roads**

Project construction requires significant vehicular movement. New access roads would have to be constructed and some of the existing roads in the area would require widening. The construction of roads can lead to the following impacts:

- The topography of project area has steep slopes which descend rapidly into narrow valleys. The conditions can give rise to erosion hazards due to net downhill movement of soil aggregates. Removal of trees on slopes and re-working of the slopes in the immediate vicinity of roads can encourage landslides, erosion gullies, etc. With the removal of vegetal cover erosive action of water gets pronounced and accelerates the process of soil erosion and formation of deep gullies. Consequently the hill faces are bared of soil vegetative cover and enormous quantities of soil and

rock can move down the rivers and in some cases the road itself may get washed out.

- Construction of new roads increases the accessibility of an undisturbed areas resulting in greater human interferences and subsequent adverse impacts on the ecosystem.
- Increased air pollution during construction phase.

Adequate measures need to be implemented as a part of EMP to ameliorate this adverse impact to the extent possible.

## 3.7 Conceptual approach for addressing noise environment impacts

To provide a basis for addressing noise environment impacts a six step model is suggested for the planning and conduction of impact studies.

Step 1 – Identification of noise impacts of proposed project

Step 2 – Preparation of description of existing noise environment condition

Step 3 – Procurement of relevant noise standards and/or guidelines

Step 4 – Impact prediction

Step 5 – Assessment of impact significance

Step 6 – Identification and incorporation of mitigation measures

In WR Projects, the impacts on noise levels are expected only during the project construction phase due to earth moving machinery, quarrying, blasting, vehicular movement etc. The noise levels due to operation of various construction equipments are shown below:

**Noise level due to operation of various construction equipment**

| **Equipment** | **Noise level (dB(A))** |
|---|---|
| **Earth moving** | |
| Compactors | 70-72 |
| Front loaders | 72-82 |
| Backhoes | 72-92 |
| Tractors | 76-92 |
| Scrappers, graders | 82-92 |
| Pavers | 86-88 |

| | |
|---|---|
| Truck | 84-94 |
| **Material handling** | |
| Concrete mixers | 75-85 |
| Movable cranes | 82-84 |
| **Stationary** | |
| Pumps | 68-70 |
| Generators | 72-82 |
| Compressors | 75-85 |
| **Others** | |
| Vibrators | 69-81 |
| Saws | 74-81 |

Under the worst case scenario considered for prediction of noise levels during construction phase it has been assumed that all these equipments generate noise from a common point.

## 3.8 Conceptual approach for addressing biological environment impacts

To provide a basis for addressing biological environment impacts a six step model is suggested for the planning and conduction of impact studies.

Step 1 – Identification of biological impacts of proposed project

Step 2 – Preparation of description of existing biological conditions and consideration of endangered or threatened species and critical habitat

Step 3 – Procurement of relevant laws, regulations or criteria related to impacts and/or conditions

Step 4 – Impact prediction

Step 5 – Assessment of impact significance

Step 6 – Identification and incorporation of mitigation measures

Biological impact is also called "Ecological impact". It is of two types:

1. Terrestrial Ecology
2. Aquatic ecology

**Terrestrial Ecology**

a) Increased human interferences

A large no. of workers are likely to assemble in the project area during construction phase. They may use wood as a fuel requirement. This causes adverse impact on terrestrial flora.

b) Acquisition of forest land

During project construction phase land will also be required for location of construction equipment, storage of construction material, muck disposal, widening of existing roads and construction of new project roads. Out of which a part of it could be forest land and rare species may be endangered.

c) Impacts on plants of ethno botanical or medicinal importance

Land acquisition can affect plants of medicinal importance.

d) Disturbance to wildlife

During construction phase large no. of machinery and construction labour will have to be mobilized. The operation of various construction equipment and blasting is likely to generate noise. These activities can lead to some disturbance to wildlife population.

e) Impacts due to increased accessibility

During the project operation phase the accessibility to the area will improve due to construction of roads, which in turn may increase human interferences leading to marginal adverse impacts on the terrestrial ecosystem.

**Aquatic ecology**

a) Construction phase

The construction would involve large scale extraction of different types of construction material from the river bed including boulders, stones, gravel, sand etc. Extraction of gravel and sand causes considerable damage to fish stocks and other aquatic life by destabilizing the sub-stratum, increasing the turbidity of water, silting of the channel bottom and modifying the flow which in turn may result in erosion of the river channel.

These alterations upset the composition and balance of aquatic organisms. The material at river sub-stratum like stones and pebbles often provide anchorage and home to the invertebrates that remain attached in a fast flowing stream. The turbidity in excess of 100 ppm brought by suspended solids chokes the gills of young fish. Fine solids in concentration greater than 25 mg/l adversely affect the development of fish eggs and fish. During construction of a river valley project huge quantity of debris is generated at various construction sites. The debris, if a separate area for dumping of the material is not marked, invariably would flow down the river during heavy precipitation. Such a condition is adverse for the development of aquatic life. The inadequate system for dumping of debris can lead to many undesirable impacts. Hence it is very much desirable that a suitable area is earmarked for the disposal of muck generation during the construction phase.

b) Operation phase

WR Project would bring about significant changes in the riverine ecology as the river transforms from a fast flowing water system to a quiescent lacustrine environment. Such an alteration of the habitat would bring changes in physical chemical and biotic life. The migratory fish species like snow trouts are likely to be affected due to obstruction created by the dam/barrage.

With the completion of dam/barrage flow in the d/s stretch of the river would be reduced considerably more so during the lean period. The most important changes which can be expected are:

- reduced flow rate
- increase in water temperature
- reduction in availability of stano-thermal aquatic animals
- increase in population of euro-thermal species

Unless the desired flow is maintained d/s of the dam/barrage, aquatic ecology in general and fisheries in particular would be affected.

## 3.9 Basic steps for cultural impact prediction and assessment

Fundamental steps associated with cultural impact assessment are:

Step 1 – Identify known cultural resources in the area of interest like historical and archaeological sites, areas of ecological, scientific, or geological significance and areas of ethnic importance.

Step 2 – Identify potential cultural resources in the area of interest.

Step 3 – Determine significance of known and potential cultural resources relative to local, regional, and national concerns

Step 4 – Delineate possible impacts of alternatives in the area of interest.

Step 5 – Depending upon the findings of step 3 and 4 above, either (a) proceed with the selection of one proposed action from the alternatives, or (b) eliminate one or more alternatives and then proceed with selection of the proposed action. Develop mitigation measures for impact minimization and cultural resource preservation.

Step 6 – Develop procedures that will be used during the construction phase in the case of discovery of previously unidentified cultural resources.

Historical and archaeological resources are often referred to as *cultural resources*. Possible impacts on cultural resources include inundation, destruction, disruption or disturbance. Cultural resources are non-renewable, so it is important. Typical mitigation measures include:

1. Limiting the magnitude of the undertaking
2. Modifying the undertaking through redesign, reorientation of construction
3. Repair, rehabilitation or restoration of an affected historic property
4. Preservation and maintenance operations for involved historic properties

5. Documentation (drawings, photographs, histories) of buildings or structures that must be destroyed or substantially altered
6. Relocation of historic properties
7. Salvage of archaeological or architectural information and materials

## 3.10 Conceptual approach for addressing socioeconomic impacts

To provide a basis for addressing socioeconomic impacts a six step model is suggested for the planning and conduction of impact studies.

Step 1 – Identification of potential socioeconomic impacts

Step 2 – Preparation of description of existing socioeconomic conditions

Step 3 – Procurement of relevant standards, criteria or guidelines

Step 4 – Impact prediction for without-project and with-project conditions

Step 5 – Assessment of socioeconomic impact significance

Step 6 – Identification and incorporation of mitigation measures in design of project activity

It is imperative to study the socio-economic characteristics of the project area as well as the study area (i.e. submergence area, buffer of 7.0 km of periphery of water spread area and other appurtenances of the project, and catchment area). Various socio-economic characteristics to be studied are:

**1. Socio-economic profile of the study area villages**

a. population – data is collected in the table below.

Population details of study area villages

| S.no. | Village name | Total popula-tion | Male | Female | SC | | ST | | Literacy | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Male | Fem-ale | Male | Female | Male | Fema-le |
| | | | | | | | | | | |

b. Caste profile – data is collected in above table format.

a. Literacy rate – data is collected in the above table format.

b. Occupational profile – data is collected in the table below.

Occupational profile of study area villages

| S. no | Village name | Total main worker | | Marginal worker | | Non-workers | |
|---|---|---|---|---|---|---|---|
| | | Male | Female | Male | female | Male | female |
| | | | | | | | |

Occupational profile of main workers in study area villages

| S. no. | Village name | Cultivators | | Agricultural labourers | | Livestock, forestry, fishing etc. workers | | Manufacturing & processing at household level | |
|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Male | Female | Male | Female | Male | Female |
| | | | | | | | | | |

Table contd/-

| Manufacturing & processing other than household level | | Construction workers | | Trade & commerce workers | | Transp. & communication workers | | Other services workers | |
|---|---|---|---|---|---|---|---|---|---|
| Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| | | | | | | | | | |

Occupational profile of main workers in the study area

| **Occupation** | **Percentage of main workers** |
|---|---|
| Cultivators | |
| Agricultural labour | |
| Livestock workers | |
| Industrial labour | |
| Construction workers | |
| Trade & Commerce workers | |
| Others | |
| Total | 100.00 |

**2. Infrastructural development**

a) Road network – data is collected in the table below

Road network in study area villages

| S. no. | Village name | Approachable by pucca road | Approachable by kutcha road | Approachable by footpath |
|---|---|---|---|---|
| | | | | |

b) Post & Telegraph facility – data is collected in the table below.

Status of P & T facilities in study area villages

| S. no. | Village name | Post office | Telegraph office | Post & Telegraph office |
|---|---|---|---|---|
| | | | | |

c) Transportation facilities – data is collected in the table below.

Transportation facilities in study area villages

| S. no. | Village name | Bus stop | Taxi /Tempo stand | Railway station |
|---|---|---|---|---|
| | | | | |

d) Medical facilities – data is collected in the table below

| S. no. | Village name | Health centre/ Hospital | Mat. & child welfare centre | Child welfare centre | Health centre | Primary health centre | Primary health sub-centre | Dispensary | Regd. Private practitioner |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

e) Educational facilities – data is collected in the table below

| S. no. | Village name | Primary school | Middle school | High school | Pre university college |
|---|---|---|---|---|---|
| | | | | | |

**3. Socio-economic impacts**

a) Immigration of labour population

b) Increased incidence of water related diseases

4. Socio-economic aspects

a) Caste status – The caste profile amongst the surveyed household is outlined below

Caste profile of surveyed households

| **Caste** | **No. of households** |
|---|---|
| General caste | |
| Schedule Tribes | |
| No response | |
| total | |

b) Population – Population detail of project affected families (PAFs) are outlined below

Population of surveyed households

| S. no. | Village name | No. of households | Male | Female | Total | Family size | No. of female per 1000 male |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

c) Marital status – The detail of marital status of the surveyed population is also collected as a part of social survey in the table below.

Marital status of project affected population

| S. no. | Village name | Single | Married | Widow | Widower | Total |
|---|---|---|---|---|---|---|
| | | | | | | |

d) Literacy rate – data of PAFs is collected in the table below

| **Level** | **Village 1** | **Village 2** | **Total** |
|---|---|---|---|
| Primary | | | |
| Middle school | | | |
| Secondary | | | |
| Graduate | | | |
| Post-graduate | | | |
| No response | | | |
| Illiterates | | | |
| Total | | | |

e) Occupational profile – data of PAPs are collected in the table below

Occupational profile of the surveyed population

| **Category** | **Number** |
|---|---|
| Agriculture | |
| Government service | |
| Private service | |
| Army | |
| House wife | |
| Student | |
| Student | |
| Business/shop | |
| Others | |
| No response | |
| Retired | |
| Unemployed/not working | |
| **Total** | |

f) House – facility in house of PAFs is collected in the table below

| **Facility available** | **Number of houses** |
|---|---|
| Separate kitchen | |
| Lavatory | |
| Grain storage | |
| Cattle shed | |

g) Livestock – detail is collected in the table below.

Livestock owned by PAFs

| **Livestock** | **Number** |
|---|---|
| Cows | |
| Calf | |
| Pig | |
| Buffalo | |
| Goat | |
| Total | |

h) Material assets – common type of assets owned by PAFs is collected in the table below.

Details of assets owned by surveyed households

| **Assets** | **Number** |
|---|---|
| Television | |
| Tape-recorder | |
| Radio | |
| LPG | |
| Plough | |
| Cycle | |
| Two wheeler | |
| Four wheeler | |

i) Resident households – the information of resident population amongst the PAFs are collected in the table below.

Status of resident population

| S. no. | Village name | Within village | Outside village | Total |
|---|---|---|---|---|
| | | | | |

j) Source of water – data is collected in the table below.

Source of water used by PAFs

| S. no. | Village name | River/stream | Pipe & Tap water | Data not available | Total |
|---|---|---|---|---|---|
| | | | | | |

k) Source of fuel – major sources of fuel used by PAFs are collected in the table below.

Sources of fuel used by PAFs

| S. no. | Village name | Chulah | LPG | Gobar gas | Data not available | Total |
|---|---|---|---|---|---|---|
| | | | | | | |

l) Sources of irrigation – data is collected in the table below

Source of irrigation for PAFs

| S. no. | Village name | Rain | Stream | Data not available | Total |
|---|---|---|---|---|---|
| | | | | | |

m) Tree owned by PAFs – number of trees owned by PAFs are collected in the table below

Number of trees owned by PAFs

| **Tree** | **Number** |
|---|---|
| Mango | |
| Neem | |
| Apple | |
| Orange | |
| Others | |

**5. Rehabilitation and Resettlement (R&R) Aspect**

R&R is probably one of the most important aspect for any WR Project. Rehabilitation and Resettlement refers to two distinct aspects.

a) Rehabilitation

When the means of earning are lost due to the land acquisition for a project, the affected person needs similar or alternate source of sustenance. The term Rehabilitation refers to the processes or means which enable the affected person to regain, if not improve, his previous level of income and standard of living. For example if a part or entire land of a person is lost due to land acquisition for a project, the affected person loses the source of income. In a rural environment a farmer has practiced agriculture for generations and has developed substantial skills to sustain even under adverse environment conditions. When the land is taken away for the project, he may have little skills to adapt to alternate means of income. That is the precise reason why in India, land based settlement is preferred. However it is difficult to get alternative land for rehabilitation.

b) Resettlement

When a person loses his homestead due to land acquisition for a project, alternate homestead is to be provided. The term Resettlement refers to the process through which the affected person is shifted to his new homestead which enables him to continue his 'business as usual' activities, if not an improved lifestyle.

**6. Need for R&R plan**

R&R plan is essential because of the following:

- Though the land is acquired for different interest, the acquisition is involuntary. The affected person faces forcible eviction and has no choice, but to accept the consequences. The affected person therefore needs support to regain his previous levels of standard of living.
- Improper resettlement and rehabilitation is the root cause of discontentment and alienation among Project Affected Persons (PAPs). No project can be successfully implemented without the cooperation of the local population.

**7. Basic issues involved in framing a Rehabilitation Action Plan (RAP)**

Acquisition of land induces a large scale change in land use patterns and can destroy the economic base. The RAP is to be formulated so that after a reasonable transition period the displaced persons improve or at least regain their previous standard of living, earning capacity and production levels. The transition gap is to be reduced to a minimum.

**8. Categories of PAPs and RAP Entitlements**

For R&R purpose it is necessary that the PAPs be classified into different categories. PAPs cover the following:

- A person whose entire land is acquired.
- A person owing land which is not economically viable after acquisition. In some states the minimum amount of land considered economically viable is 2 ha,

adjustment needs to be made depending on local conditions such as soil fertility, access to water (irrigation) and other factors.

- A person whose homestead only is acquired.
- A person whose homestead and land is acquired.
- A person (tenant tiller) who is in actual possession of land which is acquired.
- A person (agricultural labour) who does not have legal title to the land which is acquired but earns his living principally through manual labour on that land.
- A tribal residing or deriving livelihood from the forest land which is acquired.
- A landless person cultivating on the government land which is acquired.
- Persons dependent upon the land either directly or indirectly and having a client relationship with the displaced community.
- In a joint family or joint holding, a person (major) who has a share in the land or homestead.
- A permanent resident of the area which is acquired but not defined above.
- A person (absentee land owner or absentee homestead owner) who is not in actual possession of land or homestead for 5 years prior to the date of notification under the LA Act.

*Eligibility Status*

The resettlement and rehabilitation entitlements for various categories of PAPs are given in the table below.

**Resettlement and Rehabilitation entitlements for various categories of PAPs**

| S. No. | Category of PAPs | Resettlement/Rehabilitation Entitlements |
|---|---|---|
| 1. | Person losing entire land | Land for land or self-employment or shop or award of petty contract or job (after accounting for compensation legally due under land acquisition act) – **(Set-A)** |
| 2. | Person left with land not economically viable (less than 2 ha.) | Set-A |

| | | |
|---|---|---|
| 3. | Person whose homestead is acquired | Alternate house site along with community infrastructural facilities and other rehabilitation assistance – **(Set-B)** |
| 4. | Person whose homestead and land is acquired | Both Set-A and Set-B |
| 5. | Person (tenant tiller) in actual possession of land | Set-A when no claim made by original landlord |
| 6. | Agricultural laborer without legal title of land | Self-employment or shop or award of petty contract or job – **(Set-C)** |
| 7. | Tribal residing or deriving livelihood from forest land | Set-C and Set-D. Tribal will receive special attention to restore their income |
| 8. | Landless person cultivating government land | Set-C |
| 9. | Person having client relationship with displaced community | Assistance to establish the type of facilities lost on account of land acquisition. Assessment in such case will be separately carried out by working department and/or the State Administration with PAPs – **(Set-D)** |
| 10. | Permanent resident of land not covered above | Set-D |
| 11. | In a joint family or joint holding, a person (major) who has share | Set-B |

**9. Monitoring and Evaluation**

The R&R scheme will be monitored and evaluated periodically after the completion of the land acquisition process. A separate group, both at the project (site group and corporate centre group) would be constituted for implementation of the RAP, monitoring and evaluation of the RAP with respect to time and cost frame.

## 3.11 Conclusion

Environmental indicators and/or environmental indices can be useful tools in preparing a description of the environmental setting for a proposed project. These tools can aid in gathering and summarizing extant data in communicating information on existing environmental quality and in providing a structured basis for impact prediction and assessment. The preparation of an appropriate description of the environmental setting is one of the key steps in the EIA process. Several approaches can be used for developing a list of

pertinent environmental factors for a given project. No single approach is universal and utilization of a combination of approaches leads to the best results.

## 4.1 Introduction

Based on the environmental baseline conditions, planned project activities and impacts assessed earlier the Environmental Management Plan (EMP) enumerates set of measures to be adopted to minimize the adverse impacts. The most reliable way to ensure the implementation of EMP is to integrate the management measures in the overall project planning, designing, construction and operation phases.

Environmental monitoring is an essential component for sustainability of any water resources project. It is an integral part of any environmental assessment process. Any WR Development project introduces complex interrelationships in the project area between people, various natural resources, biota and the many developing forces. Thus a new environment is created. It is very difficult to predict with complete certainty the exact post-project environmental scenario. Hence monitoring of critical parameters is essential in the project operation phase. An environmental monitoring programme has following objective:

1. Assess the changes in environmental conditions if any during construction and operation of the project.
2. Monitor the effective implementation of mitigatory measures.
3. Warning of any significant deterioration in environmental quality so that additional mitigatory measures may be planned in advance.

## 4.2 Environmental Management Plan (EMP)

Environment Management Plan should include:

- Delineation of mitigation and compensation measures for all the identified significant impacts
- Delineation of unmitigated impacts
- Physical planning including work programme, time schedule and locations for putting mitigation and compensation systems in place

- Delineation of financial plan for implementing the mitigation measures in the form of budgetary estimates and demonstration of its inclusion in the project budget estimates.

Management plans for ensuring sustenance and friendly environment in River-Valley projects includes:

**1. Rehabilitation**

Efforts should be made towards improving the quality of life of displaced families and preserving to the extent possible the special characteristics of their life style. Preference should be given to land oustees in employment and allotment of shops in the project township.

**2 Live Storage of Reservoir and Silt Deposition**

For maintaining live storage capacity on a long term basis appropriate sediment control measures in the catchment area should be taken. In the design of dam an effective method of silt control is by releasing water through a series of outlets at various elevations during monsoon periods.

**3. Stream flow**

The dam will change the river flow d/s. The minimum river flow should normally not fall below average10-days minimum flow of the river in its natural state. Reservoir operation should be such that 2 or 3 spills of reasonable discharge are allowed in the river on a regular basis so that river water quality is maintained within the permissible limits.

**4. Safety of Structures**

The design should ensure that the hydraulic structures are safe against the largest expected earthquakes.

**5. Water Quality Management**

Water quality can be maintained or enhanced by catchment area treatment to reduce sediment load, adequate treatment of effluents to attain the standards.

**6. Water Demands and Sanitation**

Demand on fresh water can be reduced through water pricing as well as recycling and reuse.

**7. Water logging and Salinity**

Water logging can be prevented by providing adequate drainage adopting conjunctive use of ground water, prevention of leakage and seepage losses and use of water efficient methods of irrigation (drip, sprinkler) and water conservation measures.

Saline land can be utilized for raising crops having higher salt tolerance like alfalfa, barley, tobacco, cotton, sugarcane. Crop rotation, chemical treatment can also be used.

**8. Prevention of Lake Eutrophication**

Eutrophication can be prevented by:

c. Proper treatment of domestic and industrial waste reaching to water bodies.

d. Efficient application of fertilizers to the crops so that the amount leached is kept to a minimum.

e. Soil conservation measures.

**9. Control of Aquatic Weeds**

Three methods are used mechanical, chemical, and biological..

**10. Wild Life Conservation**

The EIA should include a description of significant wildlife resources in the project area. This includes description of their behavioral and ranging patterns and habitat requirements in order to indicate the projects expected effects on the species and measures for offsetting any detrimental effects.

**11. Management of Aquatic Life**

The quality of effluents entering the stream/reservoir must confirm to discharge standards stipulated in IS-2490. The stream/reservoir water quality must satisfy IS-2296. The Oxygen

level in stream/reservoir must remain above 4.0 mg/l, or as required by the species whichever is higher.

**12. Preservation of Archaeological Monuments**

Historical and archaeological resources are often referred as 'cultural resources'. Cultural resources management may involve consideration of the potential impacts of proposed projects on various components constituting society's culture, including its historic and archaeological resources. As per NEPA "preserve important historic, cultural, and natural aspects of our national heritage".

**13. Eco- Tourism**

The lake with its water spread area will provide excellent potential for developing tourist centers. The lake can be provided for boating. Recreation centre at appropriate locations can be developed where plantations, gardens, resting places etc. can be planned.

**14. Public Health**

Possible effects on the community as a whole should focus on aspects of project that could increase the risk of personal harm such as, air quality, water quality, possibility of accidental release of health threatening pollutants into water supply, increased chances of flooding problems.

**15. Education for Sustainable Water Resources Management**

People should be educated for proper use and conservation of water resources such as Groundwater, Surface water, Water supply and wastewater system, Wild and scenic rivers.

**16. People's Participation in Management of National Water Wealth**

People should treat water as a national wealth. People should participate to manage water.

## 4.3 What should be monitored

- Stipulated conditions
- Implementation of EMP

- Priority should be given to specific condition(s) related to the project
- Issues raised in the Public Hearing

Environmental Monitoring System

Environmental monitoring and evaluation is the most valuable tool to determine whether the sources of pollution of natural resource exploitation are exceeding the acceptable limits, and if they do it will serve as formulation and enforcement of environment related policies, laws, rules and regulations. Only the actual implementation of an activity will be able to give rise to an environmental impact. Monitoring of the actual impact of the implemented activity is therefore considered as utmost important. Monitoring can be done for different purposes. The main reason is data acquisition for improved management of the environment. Monitoring has two components:

i) to maintain the correct implementation of the decision

ii) compare the actual impact with the impact as predicted during EIA

Monitoring goals can be specified in terms of:

a) Identification- recognizing trends, patterns and relations

b) Surveillance- reconnaissance of critical parameters, determination of threshold values

c) Process control- feed back between measured and desired values

d) Recording of archives- generating statistical evidence of mean values, extreme values and specific percentiles.

With regard to WR projects common parameters to be monitored are:

a) Physical parameters- hill cutting, blasting, land use change, laying of tunnel and potential seismic impact of reservoir loading.

b) Biological parameters- flora and fauna, wild life breeding areas, migration route, change in agriculture and impact of construction workers on surroundings

c) Geo-chemical parameters- degradation of soil, salinity, water logging, leaching of nutrients trace elements, water table, pesticide/fertilizer use and soil erosion.

d) Socio-economic parameters- immigrant population, change in existing/future development in the region, human health and safety, sites and monuments of historical culture and tourist significance

## 4.4 When to monitor

Monitoring can be carried out before construction, during construction and operation phase.

## 4.5 Where to monitor

Monitoring can be focused on the activity itself. Monitoring can also be focused on the external environment comprising of catchment area treatment, command area development etc.

## 4.6 How to monitor

It depends on time and budget constraints. Results of monitoring are utilized for taking preventive measures to control pollution.

## 4.7 Purposes of Environmental Monitoring

Numerous purposes and implied benefits can be delineated for pre and/or post environmental monitoring. Following are six general uses of information obtained from the conduction of post monitoring:

1. Environmental monitoring provides information that can be used for documentation of the impacts that results from a proposed action. This information enables more accurate prediction of impacts associated with similar action.
2. The monitoring system could warn agencies of unanticipated adverse impacts or sudden change in impact trends.

3. The monitoring system could provide an immediate warning whenever a preselected impact indicator approaches a predetermined critical level.
4. Environmental monitoring provides information which could be used by agencies to control the timing, location and level of impacts of a project
5. Environmental monitoring provides information which could be used for evaluating the effectiveness of implemented mitigation measures.
6. Environmental monitoring provides information which could be used to verify predicted impacts and thus validate impact prediction techniques.

## 4.8 Guidelines and Policies

Some policy statements underlying the development of a monitoring program include:

1. *Baseline monitoring* – Baseline monitoring should be planned and initiated during the scoping phase of EIA.
2. *Formulation of impact prediction* – Predictive statements must be expressed as verifiable impact hypotheses, so that statistical tests can be applied. Where quantitative thresholds cannot be applied each term should be defined as clearly as possible and based upon (a) the importance of the environment (b) activities or interest affected (c) public acceptability of impact (d) whether the impact affects rare or endangered species, habitats or sites (e) the reversibility or irreversibility of effects (f) the frequency, duration and magnitude of impacts and (g) expert judgment.
3. *Effects monitoring* – Effects monitoring must be designed to establish cause-effect relationships which provide the basis for impact management through the implementation of corrective action.

Ten selected principles and recommendations associated with post project analysis (PPA) are as follows:

1. post project analysis should be used to complete the EIA process by providing the necessary feedback in the project implementation phase both for proper and cost effective management and for EIA-process development.
2. a preliminary plan for the PPA should be prepared during the environmental review of a project.
3. the PPA should focus on important impacts about which there is insufficient information.
4. the authority to undertake a PPA should be linked to the EIA process.
5. PPAs should be done for all major projects with potentially significant impacts.
6. the development of hypotheses to test should be a part of PPAs.
7. in order to undertake PPAs effectively, baseline data relevant to the hypotheses should be collected and should be complete as possible.
8. monitoring and evaluation of the data collected in the monitoring process should be an essential part of PPA.
9. as a tool for managing PPAs, advisory boards consisting of representatives of industry, government, contractors, independent experts and the public should be used. Such boards with well defined terms of reference, increase the credibility and quality of the PPA.
10. public participation in the PPA should be encouraged and PPA reports should be made public.

## 4.9 Conclusion

Comprehensive or targeted monitoring can be used as an integral component of environmental management of major WR Projects. Planning and implementation of a comprehensive or targeted environmental monitoring program should include usage of extant monitoring data and coordination with pertinent governmental monitoring system. Post

## 5.1 Introduction

The EIA analyst or the person charged with the preparation of An EIA report is faced with a vast quantity of raw and usually unorganized data. Hence each technique and method for the evaluation of impacts should have following qualities and characteristics:

1. It should be systematic in approach .
2. It should be able to organize a large mass of heterogeneous data
3. It should be able to quantify the impacts
4. It should be capable of summarizing the data
5. It should be able to aggregate the data into sets with the least loss of information because of the aggregation
6. It should have a good predictive capability
7. It should extract the salient features, and
8. It should finally be able to display the raw data and the derived information in a meaningful fashion

Each of the different methodologies for the assessment of environmental impacts of development project has their advantages and disadvantages and their utility for a particular application is largely a matter of choice and judgment of analyst.

## 5.2 Criteria for the Selection of EIA Methodology

a) *Simplicity*: The methodology should be simple so that the available manpower with limited background knowledge can grasp and adopt it without much difficulty.

b) *Manpower time and budget constraint*: The methodology should be applied by a small group with a limited budget and under time constraints.

*c) Flexibility*: The methodology should be flexible enough to allow for necessary modifications and changes through the course of the study.

**5.3** ***Table shown below*** contains 18 types of methods of EIA arrayed against seven activities that are typically associated with an EIA study. An X mark in the table denotes that the listed method type is, or may be, directly useful for doing that activity. However absence of X for any given type of method does not mean that it has no usefulness for the activity, it merely suggests that it may be indirectly related to the activity.

| Types of methods in EIA | Define Issues ( Scoping ) | Impact Identification | Describe Affected Environment | Impact Prediction | Impact Assessment | Decision Making | Communication Of Results |
|---|---|---|---|---|---|---|---|
| Analogs ( look-alikes) ( case studies ) | X | X | | X | X | | |
| Checklists ( simple, descr-iptive, questionnaire ) | | X | X | | | | X |
| Decision-focused check-Lists ( MCDM, MAUM, DA, scaling, rating or ranking: weighting ) | | | | | X | X | X |
| Expert opinion ( profess-ional judgment, Delphi, adaptive environmental assessment, simulation modeling ) | | X | | X | X | | |
| Expert system ( impact identification , prediction, assessment, decision making ) | X | X | X | X | X | X | |
| Laboratory testing and scale models | | X | | X | | | |
| Literature reviews | | X | | X | X | | |
| Matrices (simple, stepped, scoring ) | X | X | | X | X | X | X |
| Monitoring ( baseline ) | | | X | | X | | |
| Monitoring ( field studies of analogs ) | | | | X | X | | |
| Networks ( impact trees and chains ) | | X | X | X | | | |
| Overlay mapping ( GIS ) | | | X | X | X | | X |
| Photographs and photomontages | | | X | X | | | X |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Qualitative modeling ( conceptual ) | | | X | X | | | |
| Quantitative modeling (media, ecosystem, visual, archaeological, system analysis ) | | | X | X | | | |
| Risk assessment | X | X | X | X | X | | |
| Scenarios | | | | X | | X | |
| Trend extrapolation | | | X | X | | | |

X: potential for direct usage of method for listed activity

MCDM = multicriteria decision making

MAUM = multiattribute utility measurement

DA = decision analysis

GIS = geographical information system

From above table following observations can be made:

1. Each type of method has potential usefulness in more than one EIA study activity.
2. Each EIA activity has three or more method types which are potentially useful.
3. In a given EIA study, several types of methods will probably be used.
4. Each type of methods have advantages and disadvantages.
5. While numerous types of methods have been developed, and additional methods are being developed and tested, no universal method can be applied to all project types in all environmental settings. Every methods are project and location specific. These methods can be called ad-hoc methods.
6. Methods do not provide complete answers to all questions related to the impacts of a potential project or set of alternatives. Methods must be selected based on appropriate evaluation and professional judgment, and they must be used with the continuous application of judgment relative to data input as well as analysis and interpretation of results.

Methods which are simpler in terms of data and personnel resources requirements, and in technical complexity, are probably more useful in the EIA process. Following are the

## 5.4 EIA techniques generally used in WR Projects:

1. Analogs method
2. Matrices method (Leopold matrix method)
3. Simple matrix method (derived from Leopold matrix)
4. Network method
5. Overlays method
6. Mathematical modeling method
7. Expert advice method
8. Economic technique method
9. Simple checklist method
10. Decision-focused checklist
11. Decision support system

### *5.4.1. Analogs Method*

It is the simplest approach for impact prediction. It uses comparisons to the experienced effects of existing projects or activities. This method is also called "look-alike" method. In this information gathered from similar types of projects in similar environmental setting can be used to descriptively address the anticipated impacts of a proposed project or activity. Professional judgment is necessary when analogies are used for specific impacts on the environment.

Advantage:

- Simple
- Less time consuming
- Fairly accurate prediction of impact

Disadvantage:

- data-set from large number of existing projects
- professional judgment is necessary
- For comparison similar types of projects in similar environmental setting is required

### *5.4.2. Matrices Method*

This method is developed by Leopold in 1971.

*Objectives and applicability*

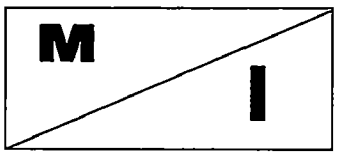
To identify the direct impacts of a series of activities in a given project and the respective quantification on two levels: magnitude and importance.

*Description*

This system consists of the listing, according to a method of matrixes, the activities encompassed by a project (the columns), and the environmental features ( the rows ) that are affected by such activities.

The original matrix consists of eighty-eight rows and one hundred columns, the total being 8800 interaction cells. The cells representing an interaction between project activities and the environmental feature that are affected by such activities are crossed by

a slanting line running from its upper right-hand corner down to the lower left-hand corner.




The upper portion is to be filled with the magnitude ratings and the lower, with ratings by order of importance according to the intensity of each impact, ranging from 0 to 10. 0 represent an interaction of lowest importance and 10 represent an interaction of highest importance.

*Critical Comments*

The following are the main objections to this method:

- It only identifies first order impacts and direct impacts. They can only effectively illustrate primary impacts.

- It does not take the time factor into consideration;

- It does not compare the eventual project alternatives;

- In case different teams have to work on it, the results are likely to differ because the criteria are highly subjective;

- It does not take the participation of the community into consideration.

In some instances this may be very serious because most of its aspects have a direct impact upon the quality of life of the population.

*Conclusions and applicability*

If, on one hand, there are strong objections to this method, on the other

it may be very useful under certain circumstances.

- It is low cost
- It is multi-disciplinary
- Identify item which require a deeper analysis with regard to any given activity likely to generate an important environmental impact
- Suitable for first evaluation of environmental impact of a project.
- Useful in bringing together the main activities developed in the case study area.
- Best suited for analysis of a specific project while its application to any area is affected by the size and multiple activities in the area being evaluated.

| Environmental factor | River control and Flow modification | Irrigation | Dams and Impoundments | Building construction | Surface excavation | Explosion | Roads | Importing of labour | Excavation and rehabilitation |
|---|---|---|---|---|---|---|---|---|---|
| Water quality | 2 / 5 | | 4 / 5 | | | | | | |
| Air quality | | | | | | | | | |
| floods | | | | | | | | | |
| sedimentation | | | | | | | | | |
| erosion | | | | | | | | | |
| Aquatic life | | | | | | | | | |
| forest | | | | | | | | | |
| Disease insect vector | | | | | | | | | |
| Water table | | | | | | | | | |

### *5.4.3. Simple Matrix Method*

Developing a specific matrix for the project being analyzed is better than using a generic matrix. The major use of matrices is to indicate cause and effect by listing activities along the horizontal axis and environmental parameters along the vertical axis. In this way the impacts of both individual components of projects as well as major alternatives can be compared. The following steps can be used in preparing a simple interaction matrix:

1. List all anticipated project action and group via temporal phases
    a Construction
    b Operation
    c Post-operation
2. List pertinent environmental factors from environmental setting and group them according to physical-chemical, cultural, biological, and socio-economic categories and spatial consideration such as site and region or upstream and downstream.
3. Discuss preliminary matrix with study team members and advisor to team.
4. Decide on impact rating scheme such as numbers, letters, or colors to be used.

5. Talk through the matrix as a team and make ratings and notes to identify impacts and summarize impacts

Matrices help to choose between alternatives by consensus. One method is to make pair-wise comparisons. First a matrix is drawn with all options listed both horizontally and vertically. Each option is then compared with every other one and a score of 1 assigned to the preferred option or 0.5 to both options if no preference is agreed.

The simplest matrices use a single mark to show whether an impact is predicted or not. However by changing the size of the mark to indicate scale or by using a variety of symbols to indicate different attributes of the impact.

| **For each environmental effect place a cross (X) in one of the columns** | | **Positive impact very likely** | **Positive impact possible** | **No impact** | **Negative impact possible** | **Negative impact very likely** | **No judgme possible at present** |
|---|---|---|---|---|---|---|---|
| | | **A** | **B** | **C** | **D** | **E** | **F** |
| Hydrology | 1-1 Low flow regime | X | | | | | |
| | 1-2 Flood regime | | X | | | | |
| | 1-3 Operation of dams | | X | | | | |
| | 1-4 Fall of water table | | | X | | | |
| | 1-5 Rise of water table | | X | | | | |
| Pollution | 2-1 Solute dispersion | | | | | | |
| | 2-2 Toxic substances | | | | | | |
| Soils | 3-1 Soil salinity | | | | | | |
| | 3-2 Soil properties | | | | | | |
| Sediments | 4-1 Local erosion | | | | | | |
| | 4-2 Hinterland effect | | | | | | |
| Ecology | 5-1 Project lands | | | | | | |
| | 5-2 Water bodies | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Socio-economic | 6-1 Population change | | | | | | |
| | 6-2 Income amenity | | | | | | |
| Health | 7-1 Water & sanitation | | | | | | |
| | 7-2 Habitation | | | | | | |
| Imbalances | 8-1 Pests & weeds | | | | | | |
| | 8-2 Animal diseases | | | | | | |
| | **Number of crosses** | | | | | | |

**Example of pair-wise comparison**

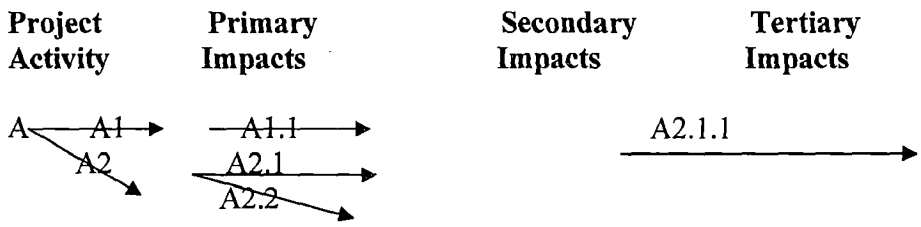
| **Compare alternative** | **With alternative** | | | | **Sum** |
|---|---|---|---|---|---|
| | **W** | **X** | **Y** | **Z** | |
| W | - | 0 | 0 | 0.5 | 0.5 |
| X | 1 | - | 1 | 0 | 2 |
| Y | 1 | 0 | - | 0 | 1 |
| Z | 0.5 | 1 | 1 | - | 2.5 |

Alternative with maximum positive total is the best.

### *5.4.4. Network Method*

Networks and system diagrams techniques are the approaches that link the main impacts to subsequent indirect impacts. They have the advantage of incorporating several alternatives into their formats and also including mitigation measures in the planning stages of the project. Similar to matrices, networks are very time-consuming processes and in addition expensive to use (Smith, 1993). Moreover, networks inability to include socio-economic impacts is considered as a major shortcoming that limits their usage.

Theoretically **networks** are superior to other techniques as these consider probability magnitude and importance of primary and higher impacts. However this theoretical elegance is not yet translatable to reality, on account of inadequate database and knowledgebase




Branch 1 :

Likely score = $P(A_1)^* M(A_1) I(A_1) + P(A_{1.1}) M(A_{1.1}) * I(A_{1.1})$

Where, $P(A_1)$ = the probability of $A_1$

$M(A_1)$ = the magnitude of $A_1$

$I(A_1)$ = the importance of $A_1$

Similar computation can be made for each of the branches.

### *5.4.5. Overlays Method*

The overlay mapping method is simply the superimposition of a set of transparent maps representing each environmental attribute on a base map of the area. The boundaries and the density of the color indicate the extent and value of impact. This spatial distribution of the project effects provides a powerful visual representation of the potential impacts that can be easily displayed. However, this presentation always lacks any probability or duration considerations and ignores the impacts arising from interaction between two or more factors. In fact, these problems were tackled when computer based Geographic Information Systems (GIS) technology was applied in the field of environmental impact assessment.

Advantage:

1 It is an excellent method for environmental planning because its main feature is to identify the potential of the environment by making an analysis of its possibilities and the compatibility of its uses.

2. It is suitable for future environmental control based on the uses it proposes and can easily be adapted to a series of different problems.

3. The knowledge of causes and effects translates the dynamic character of impacts upon the environment. The method is multi-disciplinary and makes use of existing information.

Disadvantage:

1. it is not capable of absorbing impacts of social, economic and cultural nature;

2. it does not identify the affected social groups;

3. it does not consider the participation of the community in selecting alternative uses;

4. it is highly subjective where the degree of compatibility and the selection of values are concerned;

5. it requires several maps to be drawn and results in high cost.

### *5.4.6. Mathematical modeling Method*

Mathematical modeling is one of the most useful tools for prediction work. It is the natural tool to assess both flow quantities and qualities (eg salt/water balances, pollution transport, changing flood patterns). However, it is essential to use methods with an accuracy which reflects the quality of the input data, which may be quite coarse. It should also be appreciated that model output is not necessarily an end in itself but may be an input for assessing the impact of changes in economic, social and ecological terms. Simulation modeling is a powerful interactive tool that can demonstrate and predict the response of the environmental components to the project activities. They are normally based on mathematical formulations that can be quickly processed using computer capabilities. The simulation results can guide impact assessment studies including environmental, social and economic aspects even in cases of few available data or considerable uncertainty of the dynamic relationships. Moreover, they can swiftly generate several project scenarios for comparison with various initial assumptions and help greatly in conducting sensitivity analysis. Nevertheless, a team of professional specialists in different fields is always required

to develop and verify simulation models. Also models has to be used cautiously within context otherwise it may produce misleading results

### *5.4.7. Expert advice Method*

Expert advice should be sought for predictions which are inherently non-numeric and is particularly suitable for estimating social and cultural impacts. It should preferably take the form of a consensus of expert opinion. Local experience will provide invaluable insight. Expert opinions are also likely to be needed to assess the implications of any modeling predictions. For example, a model could be developed to calculate the area of wetlands no longer annually flooded due to upstream abstractions. However, the impact on wetland species or the reduction in wetland productivity resulting from the reduced flooding may not be so precisely quantifiable but require a prediction based on expert opinion.

### *5.4.8. Economic techniques Method*

Economic techniques have been developed to try to value the environment and research work in environmental economics. It is important to stress that environmentally sound development brings long-term economic benefits. Unfortunately, short-term gains are often given priority.

The most commonly used methods of project appraisal are cost-benefit and cost-effectiveness analysis. It has not been found easy to incorporate environmental impacts into traditional cost-benefit analysis, principally because of the difficulty in quantifying and valuing environmental effects. An EIA can provide information on the expected effects and quantify, to some extent, their importance. This information can be used by economists in the preparation of cost-benefit calculations. Cost effectiveness analysis can also be used to determine what is the most efficient, least-cost method of meeting a given environmental objective, with costs including forgone environmental benefits. However, defining the objective may not be straightforward.

The two most useful methods for irrigation projects in developing countries are "Effect on Production" (EOP) and "Preventive Expenditure and Replacement Costs" (PE/RC). The EOP method attempts to represent the value of change in output that results from the environmental impact of the development. This method is relatively easy to carry out and easily understood. An example would be the assessment of the reduced value of fish catches due to water pollution or hydrological changes. The PE/RC method makes an assessment of the value that people place on preserving their environment by estimating what they are prepared to pay to prevent its degradation (preventive expenditure) or to restore its original state after it has been damaged (replacement cost). Both methods have weaknesses and must be used judiciously.

### *4.4.9. Simple Checklist Method*

The two most widely acclaimed checklists are those prepared by the World Bank (1991) and the International Commission for Irrigation and Drainage (ICID). Checklist method range from listings of environmental factors from simple to highly structured approaches. Structured approaches involve importance weightings for factors and the application of scaling techniques for the impact of each alternative on each factor.

Advantages

- Simple checklist represents lists of environmental factors or impacts, which should be addressed.
- The simplest method for the evaluation of any project impacts on the different components of the environment.

Disadvantages

- No information is provided on specific data needs, methods for measurement, or impact prediction and assessment.

Simple checklists were extensively used in the initial years of EIA studies and they still represent a valid approach for providing systemization to an environmental impact study.

**Table shown below shows a simple questionnaire checklist:**

| Topical Issue | Yes | Maybe | No | Comments |
|---|---|---|---|---|
| **Land Form**<br>Will the project result in:<br>Unstable slopes or embankments?<br>Extensive displacement of soil?<br>Changes to ground contour, shorelines or river banks?<br>Water erosion of soils? | | | | |
| **Air/ Climatology**<br>Will the project result in:<br>Air pollutant emission which will exceed standard value?<br>Alteration of air movement, humidity, temperature? | | | | |
| **Water**<br>Will the project result in:<br>Change in current or water movement?<br>Discharge to a public water system?<br>Changes to absorption rate, drainage pattern, rate of surface water runoff?<br>Alteration to the course or flow of flood water?<br>Exposure of people or property to water related hazards such as flooding? | | | | |
| **Solid Waste**<br>Will the project :<br>Generate significant solid waste? | | | | |
| **Noise**<br>Will the project:<br>Increase existing noise level?<br>Expose people to excessive noise? | | | | |
| **Flora ( plant life )**<br>Will the project:<br>Change the diversity or productivity of species or number of any species of plants?<br>Reduce the number of unique, rare, or endangered species of plants?<br>Introduce new species of plant? | | | | |
| **Fauna ( animal life )**<br>Will the project:<br>Reduce the number of unique, rare, or endangered species of animals?<br>Harm existing fish and wildlife habitats? | | | | |

| | | | | |
|---|---|---|---|---|
| **Land Use**<br>Will the project:<br>Substantially alter the present or planned use of area?<br>Impact a national forest land? | | | | |
| **Natural Resources** | | | | |

### *5.4.10. Decision-Focused Checklists*

Decision-focused checklists are systematic methods for comparing and evaluating alternatives. Different types of decision-focused checklist used commonly are:

i. Scaling Checklist- In this an algebraic scale or letter scale is assigned to the impact of each alternative on each environmental factor.

ii. Ranking Checklist- In this alternatives are ranked from best to worst in terms of their potential impacts on identified environmental factors

iii. Weighting-scaling Checklist- In this relative importance weights are assigned to environmental factors and impact scales are determined for each alternative relative to each factor.

These checklists are useful for comparative analysis of alternatives. They provide a basis for selecting the preferred alternative.

Typical categories of alternatives are:

1. Site location alternatives
2. Design alternatives for a site
3. Construction, operation, and decommissioning alternatives for a design
4. Project size alternatives
5. Phasing alternatives for size groupings
6. No-project or no-action alternatives
7. Timing alternatives relative to project construction, operation, and decommissioning

To achieve decision making among alternatives **Tradeoff Analysis** should be used. In tradeoff analysis the contributions of alternative plans are compared to determine what is gained or foregone in choosing one alternative over other. Tradeoff matrix is prepared for comparing the alternatives. Following approach can be used to complete the tradeoff matrix:

1. Qualitative approach: Descriptive information on each alternative
2. Quantitative approach: Quantitative information on each alternative
3. Ranking, rating, or scaling approach
4. Weighting approach
5. Weighting-ranking approach: weight for each decision factor is multiplied by the rank of each alternative

Tradeoff matrix:

| Decision Factors | Alternatives | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Degree of meeting needs and Objectives | | | | | | |
| Economic efficiency | | | | | | |
| Social concerns | | | | | | |
| Environmental impacts | | | | | | |
| Biophysical | | | | | | |
| Cultural | | | | | | |
| Socioeconomic | | | | | | |

Examples of decision-focused checklists are **Environmental Evaluation System (EES)**. It is a weighting-scaling checklist. It contains 78 environmental factors organized into 17 components and 4 categories, viz: Ecology, Environmental pollution, Esthetics, and Human interest. It is also called Battelle Method. The basic concept of this is that an index expressed in environmental impact units (EIUs) can be developed for each alternative and baseline environmental condition. Mathematical formulation of this index is as follows:

$$EIU_j = \sum_{i=1}^{n} (EQ)_{ij} (PIU)_i$$

where

$EIU_j$ = environmental impact units for j th alternative

$EQ_{ij}$ = environmental quality scale value for i th factor and j th Alternative

$PIU_i$ = parameter importance units for i th factor

Another example of Weighting-scaling checklist for water resources project is **Water Resources Assessment Methodology ( WRAM )**. It is developed by US army corps of engineers in 1977. Key element includes:

1. Selection of interdisciplinary team
2. Selection and inventory of assessment variables (environmental factors)
3. Impact prediction, assessment and evaluation
4. Documentation of the result

Impact prediction, assessment and evaluation are the element that includes weighting and scaling. Impact scaling in the WARM uses functional graphs, linear proportioning, or the development of alternative choice coefficients (ACCs). The concept of **commensuration** was introduced. It refers to measuring different things by a single standard i.e. it develops common units of measurement of various plans, these units serves as basis for tradeoff analysis among the alternatives.

### *5.4.11. Decision Support System*

**EIADSS Description**

The first step behind the conceptual basis of the EIADDS was to identify the environmental criteria that are susceptible to change due to irrigation projects construction or operation, and then categorize these criteria under main headings. EIADSS represent the initial output to the user's answers to the multiple choice questionnaire. The impact on each

main environmental category is then calculated assuming equal weights for all criteria impact. However, the overall impact for the project alternatives are calculated according to the given importance weights for each of the five main categories.

In this context, the five main environmental categories were natural resources, biological life, socio-economic, political and economic impacts (Table 1).

**Table 1 a**: Impacts criteria of irrigation projects

| **1.NATURAL RESOURCES IMPACTS** | **2. BIOLOGICAL LIFE IMPACTS** | 3. SOCIO-ECONOMIC IMPACTS |
|---|---|---|
| *Soil* | 2.1 Wildlife | 3.1 Public Health |
| 1.1 Soil Erosion | 2.2 Fish | 3.2 Land Use |
| 1.2 Soil Fertility | 2.3 Aquatic Life | 3.3 Tourism & Recreation |
| 1.3 Soil Salinity | 2.4 Eutrophication | 3.4 Resettlement |
| 1.4 Soil Pollution | 2.5 Pests and Rodents | 3.5 New Communities |
| *Water* | | 3.6 Sites of Special Importance |
| 1.5 Surface Water Quantity | | 3.7 Job Opportunities |
| 1.6 Surface Water Quality | | |
| 1.7 Groundwater Level | | |
| 1.8 Groundwater Quantity | | |
| 1.9 Groundwater Quality | | |
| *Air* | | |
| 1.10 Gas Emission | | |
| 1.11 Dust Pollution | | |
| 1.12 Local Climate | | |

**Table 1b**: Impacts criteria of irrigation projects

| 4.POLITICAL IMPACTS | 5.ECONOMIC IMPACTS |
|---|---|
| 4.1 National Security | *Feasibility Indicator* |
| 4.2 Foreign Affairs | 5.1 Benefit/Cost Ratio |
| 4.3 Public Opinion | *Productivity Ratios* |
| | 5.2 Net Production/Irrigated Area |
| | 5.3 Net Production/Water Volume |
| | 5.4 Net Production/No. Full Time Workers |
| | 5.5 Return/Investment (Foreign Currency) |
| | 5.6 Net Production/Invested Capital |
| | *Investment Ratios* |
| | 5.7 Jobs Created/Capital Invested |
| | 5.8 Irrigated Area/Capital Invested |
| | 5.9 Water Volume/Capital Invested |

As an example, Table 2 shows the factors affecting the four soil impacts criteria in the project area and neighboring area. It may be noticed that one factor, such as the drainage system, can be affecting more than one criterion.

**Table 2:** Factors that control the soil impacts criteria

| SOIL EROSION | SOIL FERTILITY | SOIL SALINITY | SOIL POLLUTION |
|---|---|---|---|
| Irrigation Method | Applied Fertilizers | Existing Soil Salinity | Agro-Chemicals Application |
| Irrigation Water Quality | Irrigation Method | Irrigation Advisory Services | Irrigation Water Quality |
| Irrigated Land Slope | Land Use | Drainage System | Type of Agro- |

| | | | |
|---|---|---|---|
| | | | Chemicals |
| Irrigation Advisory Services | Irrigation Advisory Services | Soil Texture | Drainage Water Disposal |
| Drainage Water Disposal | Irrigation Water Quality | Irrigation Water Salinity Downstream | Irrigation Water Quality Downstream |
| | Drainage Water Disposal | Irrigation Water Salinity | |
| | | Salt Leaching | |

**EIADSS Operation**

The user is required to answer a set of multiple-choice questions via a user-friendly graphical interface as shown in Figure 1. The design of the questions considered that the answers provide sufficient information to describe the baseline conditions and the general design for several project alternatives. In this sense, the selected answers by the user reflect the impact of the physical factors on the different criteria in the project area as well as the neighboring area. Consequently, a positive score is assigned for each factor inducing a positive impact and conversely a negative score is given for every anticipated negative impact. Assigning the scores is performed through an Expert System, which was developed especially for this EIADSS to associate an appropriate score with every selected answer to the multiple-choice questions. The scores were designed to reflect the expected impact of each factor relative to its all-possible impacts.

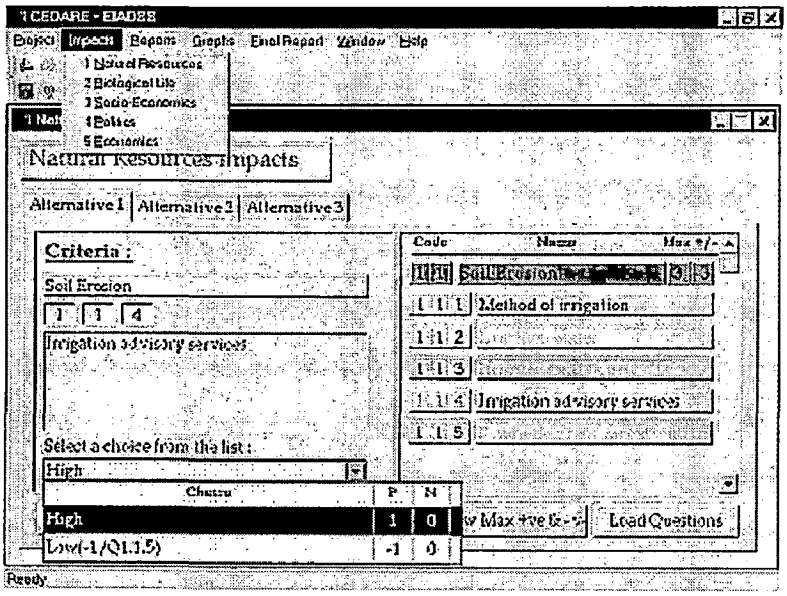



**Figure 1:** *Multiple choice questions*

The scores of the impacts on the project area and neighboring area are then summoned for each criterion separately. Depending on the sign of the total impact score of each criterion, it will be divided by the maximum possible positive or negative score of that criterion to give a normalized +/- impact on a scale from "-100%" to "+100%". The normalized impacts for all criteria are then averaged over the criteria for each environmental impact category to obtain the impacts on the main environmental categories. The pre-defined importance weights for each environmental category are used to calculate the overall environmental impact for each project alternative.

For the economic impacts, the user has to insert estimated values for some of the economic parameters required to calculate the indicators listed in Table 1b. The indicators included in the evaluation are based on the prime economic objectives of the project and the scarcest resources in the economy as identified by the user. The economic indicators enter into the final evaluation as a ratio relative to the highest values among the project alternatives. The economic impacts category, similar to the other environmental categories, are weighed according to their importance by the decision maker and added to the overall impact.

**EIADSS Output**

The main output of the EIADSS is an overall environmental index for each project alternative based on the selected answers and the values of the economic indicators as well as the importance weights set by the user for each environmental impact (Table 3). The higher the positive values the better the impact on the environment and consequently the best project alternative is that of the highest positive overall impact. Figure 2 shows how reports, in tabular and graph formats, can be viewed on screen for comparison purposes.

**Table 3**: Overall impacts

| | Importance Weights (set by the user) | Alt. 1 | Alt. 2 | Alt. 2 |
|---|---|---|---|---|
| Natural Resources Impacts | I1 | N1 | N2 | N3 |
| Biological Life Impacts | I2 | B1 | B2 | B3 |
| Socio-Economic Impacts | I3 | S1 | S2 | S3 |
| Political Impacts | I4 | P1 | P2 | P3 |
| Economic Impacts | I5 | E1 | E2 | E3 |
| Overall Impact | 100 | N1*I1+B1*I2+... | N2*I1+B2*I2+... | |

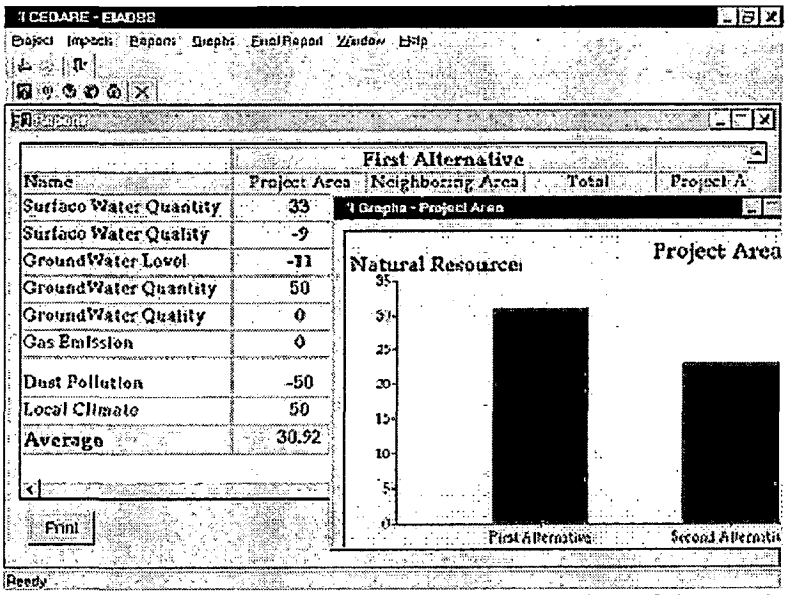



**Figure 2**: Numerical and graphical representation of the results

The EIADSS was based on a comprehensive checklist containing most criteria susceptible to change, due to irrigation projects construction or operation, coupled with suggested mitigation measures. The user is asked to reply to a series of multiple-choice questions through a user-friendly graphical interface operating under Windows environment. The multiple-choice questions were designed so that the selected answers should give sufficient information on the baseline conditions and the general design of the project alternatives. The built-in Expert System utilizes this information to retrieve positive and negative scores corresponding to the user's selected answers, and reflecting the impact of the project design on the baseline conditions. These scores are manipulated to calculate an overall environmental index for each project alternative. The final output generated by the EIADSS may be presented in tabular, graphical, and descriptive text formats allowing quick decision-making and comprehensive comparison between different project alternatives.

## 5.5 Conclusion

Numerous EIA methodologies have been developed within the last two decades. The most used methodologies can be categorized as interaction matrices, networks or checklists. Interaction matrices are of greatest value in impact identification and comparative

information on alternatives. Network methodologies provide useful information for impact identification as well as valuable approaches for communicating information on interrelationships between environmental factors and anticipated project impacts. Checklist approaches range from simple listings of environmental factors to complex methods involving assignment of relative importance weights to environmental factors. Simple and descriptive checklist approaches including questionnaire-checklists are useful for identifying environmental factors and providing information on impact prediction and assessment.

# Ch.6 - Catchment Area Treatment Plan For Environment Protection

## 6.1 Introduction

It is a well established fact that reservoirs formed by dams on rivers are subjected to sedimentation. The process pf sedimentation embodies the sequential process of erosion, entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity and thus affecting the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment adversely affects the agricultural production. Thus a well designed catchment area treatment (CAT) plan is essential to ameliorate the above mentioned adverse process of soil erosion

Soil erosion may be defined as the detachment and transportation of soil. Water is the major agent responsible for this erosion. In many locations winds glaciers etc. also cause soil erosion. In the catchment area of a hilly area water erosion is a common phenomenon and is considered as CAT plan.

The CAT plan pertains to preparation of a management plan for the treatment of erosion prone areas in the catchment area of WR project. It has been observed from past experience that the life span of a reservoir is greatly reduced due to erosion in its catchment area. The costs of dredging and disposal of the sediment increases whereas the storage capacity of the reservoir decreases. Thus adequate preventive measures are needed for the treatment of catchment area so that the area is stabilized against future erosion.

The areas which are erosion prone are also prone to natural disasters like landslides, rainfall runoff, washing away of crops due to excessive rainfall etc. Construction and development activities also cause a large increase in erosion. CAT leads to the welfare of the people living in catchment area.

The Catchment area treatment involves

- Understanding of the erosion characteristics of the terrain
- Suggesting remedial measures to reduce erosion rate

Silt Yield Index (SYI) method can be used for CAT. In this method the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides comparative erodibility criteria of catchment (low, moderate, high etc.) and do not provide the absolute silt yield. SYI method is widely used because of the fact that it is easy to use and has lesser data requirement. Moreover it can be applied to larger areas.

## 6.2 Approaches for the Study

A detailed database on natural resources, terrain conditions, soil type of the catchment area, socio-economic status etc. is pre-requisite to prepare treatment plan keeping in view the concept of sustainable development. Various thematic maps have been used in preparation of the CAT plan. Due to the spatial variability of site parameters such as soils, topography, land use and rainfall, not all areas contribute equally to the erosion problem. Several techniques like overlay using GIS of spatially indexed mapped data have been used to estimate soil erosion in complex landscapes. In order to ensure that latest and accurate data is used for analysis, satellite data has been used for deriving land use data and ground truth studies too have been conducted.

Various steps covered in the study are as follows:

- Definition of the problem
- Data acquisition and preparation
- Data analysis
- Output presentation

## 6.3 Definition of the problem

The requirement of the study is first defined and the output expected are noted. The various thematic maps of the catchment are:

- Slope map
- Soil map
- Land use classification map
- Current management practices
- Catchment area map

## 6.4 Data acquisition and preparation

The data available from various sources are collected. The ground maps, contour maps etc. are scanned digitized and registered as per the requirement. All the layers are geo-referenced and brought to a common scale, so that overlay can be performed.

## 6.5 Data analysis

The input data is analyzed for each layer. Land use classification is done using remote sensing techniques. Digitized contours from toposheets were used for preparation of Digital Elevation Model (DEM) of the catchment area and to prepare a slope map. Various layers thus prepared were used for modeling.

## 6.6 Output/presentation

The result of modeling is interpreted in pictorial form to identify the areas with high soil erosion rates. This output and the other primary and secondary data collected as a part of the field studies are used to prepare a CAT plan.

## 6.7 Methodology Used

### 1. Data Acquisition

The land use classification map of the catchment area is prepared and important locations are marked on it. For modeling purpose this map is geo-referenced to real coordinates and converted to a vector layer and each land use class is converted to a polygon in different layers with its land use class information attached to it.

**2. Slope map preparation**

Slope is a measure of change in altitude over distance which can be expressed in degree or as a percentage. DTM of the area is used to prepare slope map of catchment.

**3. Estimation of soil loss using SYI method**

The SYI considering sedimentation as product of erosivity, erodibility and arial extent. The erosivity determinants are the climatic factors and soil and land attributes that have direct bearing on the unit of the detached soil material. The relationship can be expressed as:

Soil erosivity = f (climate, physiography, slope, soil parameters, land use/land cover, soil management)

Silt Yield Index

The SYI is defined as the yield per unit area. SYI value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation.

$$SYI = \frac{\sum (A_i \times W_i) \times 100}{A_w}$$

Where i = 1 to n

$A_i$ = Area of the i th unit

$W_i$ = Weightage value of i th mapping unit

N = No. of mapping units

$A_w$ = Total area of sub-watershed

The SYI values for classification of various categories of **erosion intensity rates** are given below:

| Sl. No. | Erosion intensity rate (Priority category) | SYI Values |
|---|---|---|
| 1. | Very High | >1300 |
| 2. | *High* | 1200-1299 |
| 3. | *Medium* | 1100-1199 |

| | | |
|---|---|---|
| *4.* | *Low* | 1000-1099 |
| 5. | Very Low | <1000 |

**4. Prioritization of watersheds/sub-watersheds:**

The prioritization of smaller hydrologic units within the vast catchments is based on the SYI of the smaller units. The boundary values or range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking points. The watersheds/sub-watersheds is subsequently rated into various categories corresponding to their respective SYI values.

The application of SYI model for prioritization of sub-watersheds in the catchment areas involves the evaluation of:

a) climatic factors comprising total precipitation its frequency and intensity

b) geomorphic factors comprising land forms, physiography, slope and drainage characteristics

c) surface cover factors governing the flow hydraulics, and

d) management factors

The data on climatic factors can be obtained for different locations in the catchment area from the meteorological stations whereas the field investigations are required for estimating the other attributes.

The various steps involved in the application of model are:

- Preparation of a framework of sub-watersheds through systematic delineation
- Rapid reconnaissance surveys on 1:50000 scale leading o the generation of a map including erosion-intensity mapping units.
- Assignment of weightage values to various mapping units based on relative silt-yield potential.
- Computing SYI for individual watersheds/sub-watersheds.

- Grading of watersheds/sub-watersheds into very high, high, medium, low, very low priority categories

area of each of the mapping units is computed and SYI of individual sub-waterways are ulated using the empirical equation for SYI.

**Vatershed Management**

Watershed management is the optimal use of soil and water resources within a given graphical area so as to enable sustainable production. It implies changes in land use, station cover and other structural and non-structural action that are taken in a watershed to eve specific watershed management objective. The overall objectives of watershed agement programme are to:

- increase infiltration into the soil
- control excessive runoff
- manage & utilize runoff for useful purpose

owing **Engineering** and **Biological** measures have been used for the CAT.

1. Engineering measures
    - step drain
    - angle iron barbed wire fencing
    - stone masonry
2. Biological measures
    - development of nurseries
    - plantation/afforestation
    - pasture development
    - social forestry

basis for site selection for different Biological and engineering treatment measures under are given below:

**Basis for selection of CAT measures**

| Sl.No. | Treatment measures | Basis for selection |
|---|---|---|
| 1. | Social forestry, fuel wood and fodder grass development | Near settlements to control tree felling |
| 2. | Contour Bunding | Control of soil erosion from agricultural fields |
| 3. | Pasture development | Open canopy, barren land, degraded surface |
| 4. | Afforestation | Open canopy, degraded surface, high soil erosion, gentle to moderate slope |
| 5. | Barbed wire fencing | In the vicinity of afforestation work to protect it from grazing etc. |
| 6. | Step drain | To check soil erosion in small streams, steps with concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current |
| 7. | 1:4:8 Stone masonry | Steep slopes, sliding surfaces, less vegetative cover and silt erosion is high |
| 8. | Nursery | Centrally located points for better supervision of proposed afforestation minimize cost of transportation of seedling and ensure better survival. |

## 6.8 Conclusion

Catchment area treatment (CAT) plan pertains to preparation of a management plan for the treatment of erosion prone areas in the catchment area of a WR Project. Life span of a reservoir is greatly reduced due to erosion in its catchment area. The cost of dredging and disposal of the sediment increases whereas the storage capacity of the reservoir decreases. Thus adequate preventive measures are needed for the treatment of catchment area so that the area is stabilized against future erosion. We can say that CAT plan is very useful for the protection of project affected environment.

## 7.1 Introduction

Environmental audit is defined as "a management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental management system and equipment are performing." Environmental audit (EA) is one of the management information system (MIS) that provide management with specific information on how the project is performing the environmental requirements and the internally established environmental objectives and policies. EA is a productivity linked concept. Waste reduction is an integral part of any EA. A waste audit is the first step in an on-going programme designed to achieve a maximum resource optimization and improved process performanc

Auditing can be defined as a systematic, documented, periodic and objective review conducted by regulated entities, of facility operations and practices related to meeting environmental requirements. Some purposes of environmental auditing are:

- to verify compliance with environmental requirements
- to evaluate the effectiveness of in-place environmental management system, and
- to assess risks from regulated and unregulated substances and practices

Some direct results of an auditing program include:

- an increased environmental awareness by project employees
- early detection and correction of problems, and
- avoidance of environmental-agency enforcement actions and improved management control of environmental programs.

## 7.2 Objectives of Environmental Audit

The environmental audit helps in pollution control, improved production, safety, health and conservation of natural resources. Hence its overall objective can be stated as achievement of sustainable development. The objectives of the Environmental audit are:

- To determine the mass balance of various materials used and the performance of different process equipments so as to identify usage of materials used in excess, to review the conversion efficiencies of process equipment and accordingly fix up norms for equipment/operation performance and minimization of the wastes.
- To identify the areas of water usage, used waste water and determine the characteristics of waste water.
- To determine the emissions and their sources, quantities and characteristics
- To determine the performance of existing waste treatment/control system so as to modify or install additional or alternative control equipment.
- To determine the impact on the surrounding environment like groundwater, stream, residential area and agricultural area due to disposal of waste water, emission and solid waste and accordingly identify suitable preventive measures, if necessary.
- To check the effectiveness of environmental policy of the company.

## 7.3 Advantages of Environmental Audit

The advantages of environmental audit are:

- Determines how well the systems are performing and identify the operations of poor performance
- Identifies potential costs savings which can be accrued through reduction in raw material consumption by way of waste minimization and adoption of recycle/recovery/reduction in pollution load.
- Increases awareness of environmental requirements, policies and responsibilities.
- Helps in understanding the technical capabilities and attitude of the environmental organization in a company.
- Provides up-to-date environmental database for use in plant modification, emergencies, and other situations.

- Unravels surpluses and hidden liabilities which can reduce regulatory risk and exposure to litigation
- Ensures independent verification, identifies matters needing attention and provides timely warning to management on potential future problems.
- Helps to safeguard environment and assists in complying with local, regional and national laws and regulations without compromising on the company's policy and the environmental standards.
- Helps to improve public image.
- Increases information transfer.
- Better efficiency, cost reduction, waste minimization.

## 7.4 Types of Environmental Audit

The following are various types of EA practiced

1. Waste audit
2. Energy audit
3. Health & safety audit
4. Compliance audit
5. Management audit
6. Waste minimization audit
7. Liabilities definition audit
8. Property transfer audit

In a waste audit quantities and types of wastes generated from different sources are identified and the optimum methods to minimize the quantities of wastes are evolved. Waste audit is a technical tool meant for waste reduction from all possible sources.

In an energy audit the quantities and types of fuels consumed at different stages are identified and means to minimize consumption to eliminate the losses of fuels are suggested.

In health & safety audit the operating procedures and emergency procedures, maintenance and permit system, fire fighting system, fire protection system, safety policy and safety organization for taking up safety activities effectively, and plant health monitoring system are reviewed. Safety audit is normally carried out for an operating project.

Audits required to be carried out as per regulations procedures are known as compliance audits.

A management audits determines whether an adequate compliance management system is established, implemented and used correctly to integrate environmental compliance into everyday operating procedures.

Waste minimization audit examines the waste generated by a facility with the objective of identifying viable actions to reuse, recycle or otherwise reduce the quantity and toxicity of each waste stream.

Liabilities definition audit are typically done for prospective buyers of real estate and for proposed mergers and acquisition.

A property transfer audit differs in two key ways from a compliance audit. It is usually conducted in a phased approach and it focuses on historic practices.

Environmental monitoring can also serve as a basic component of a periodic environmental regulatory auditing program for a project. There are several Protocols and experiences in *auditing* related to EIA process.

## 7.5 Stages of Environmental Audit

Regardless of the type of audit being performed, the whole programme consists of three stages:

1. Audit program planning (including pre-visit data collection)
2. On-site activities
3. Evaluation of audit data and preparation of audit report

***Audit program planning includes***

- program planning
- commitment by management
- definition of requirements
- confidentiality
- organization of auditing program
- team of auditing specialists
- pre-visit data collection
- general issues

***Onsite activities includes***

- deriving material balance
- identifying waste flow lines
- monitoring of characteristics
- evaluation of the performance of process
- accessing environmental quality
- holding discussions with the management and finally preparing the draft report

***Evaluation of audit data and preparation of audit report***

In developing the report and the format, style is important. The following guidelines should apply to any audit report:

- be clear and concise
- be sure to distinguish between isolated incidents and chronic problems
- state the facts as discovered
- donot attach unsubstantiated findings to the facts
- state the nature of the problem clearly and exactly without using generalities
- be careful not to draw legal conclusions

The final report may if necessary be sent to the top management for comments so as to make further modifications.

## 7.6 Follow-up Actions

Follow-up actions should be taken to check the progress of implementation of the recommendations.

## 7.7 Conclusion

The EA is considered for a broad purpose, i.e., to provide an indication to management of how the environmental organization systems and equipments are performing and apply the best practicable means to preserve air, water, soil, plant and animal life from the adverse effects of this project operation and to minimize any nuisance that may arise.

The EA should not be undertaken simply to facilitate compliance with law. It should be seen as a means to accomplish long-term strategic goals.

Project authorities can be benefited from a critical self examination of the purposes and technologies. It must see in which area problems might arise, particularly with regard to human health.

## Ch.8 - Case Study

# EIA STUDY FOR TAPOBAN VISHNUGAD HYDROELCTRIC PROJECT, DISTRCT CHAMOLI, UTTRANCHAL.

## 8.1 Objective of the Case Study

Objective of present case study is to understand the live demonstration of EIA in water resources projects. This case study gives idea about how EIA of WR project is done and to what extent EIA is beneficial to timely and cost effective completion of WR projects. How it helps in avoiding public protest, how it maintains socio-economic and ecology of the project affected area intact.

## 8.2 Location and Description of Site

Tapoban Vishnugad Project is a run of the river scheme across river Dhauliganga. The scheme utilizes the drop of approximately 519m available in the river and involves construction of a barrage near village Tapovan at a distance of about 15 km from Joshimath and underground power house near village Vishnugad. The powerhouse is proposed to be located about 200 m u/s of confluence of Animathgad with river Alaknanda near Shelong in district Chamoli.

The study area can be divided into three parts:

1. Submergence area (area within the high flood level of the water spread area)
2. Area within 7 km of periphery of water spread area and other appurtenances of the project
3. Catchment area

The salient features within 7 km radius from the project are listed below.

| S. No. | Particulars | Details |
|---|---|---|
| 1 | Latitude | $30^0 29'30"$ N |
| 2 | Longitude | $79^0 37'30"$ E |
| 3 | Nearest highway | NH-58 |
| 4 | Nearest railway station | Dehradun |

| | | |
|---|---|---|
| 5 | Nearest airstrip | Dehradun |
| 6 | Nearest village | Tapoban |
| 7 | Nearest town | Joshimath |
| 8 | Hills/valleys | Project area is located in the mountain ranges of western Himalayas. |
| 9 | Monuments | Nil |
| 10 | Archaeologically important places | Nil |
| 11 | National parks | Nil |
| 12 | List of industries | Nil |
| 13 | Siesmicity | Seismic Zone-V |

The brief scope of EIA study includes:

- assessment of the existing status of physio-chemical, ecological and socio-economic aspects of environment
- identification of potential impacts on various environmental components due to activities during construction and operation phases of the proposed hydro-electric project
- prediction of significant impacts on major environmental components using EIA methods
- delineation of Environmental Management Plan (EMP) outlining measures to minimize adverse impacts during construction and operational phases of the proposed project
- formulation of environmental quality monitoring programmes for construction and operational phases
- formulation of CAT plan, Afforestation, Greenbelt plan, etc.

## 8.3 Project Description

**Catchment area**

| | |
|---|---|
| Catchment area | 3100 sq km |
| Snow bound | 1483 sq km |
| **Design flood** | |
| Hydraulic design of barrage | 4100 cumecs |
| Free board diversion | 6600 cumecs |
| Diversion | 250 cumecs |
| **Barrage** | |
| Maximum water level | 1794 m |
| Minimum water level | 1790 m |
| Length | 55.50 m |
| **Power tunnel** | |
| Length | 11.646 km |
| Diameter | 5.4 m |
| Shape | standard horse shoe |
| Design discharge | 119.2 cumecs |
| **Power house** | |
| Type | underground |
| Installed capacity | 520 MW (4*130 MW) |
| Type of turbine | Francis |
| Max. head | 524.60 m |
| Min. head | 485.83 m |
| **Tail Race Tunnel** | |
| Shape | Horse shoe |
| Length | 513 m |
| Diameter | 5.4 m |

**Tail Race Channel**

| | |
|---|---|
| Length | 35.0 m |
| Size | 5.3 m |
| Shape | Square |
| Energy dissipation device | submerged slotted bucket |

**Land Requirement**

| Project appurtenance | Private land (ha) | Government land (ha) | Total (ha) |
|---|---|---|---|
| Barrage | 51.72 | 65.57 | 117.29 |
| Power house | 19.83 | 57.18 | 77.01 |
| Surge shaft | 4.70 | 4.89 | 9.59 |
| Residential & Administrative area | 17.28 | 7.57 | 24.85 |
| Switch yard | 6.47 | 4.79 | 11.26 |
| **Total** | **100.00** | **140.00** | **240.00** |

Total land requirement of the project is 240.00 ha. The land requirement is exclusive of land required for access road, muck disposal, quarry etc.

## 8.4 Environmental Baseline Status

### 8.4.1 Water quality

The proposed project is located in an area with low population density with no major sources of pollution. As a part of the field studies water samples from various locations from river Dhauliganga were collected and analysed for various physico-chemical parameters.

The various sampling locations are listed as below:

W1 – River Dhauliganga u/s of barrage site

W2 – River Dhauliganga d/s of barrage site

W3 – Near Bargaon to assess the water quality near habitations

W4 – Tributary confluencing in river Dhauliganga

W5 – River Dhauliganga d/s of power house site

As per the terms of references, water quality is to be monitored for two seasons namely post-monsoon and summer seasons. The results obtained from samples are:

**Water quality analysis in the study area**

| Parameter | Unit | W1 | W2 | W3 | W4 | W5 |
|---|---|---|---|---|---|---|
| PH | - | 7.6 | 7.4 | 7.4 | 7.5 | 7.5 |
| Temperature | $^0$C | 7.5 | 8.1 | 8.1 | 7.8 | 7.9 |
| Dissolved Oxygen | Mg/l | 8.0 | 8.2 | 8.4 | 8.4 | 8.2 |
| Total dissolved solids (TDS) | Mg/l | 46 | 47 | 45 | 46 | 46 |
| Total suspended solids | Mg/l | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Alkalinity | Mg/l | 7.2 | 8.1 | 7.4 | 7.4 | 7.2 |
| Hardness | Mg/l | 34 | 35 | 35 | 41 | 36 |
| Fluorides | Mg/l | 0.3 | 0.2 | 0.5 | 0.2 | 0.2 |
| Carbonates | Mg/l | 4 | 4 | 4 | 4 | 7 |
| BOD | Mg/l | 1.0 | 1.0 | 1.0 | 1.1 | 1.0 |
| COD | Mg/l | 3.2 | 3.1 | 3.2 | 3.0 | 3.0 |
| Nitrates | Mg/l | 3.4 | 3.5 | 3.4 | 3.4 | 3.4 |
| Faecal Coliform | MPN/100 ml | Absent | Absent | Absent | Absent | Absent |
| Total coliform | MPN/100 ml | 58 | 32 | 65 | 78 | 97 |

MPN = Most Probable Number

**Drinking water standards**

| Parameters | value | |
|---|---|---|
| | Acceptable* | Cause for Rejection+ |
| Turbidity | 2.5 | 10 |
| pH | 7.0-8.5 | <6.5 or >9.2 |
| Total dissolved solids (mg/l) | 500 | 1500 |
| Total hardness (mg/l) | 200 | 600 |
| Chlorides (mg/l) | 200 | 1000 |
| Sulphates (mg/l) | 200 | 400 |
| Fluorides (mg/l) | 1.0 | 1.5 |
| Nitrates (mg/l) | 45 | 45 |
| Calcium (mg/l) | 75 | 200 |
| Magnesium (mg/l) | 30 | 150 |
| Iron (mg/l) | 0.1 | 1.0 |
| Faecal coliform (MPN/100 ml) | Nil | Nil |
| Total coliform | 10 | 10 |

**Note:-** * Limits upto which water is generally acceptable to the consumers.

+ Figures in excess of those mentioned under column 'Acceptable' render the water not acceptable, but still may be tolerated in the absence of alternative and better source, but up to the limits indicated under column 'Cause for Rejection', above which the supply will have to be rejected.

The total coliform is higher than permissible limits. However in past no major water borne epidemic has been reported in the area. It can be concluded that apart from coliform level, water quality was observed to be quite good.

### 8.4.2 Meteorology & Air Environment

**Average Meteorological condition in the project area**

| S. No. | Month | Mean Temp. Daily ($^0$C) | | Rainfall (mm) | No. of rainy days | Relative Humidity (%) | |
|---|---|---|---|---|---|---|---|
| | | Max. | Min. | | | Max | Min |
| 1 | January | 11.7 | 2.0 | 77.8 | 5.0 | 53 | 48 |
| 2 | February | 13.0 | 3.3 | 107.6 | 6.3 | 57 | 50 |
| 3 | March | 17.9 | 6.4 | 113.0 | 7.0 | 52 | 49 |
| 4 | April | 22.5 | 10.9 | 59.1 | 4.8 | 49 | 41 |
| 5 | May | 25.4 | 14.0 | 52.9 | 4.9 | 53 | 44 |
| 6 | June | 26.4 | 16.6 | 111.5 | 8.8 | 72 | 61 |
| 7 | July | 24.5 | 16.9 | 267.1 | 17.7 | 89 | 78 |
| 8 | August | 23.8 | 16.8 | 232.7 | 17.7 | 91 | 80 |
| 9 | September | 23.2 | 14.8 | 124.3 | 10.0 | 82 | 72 |
| 10 | October | 21.1 | 10.4 | 40.4 | 3.4 | 65 | 59 |
| 11 | November | 17.0 | 6.3 | 14.9 | 1.3 | 51 | 48 |
| 12 | December | 13.8 | 3.9 | 24.3 | 1.5 | 47 | 43 |

### 8.4.3 Ambient noise level

Noise level is to be monitored for two seasons. The noise levels were monitored continuously for 12 hours at each location and hourly equivalent noise level was measured. Sound pressure level (SPL) measurement in the ambient environment was made using sound pressure level meter. The monitoring was carried out during day time.

**Hourly equivalent noise levels in the study area (unit: dB(A))**

| Time | Tapoban | Vishnugad | Shellong | Hellong | Peni |
|---|---|---|---|---|---|
| 8-9 am | 39 | 34 | 35 | 35 | 32 |
| 9-10 am | 37 | 38 | 35 | 38 | 35 |
| 10-11 am | 36 | 40 | 35 | 39 | 39 |
| 11am-12noon | 38 | 34 | 34 | 36 | 37 |
| 12-1 pm | 40 | 34 | 34 | 35 | 37 |
| 1-2 pm | 40 | 35 | 34 | 34 | 36 |
| 2-3 pm | 38 | 34 | 32 | 35 | 35 |
| 3-4 pm | 38 | 34 | 34 | 35 | 34 |
| 4-5 pm | 36 | 34 | 34 | 35 | 33 |
| 5-6 pm | 38 | 34 | 32 | 32 | 33 |
| 6-7 pm | 32 | 32 | 34 | 32 | 33 |
| 7-8 pm | 32 | 32 | 32 | 32 | 33 |

| | | | | | |
|---|---|---|---|---|---|
| 8-9 pm | 32 | 32 | 32 | 32 | 33 |

**Acceptable outdoor noise levels as prescribed by Central Pollution Control Board (CPCB)**

| Area Code | Category of Area | Limits in dB(A) | |
|---|---|---|---|
| | | Day Time | Night Time |
| A | Industrial area | 75 | 70 |
| B | Commercial area | 65 | 55 |
| C | Residential area | 55 | 45 |
| D | Silence zone | 50 | 40 |

Note:

1. day time is reckoned in between 6 am and 9 pm
2. night time is reckoned in between 9 pm and 6 am
3. silence zone is defined as area upto 100 m around such premises as hospital, court, educational institution etc.

### 8.4.4 Land use pattern

Land use describes how a patch of land is used (e.g. for agriculture, settlement, forest), whereas land cover describes the materials (such as vegetations, rocks or buildings) that are present on the surface. It is studied through Remote sensing.

**Land use pattern of the study area**

| **Land use cover** | **Area ha (%)** |
|---|---|
| Dense vegetation | 4475 (13.6) |
| Open vegetation | 5797.3 (17.3) |
| Water bodies/River bed | 199.0 (0.60) |
| Exposed rock | 4071 (12.4) |
| Agriculture land | 9830.8 (29.9) |
| Grassland | 2143.4 (6.5) |
| Scrub | 3247 (9.9) |
| Snow | 1120 (3.3) |
| Silty land | 2034.5 (6.2) |
| **Total** | **32918 (100)** |

The major land use category in the study area is area under vegetation, which accounts for 31% of the study area. The other dominant land use category is agriculture land (30%).

### 8.4.4.1 Soils

Soil samples were collected from five locations in catchment area. The results are shown below:

**Results of soil sampling analysis**

| Sample No. | Parameters | | | | |
|---|---|---|---|---|---|
| | pH | Sodium (%) | Potassium (%) | Nitrogen (%) | Phosphorus (%) |
| S1 | 6.2 | 74 | 23 | 1.2 | 2.8 |
| S2 | 6.66 | 67 | 20 | 1.8 | 2.4 |
| S3 | 6.95 | 66 | 31 | 1.0 | 3.2 |
| S4 | 7.75 | 52 | 24 | 5.0 | 1.6 |
| S5 | 6.46 | 58 | 18 | 1.7 | 1.3 |

### 8.4.5 Biological Environment

### 8.4.5.1 Vegetation

A total no. of 138 plant species were recorded during floristic survey in the sample site

**Summary table of plants belonging to different groups**

| Plant group | No. of species |
|---|---|
| Tree | 24 |
| Shrub | 43 |
| Herb | 48 |
| Climber | 16 |
| Economically important | 7 |
| **Total** | **138** |

### 8.4.5.2 Fauna

In the lower reaches species such as leopard, jungle cat, civet, wild dog, fox are reported. In the upper reaches species such as musk deer, snow leopard, brown bear are reported. Amongst birds, piegeons, cuckoos, wood peckers are reported.

**8.4.5.3 Aquatic ecology**The data on plankton community of the river Dhauliganga are very meager. The Garhwal Himalayas are rich in fisheries potential. There are about 10 (ten) fish species reported in the river Alaknanda of which Dhauliganga is a tributary.

## 8.5 Prediction of Impacts

### 8.5.1 Water Quality

**a. Construction Phase**

The major sources of surface water pollution during project construction phase are as follows:

- Sewage from labour camp/colonies
- Effluent from crushers
- Effluents from other sources

**Sewage from labour camps**

The project construction is likely to last for a period of 7 years. The peak labour likely to be employed is about 2000 workers and 600 technical staff. The domestic water requirement has been estimated as 70 lpcd. The lowest minimum 10 day daily flow at Tapoban-Vishnugad barrage site was observed at 18 cumecs in the month of February. It is assumed that all the sewage generated from various labour camps outfalls at a common point. It is also assumed that the sewage is discharged without any treatment. For these conditions, the minimum flow required for dilution of sewage is 8 cumecs. So the minimum flow in river Dhauliganga is much higher than the flow required for dilution of untreated sewage. The D.O. level modeling was done using Streeter Phelp's model. Following equation used:

$$D_t = \frac{K_1 L_1 \left[10^{-k_1 t} - 10^{-k_2 t}\right]}{K_2 - K_1} + D_A 10^{-k_2 t}$$

where:

$D_t$ = D.O. deficit d/s at time t

$K_1$ = deoxygeration rate

$K_2$ = reaeration rate

$L_A$=ultimate u/s B.O.D.

$D_A$=D.O. deficit u/s

t = time of stream flow u/s to point at which D.O. level is to be estimated.

The D.O. level in the river was taken as 8.0 mg/l. The minimum flow in the river Dhauliganga was taken as 18 cumecs. The results of D.O. model are as below.

**Results of D.O. due to disposal of sewage from labour camp**

| Distance from outfall | D.O. (mg/l) |
|---|---|
| 0.1 | 8.0 |
| 0.2 | 8.0 |
| 0.3 | 8.0 |
| 0.4 | 8.0 |
| 0.5 | 8.0 |
| 1.0 | 8.0 |

It can be observed that no impact is anticipated on river water quality, as a result of disposal of sewage from labour camps.

### 8.5.2 Effluent from crusher

During construction phase at least one crusher each will be commissioned at the barrage and the power project sites. Total capacity of two crushers is of the order of 120-150 tph. About 0.1 $m^3$ of water per tonne of material crushed is required. The effluent from crusher would contain high suspended solids 3000 to 4000 mg/l. About 12-15 $m^3$/hr of waste water is expected to be generated from each crusher. This amounts to a discharge of 0.0033 to 0.0042 cumecs. The lowest 10 daily flow in river Dhauliganga is 18 cumecs. Suspended solids observed at various sampling location to be <0.1 mg/l. Thus no adverse impacts are anticipated.

**b. Operation phase**

The major sources of water pollution during operation phase include:

- effluent from project colony
- impacts on water quality
- eutrophication risks

### 8.5.3 Effluent from project colony

It is proposed to provide biological treatment plat to reduce the B.O.D.

### 8.5.4 Impacts on water quality

The flooding of previously forest and agricultural land in the submergence area will increase the availability of nutrients resulting from decomposition of vegetative matter. Enrichment of water with organic and inorganic nutrients will be the main water quality problem immediately on commencement of the operation. This is likely to last for a short duration of few years from the filling up of reservoir. In this project most of the land is barren land with few patches of trees. These trees are to be cleared before filling up of reservoir. It is a runoff a river scheme, so significant reaeration from atmosphere will take place, which maintains the D.O. level.

### 8.5.5 Eutrophication risks

In the reservoir spread area problem of eutrophication will occur due to disposal of nutrient rich effluent from agriculture lands. As population density is low and fertilizer use is negligible. So runoff will not contain significant amount of nutrients. As it is a run off a river scheme, so residence time of water in reservoir would be of the order of few days, which is too small to cause any eutrophication.

### 8.5.6 Impacts on noise environment

The noise level due to various construction equipment is as below:

**Noise level due to operation of various construction equipment**

| **Equipment** | **Noise level (dB(A))** |
|---|---|
| **Earth moving** | |
| Compactors | 70-72 |
| Front loaders | 72-82 |
| Backhoes | 72-92 |
| Tractors | 76-92 |
| Scrappers, Graders | 82-92 |
| Pavers | 86-88 |
| Truck | 84-94 |
| **Material handling** | |

| | |
|---|---|
| Concrete mixers | 75-85 |
| Movable cranes | 82-84 |
| **Stationary** | |
| Pumps | 68-70 |
| Generators | 72-82 |
| Compressors | 75-85 |
| **Others** | |
| Vibrators | 69-81 |
| Saws | 74-81 |

Under worst case it is assumed that all these equipment generate noise from a common point.

The increase in noise levels due to operation of various construction equipments are given below:

**Increase in noise level due to operation of various construction equipments**

| Distance (m) | Ambient noise levels dB(A) | Noise levels due to construction activities dB(A) | Increase in ambient noise level due to construction activities dB(A) |
|---|---|---|---|
| 100 | 40 | 76 | 36 |
| 200 | 40 | 70 | 30 |
| 500 | 40 | 62 | 22 |
| 1000 | 40 | 56 | 16 |
| 1500 | 40 | 52 | 12 |
| 2000 | 40 | 50 | 10 |
| 2500 | 40 | 49 | 9 |
| 3000 | 40 | 47 | 7 |

There is reduction in noise level as sound wave passes through a barrier. The transmission loss value for common construction materials is as below:

**Transmission loss for common construction material**

| Material | Thickness of construction material (inches) | Decrease in noise level dB(A) |
|---|---|---|
| Light concrete | 4 | 38 |
| | 6 | 39 |
| Dense concrete | 4 | 40 |
| Concrete block | 4 | 32 |
| | 6 | 36 |
| Brick | 4 | 33 |
| Granite | 4 | 40 |

Thus the wall of various houses will attenuate at least 30 dB(A) of noise. In addition there are attenuation due to the following factors:

- air absorption

- rain
- atmospheric inhomogeneties
- vegetal cover

Thus no increase in noise level is anticipated as a result of various activities, during the project construction phase.

**8.5.7 Impacts on land environment**

The major impacts anticipated on land environment are as follows:

- Quarrying operations
- Operation of construction equipment
- Soil erosion
- Muck disposal
- Impacts due to construction of roads
- Acquisition of land

**8.5.8 Quarrying operations**

Project of this magnitude require a significant amount of construction material. Part of the requirement is met by using muck generated during excavation of tunnel, power house and other appurtenances by crushing into required size depending upon engineering properties of the muck. The balance requirements are met by quarrying from appropriate locations. It is necessary to implement slope stabilization measures to prevent the possibilities of soil erosion and landslides in the quarry sites. Excavation of material leaves borrow pits. The pit so created impedes the natural drainage, increase potential for soil erosion and stores rain water and runoff. These pool of water can lead to increased incidence of vector-borne disease.

**8.5.9 Operation of construction equipment**

Construction equipments requires land to site it. Various criteria for site selection would be:

- proximity to the site of use
- sensitivity of forests in the nearby areas
- proximity from habitation

Locate the construction, so that impacts on human and faunal population are minimal.

**8.5.10 Soil erosion**

The runoff from construction site will increase turbidity in river. This will have adverse impacts on photosynthetic action and biological productivity. Adequate measures need to be taken in EMP to reduce this adverse impact.

**8.5.11 Muck disposal**

Adequate area shall be earmarked to cater the entire quantity of muck. A part of muck can be used as land filling, restoration of construction sites.

**8.5.12 Construction of roads**

It can lead to following impacts:

- Project area has steep slope. Removal of trees on slopes can encourage landslides, erosion gullies.
- Increased accessibility of an undisturbed area and subsequent adverse impact on ecosystem.
- Increased air pollution during construction phase.

**8.5.13 Impacts on ecology**

**a. Terrestrial Ecology**

**Increased human interferences**

Population residing in the project area may use fuel wood, wood for construction of houses. Proper measures need to be taken to avoid adverse impact on terrestrial flora.

**Acquisition of forest land**

The density and diversity of forest land in the project area to be acquired is quite low. No rare or endangered species are observed. The tree loss as a result of acquisition of land must be compensated by greenbelt development along the periphery of impounded water, project colony, township, etc. and compensatory afforestation.

**Disturbance to wildlife**

No major fauna is observed in the project area. Hence the impacts on terrestrial fauna are not expected to be significant. To provide safety to drifted animals measures are suggested in EMP.

**Aquatic ecology**

**a. Construction Phase**

Extraction of considerable amount of construction material from the river bed causes barrage to fish stock and other aquatic life by destabilizing the sub-stratum, increasing turbidity of water, silting of channel bottom and modifying the flow which in turn may result in erosion of river channel. The material at the river bed like stones and pebbles often provide anchorage and home to the invertebrates who remain attached in a fast flowing stream. During swapping season, the fertilized egg are laid on the gravel where it is made sure that eggs are not washed away in fast flowing stream. The eggs of almost all species are sticky in nature which provides additional safety. The turbidity in excess of 100 ppm chokes the gills of young fish. Fine solids in concentration greater than 25 mg/l adversely affect the development of fish eggs and fish. During construction of a river valley project huge quantity of debries is generated at various construction sites. If a separate area for dumping of the material is not earmarked it would flow down the river during the heavy precipitation. Such a condition is adverse for the development of aquatic life. So it is desirable to earmark a suitable area for disposal of muck during construction phase.

**b. Operation Phase**

Completion of Project would bring about significant changes in the riverine ecology as the river transforms from a fast flowing water system to a quiescent lacustrine environment. Such an alteration of the habitat would bring changes in physical chemical and biotic life. Among the biotic community certain species can survive the transitional phase and can adapt to the changed river system. There are other species which however for varied reasons related to feeding and reproductive characteristics cannot acclimatize to the changed environment and may disappear in the early years of impoundment of water. The micro-biotic organism especially diatoms, algee before the operation of project, have their habitants beneath boulders, stones, fallen logs along the river, where depth is such that light penetration can take place. But with the damming of river, these organism may perish as a result of increase in depth. Amongst the acquatic animals, it is the fish life which would be most affected. The migratory fish species like snow trouts are likely to be affected due to obstruction created by the dam/barrage.

With the completion of barrage flow in the d/s stretch of the river would be reduced considerably more so during the lean period. The most important changes which can be expected are:

- reduced flow rate
- increase in water temperature
- reduction in availability of stano-thermal aquatic animals
- increase in population of euro-thermal species

Unless the desired flow is maintained d/s of the dam/barrage, aquatic ecology in general and fisheries in particular would be affected.

**8.5.14 Socio-Economic Aspects**

**8.5.14.1. Socio-economic profile of study area villages**

**Population**

The study area comprises of 12 villages. The total population as per 2001 census is 2776. The average decadal growth is of the order of 25%. The sex ratio i.e. no of female per 1000 male is 966.

| S.no. | Village name | Total popula-tion | Male | Female | SC | | ST | | Literacy | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Male | Fem-ale | Male | Female | Male | Fema-le |
| 1 | Regari | 79 | 41 | 38 | 13 | 11 | 0 | 0 | 19 | 4 |
| 2 | tapoban | 735 | 421 | 314 | 84 | 68 | 27 | 18 | 296 | 104 |
| 3 | bhangyol | 186 | 101 | 85 | 43 | 7 | 0 | 0 | 67 | 31 |
| 4 | karchho | 306 | 149 | 157 | 4 | 2 | 25 | 31 | 68 | 12 |
| 5 | juwagwar | 113 | 55 | 58 | 0 | 0 | 54 | 58 | 37 | 19 |
| 6 | Jugnuch-ak Lata | 40 | 17 | 23 | 0 | 0 | 17 | 23 | 12 | 8 |
| 7 | lata | 348 | 153 | 195 | 26 | 29 | 114 | 166 | 72 | 46 |
| 8 | Bouhach-ak Lata | 98 | 54 | 44 | 5 | 1 | 35 | 40 | 32 | 14 |
| 9 | Paingcha-k Lata | 104 | 45 | 59 | 0 | 0 | 44 | 59 | 27 | 23 |
| 10 | subhai | 405 | 209 | 196 | 9 | 10 | 87 | 88 | 97 | 32 |
| 11 | Raingch-ak Subhai | 149 | 64 | 85 | 0 | 0 | 63 | 85 | 35 | 31 |
| 12 | Ringi | 213 | 103 | 110 | 4 | 3 | 3 | 2 | 68 | 32 |
| | **Total** | **2776** | **1412** | **1364** | **158** | **131** | **469** | **570** | **830** | **353** |

**Caste profile**

The general caste is the dominant caste as they account for about 50.4% of total population, ST accounts for about 39.2% of the total population, and the SC comprise the balance 10.4%.

**Literacy Rate**

The overall literacy rate in the study area villages is 42.6%. The male and female literacy rates are 58.8% and 25.9% respectively.

The highest literacy rate was observed in village Tapoban (54.4%). The lowest literacy rate was in village Lata (13.6%). In other villages literacy rate ranged from 30 to 50 %.

**Occupational profile**

The percentage of main worker to the total population is 48.6%. The marginal and non-workers accounted for 5.9% and 45.5% respectively. Details are as below:

**Occupational profile of study area villages**

| S. no | Village name | Total main worker | | Marginal worker | | Non-workers | |
|---|---|---|---|---|---|---|---|
| | | Male | Female | Male | female | Male | female |
| 1 | Regari | 21 | 12 | 0 | 8 | 20 | 18 |
| 2 | tapoban | 227 | 128 | 7 | 26 | 187 | 160 |
| 3 | bhangyol | 49 | 48 | 2 | 1 | 50 | 36 |
| 4 | karchho | 57 | 42 | 3 | 34 | 89 | 81 |
| 5 | juwagwar | 34 | 37 | 0 | 0 | 21 | 21 |
| 6 | Jugnuch-ak Lata | 8 | 13 | 0 | 0 | 9 | 10 |
| 7 | lata | 72 | 33 | 16 | 58 | 65 | 104 |
| 8 | Bouhach-ak Lata | 32 | 27 | 1 | 3 | 21 | 14 |
| 9 | Paingcha-k Lata | 19 | 31 | 1 | 0 | 25 | 28 |
| 10 | subhai | 115 | 123 | 1 | 0 | 93 | 73 |
| 11 | Raingch-ak Subhai | 33 | 43 | 0 | 3 | 31 | 39 |
| 12 | Ringi | 46 | 61 | 0 | 1 | 57 | 48 |
| | **Total** | **713** | **615** | **31** | **134** | **668** | **615** |

The information on major occupations of main workers in the study area is as below:

**Occupational profile of main workers in study area villages**

| S. no. | Village name | Cultivators | | Agricultural labourers | | Livestock, forestry, fishing etc. workers | | Manufacturing & processing at household level | |
|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Male | Female | Male | Female | Male | Female |
| 1 | Regari | 17 | 12 | 0 | 0 | 0 | 0 | 1 | 0 |
| 2 | tapoban | 87 | 123 | 0 | 0 | 6 | 0 | 4 | 0 |
| 3 | bhangyol | 35 | 46 | 1 | 0 | 1 | 0 | 0 | 0 |
| 4 | karchho | 46 | 41 | 4 | 1 | 1 | 0 | 2 | 0 |
| 5 | juwagwar | 32 | 37 | 0 | 0 | 5 | 0 | 0 | 0 |
| 6 | Jugnuch-ak Lata | 8 | 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | lata | 33 | 24 | 9 | 0 | 5 | 0 | 1 | 6 |
| 8 | Bouhach-ak Lata | 11 | 26 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Paingcha-k Lata | 18 | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | subhai | 96 | 122 | 0 | 0 | 2 | 0 | 0 | 0 |
| 11 | Raingch-ak Subhai | 31 | 41 | 0 | 0 | 0 | 0 | 1 | 1 |
| 12 | Ringi | 35 | 57 | 1 | 1 | 0 | 0 | 1 | 3 |
| | **Total** | **449** | **591** | **15** | **2** | **20** | **0** | **10** | **10** |

...table contd.

| Manufacturing & processing other than household level | | Construction workers | | Trade & commerce workers | | Transp. & communication workers | | Other services workers | |
|---|---|---|---|---|---|---|---|---|---|
| Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 9 | 0 | 10 | 0 | 3 | 0 | 105 | 5 |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 10 | 2 |
| 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1 | 13 | 0 | 0 | 0 | 0 | 0 | 8 | 1 |
| 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 18 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 7 | 0 | 4 | 0 | 1 | 0 | 5 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| **8** | **1** | **36** | **0** | **20** | **0** | **5** | **0** | **156** | **11** |

**Occupational profile of main workers in the study area**

| **Occupation** | **Percentage of main workers** |
|---|---|
| Cultivators | 78.3 |
| Agricultural labour | 2.0 |
| Livestock workers | 1.5 |
| Industrial labour | 2.2 |
| Construction workers | 2.7 |
| Trade & Commerce workers | 1.5 |
| Others | 11.9 |
| **Total** | **100.00** |

It can be observed from above tables that the major occupation in the study area villages is agriculture as almost 80% of the working population is involved in this occupation.

### 8.5.14.2. Infrastructural Development

**Road Network**

Out of 12 villages 1 village is approachable by pucca road, 8 villages are approachable by kutchha road and 3 villages are approachable by foothpath.

**Road network in study area villages**

| S. no. | Village name | Approachable by pucca road | Approachable by kutcha road | Approachable by footpath |
|---|---|---|---|---|
| 1 | Regari | - | Yes | - |
| 2 | tapoban | Yes | - | - |

| | | | | |
|---|---|---|---|---|
| 3 | bhangyol | - | Yes | - |
| 4 | karchho | - | Yes | - |
| 5 | juwagwar | - | Yes | - |
| 6 | Jugnuch-ak Lata | - | Yes | - |
| 7 | lata | - | - | Yes |
| 8 | Bouhach-ak Lata | - | - | Yes |
| 9 | Paingcha-k Lata | - | Yes | - |
| 10 | subhai | - | Yes | - |
| 11 | Raingch-ak Subhai | - | - | Yes |
| 12 | Ringi | - | yes | - |

**Post & Telegraph facility**

Post office facility is available in only 6 study area village.

**Status of P & T facilities in study area villages**

| S. no. | Village name | Post office | Telegraph office | Post & Telegraph office |
|---|---|---|---|---|
| 1 | Regari | 1 | - | - |
| 2 | Tapoban | - | - | 1 |
| 3 | Bhangyol | - | - | - |
| 4 | Karchho | - | - | - |
| 5 | Juwagwar | - | - | - |
| 6 | Jugnuchak Lata | - | - | - |
| 7 | Lata | 1 | - | - |
| 8 | Bouhachak Lata | 1 | - | - |
| 9 | Paingchak Lata | - | - | - |
| 10 | Subhai | 1 | - | - |
| 11 | Raingchak Subhai | 1 | - | - |
| 12 | Ringi | - | - | - |

**Transportation Facilities**

Bus is the only form of community transport available in the 3 study area villages. They are not connected by train. The nearest railway stations are at Haridwar and Dehradun located about 280 km and 350 km respectively from the project area.

Transportation facilities in study area villages

| S. no. | Village name | Bus stop | Taxi /Tempo stand | Railway station |
|---|---|---|---|---|
| 1 | Regari | - | - | - |
| 2 | Tapoban | 1 | - | - |
| 3 | Bhangyol | - | - | - |

| | | | | |
|---|---|---|---|---|
| 4 | Karchho | - | - | - |
| 5 | Juwagwar | - | - | - |
| 6 | Jugnuchak Lata | - | - | - |
| 7 | Lata | 1 | - | - |
| 8 | Bouhachak Lata | 1 | - | - |
| 9 | Paingchak Lata | - | - | - |
| 10 | Subhai | - | - | - |
| 11 | Raingchak Subhai | - | - | - |
| 12 | Ringi | - | - | - |

**Medical facilities**

The medical facilities are not well developed in the study area villages. Medical infrastructure is very poor in the area.

**Medical facility in study area villages**

| S. no. | Village name | Health centre/ Hospital | Mat. & child welfare centre | Child welfare centre | Health centre | Primary health centre | Primary health sub-centre | Dispensary | Regd. Private practitioner |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Regari | - | - | - | - | - | - | - | - |
| 2 | tapoban | 1 | - | 1 | - | - | - | - | - |
| 3 | bhangyol | - | - | - | - | - | - | - | - |
| 4 | karchho | - | - | - | - | - | - | - | - |
| 5 | juwagwar | - | - | - | - | - | - | - | - |
| 6 | Jugnuch-ak Lata | - | - | - | - | - | - | - | - |
| 7 | lata | - | - | 1 | - | - | - | - | - |
| 8 | Bouhach-ak Lata | - | - | - | - | - | - | - | - |
| 9 | Paingcha-k Lata | - | - | - | - | - | - | - | - |
| 10 | subhai | - | - | - | - | - | - | - | - |
| 11 | Raingch-ak Subhai | - | - | - | - | - | - | - | - |
| 12 | Ringi | - | - | - | - | - | - | - | - |

**Educational Facilities**

All the villages have primary school. Middle school facilities are available in 5 out of 12 study area villages. Pre-university is available in only one village Tapoban.

**Educational institutions in the study area villages**

| S. no. | Village name | Primary school | Middle school | High school | Pre university college |
|---|---|---|---|---|---|
| 1 | Regari | 1 | 1 | - | - |
| 2 | Tapoban | 1 | 1 | - | 1 |
| 3 | Bhangyol | 1 | - | - | - |
| 4 | Karchho | 1 | - | - | - |

| | | | | | |
|---|---|---|---|---|---|
| 5 | Juwagwar | 1 | - | - | - |
| 6 | Jugnuchak Lata | 1 | - | - | - |
| 7 | Lata | 1 | - | - | - |
| 8 | Bouhachak Lata | 1 | 1 | - | - |
| 9 | Paingchak Lata | 1 | - | - | - |
| 10 | Subhai | 1 | 1 | - | - |
| 11 | Raingchak Subhai | 1 | 1 | - | - |
| 12 | Ringi | 1 | - | - | - |

### 8.5.14.3. Socio-Economic Impacts

**Immigration of labour population**

Workers who migrate to this area in search of job are likely to come from various parts of the country having different cultural, ethnic and social backgrounds. Such a mixture of population has its own advantages and disadvantages. The advantages include exchange of ideas and cultures between various groups of people which would not have been possible otherwise. Due to longer residence of this population in one place, a new culture, having a distinct socio-economic similarity would develop which will have its own entity.

Job opportunities will drastically improve in this area. The project will open a large number of jobs to the local population both during project operation and construction phases.

The availability of infrastructure could be a problem during the initial construction phase.

**Increased incidence of water related diseases**

The construction of project would lead to formation of water spread area. The vectors of various diseases breed in shallow areas not very far from the margins of the water spread area. Thus incidence of malaria may increase marginally.

Normally mosquitoes which are the vectors for transmission of malaria are observed upto an elevation of 2000 m. The proposed project is located at an elevation of about 1500 m to 1600 m. Thus adequate control measures are not taken, there could be increased incidence of malaria.

**Impacts on cultural/religious/historical monuments**

Apart from village temple in the study area, no monuments of cultural/religious/historical importance are reported in the project as well as the study area.

**8.5.14.4. Socio-Economic Aspects**

Survey of 108 PAFs of two villages Tapoban (67) and Shellong (41) were covered as a part of the socio-economic survey.

**Caste Status**

About 92.6 % of the surveyed household belongs to general caste category.

**Caste profile of surveyed households**

| **Caste** | **No. of households (%)** |
|---|---|
| General caste | 100 (92.6) |
| Schedule Tribes | 3 (2.8) |
| No response | 5 (4.6) |
| **total** | **108 (100)** |

Figures in bracket indicate percentage.

**Population**

The total population of the surveyed household was 502 and family size works out to be 4.7. The female population is almost equal to that of male population. The number of females per 1000 males works out to 984. As compared to village Tapoban, female population was marginally higher in village Shellong.

**Population of surveyed households**

| S. no. | Village name | No. of households | Male | Female | Total | Family size | No. of female per 1000 male |
|---|---|---|---|---|---|---|---|
| 1 | Tapoban | 61 | 148 | 145 | 293 | 4.8 | 980 |
| 2 | Shellong | 47 | 105 | 104 | 209 | 4.5 | 990 |
| | **Total** | **108** | **253** | **249** | **502** | **4.7** | **984** |

**Marital Status**

About 51.9 % of the surveyed population was unmarried and about 44.5 % was married.

Marital status of project affected population

| S. no. | Village name | Single | Married | Widow | Widower | Total |
|---|---|---|---|---|---|---|
| 1 | Tapoban | 154 | 125 | 12 | 2 | 293 |
| 2 | Shellong | 106 | 99 | 4 | - | 209 |
| | **Total** | **260** | **224** | **16** | **2** | **502** |

**Literacy rate**

About 16.6 % of the population is illiterate.

| **Level** | **Tapoban** | **Shellong** | **Total** |
|---|---|---|---|
| Primary | 78 | 83 | 161 |
| Middle school | 35 | 51 | 86 |
| Secondary | 83 | 23 | 106 |
| Graduate | 25 | 13 | 38 |
| Post-graduate | 20 | 1 | 21 |
| No response | 5 | 2 | 7 |
| Illiterates | 47 | 36 | 83 |
| **Total** | **293** | **209** | **502** |

**Occupational Profile**

The main occupation is agriculture. Student and female population account for about 38.6 % and 22.6 % respectively.

Occupational profile of the surveyed population

| **Category** | **Number (%)** |
|---|---|
| Agriculture | 92 (18.2) |
| Government service | 12 (2.4) |
| Private service | 14 (2.8) |
| Army | 4 (0.8) |
| House wife | 112 (22.3) |
| Student | 193 (38.6) |
| Business/shop | 5 (1.0) |
| Others | 8 (1.6) |
| No response | 52 (10.3) |
| Retired | 1 (0.2) |
| Unemployed/not working | 9 (1.8) |
| **Total** | 502 (100%) |

Note: Figure in brackets indicate percentage.

**House**

- 2 houeholds (1.9 %) had cattleshed
- 89 households (82.4 %) had separate kitchen
- 59 households (54.6 %) had lavatory facilities
- 56 households (51.9 %) had storage facilities

**Livestock**

The major livestock owned by the families are cow and goat.

**Livestock owned by PAFs**

| Livestock | Number |
|---|---|
| Cows | 174 |
| Calf | 147 |
| Pig | 15 |
| Buffalo | 78 |
| Goat | 396 |
| **Total** | **810** |

**Material Assets**

About 63 % of the PAFs owned radio, while percentage of families owing T.V. was 51.9 %. LPG was used by large proportion of PAFs. Very few families had their own mode of transportation.

**Details of assets owned by surveyed households**

| Assets | Number |
|---|---|
| Television | 56 |
| Tape-recorder | 58 |
| Radio | 68 |
| LPG | 104 |
| Plough | 66 |
| Cycle | 3 |
| Two wheeler | 3 |
| Four wheeler | 6 |

**Resident households**

About 11.5 % of the population did not live in the village.

**Status of resident population**

| S. no. | Village name | Within village | Outside village | Total |
|---|---|---|---|---|
| 1 | Tapoban | 254 | 39 | 293 |
| 2 | Shellong | 191 | 18 | 209 |
| | **Total** | **445** | **57** | **502** |

**Source of water**

Most of the PAFs (95.4 %) had pipe and tap water supply.

**Source of water used by PAFs**

| S. no. | Village name | River/stream | Pipe & Tap water | Data not available | Total |
|---|---|---|---|---|---|
| 1 | Tapoban | - | 66 | 2 | 68 |
| 2 | Shellong | 1 | 37 | 2 | 40 |
| | **Total** | **1** | **103** | **4** | **108** |

**Source of fuel**

About 60 % of the PAFs were using LPG.

Sources of fuel used by PAFs

| S. no. | Village name | Chulah | LPG | Gobar gas | Data not available | Total |
|---|---|---|---|---|---|---|
| 1 | Tapoban | 13 | 50 | - | 4 | 67 |
| 2 | Shellong | 23 | 13 | 1 | 4 | 41 |
| | **Total** | **36** | **63** | **1** | **8** | **108** |

**Sources of irrigation**

About 84.3 % of the households were dependent on rain water for meeting their irrigation water requirements. Only one PAF was using river water for meeting irrigation requirements.

Source of irrigation for PAFs

| S. no. | Village name | Rain | Stream | Data not available | Total |
|---|---|---|---|---|---|
| 1 | Tapoban | 62 | 1 | 4 | 67 |
| 2 | Shellong | 29 | - | 12 | 41 |
| | **Total** | **91** | **1** | **16** | **108** |

**Tree owned by PAFs**

**Number of trees owned by PAFs**

| **Tree** | **Number** |
|---|---|
| Almond | 71 |
| Apricot | 128 |
| Apple | 1793 |
| Orange | 126 |
| Others | 41 |

### 8.5.14.5. Rehabilitation and Resettlement (R&R) Aspect

R&R is probably one of the most important aspect for any WR Project. Rehabilitation and Resettlement refers to two distinct aspects.

**a) Rehabilitation**

When the means of earning are lost due to the land acquisition for a project, the affected person needs similar or alternate source of sustenance. The term Rehabilitation refers to the processes or means which enable the affected person to regain, if not improve, his previous level of income and standard of living. For example if a part or entire land of a person is lost due to land acquisition for a project, the affected person loses the source of income. In a rural environment a farmer has practiced agriculture for generations and has developed substantial skills to sustain even under adverse environment conditions. When the land is taken away for the project, he may have little skills to adapt to alternate means of income. That is the precise reason why in India, land based settlement is preferred. However it is difficult to get alternative land for rehabilitation.

**b) Resettlement**

When a person loses his homestead due to land acquisition for a project, alternate homestead is to be provided. The term Resettlement refers to the process through which the affected person is shifted to his new homestead which enables him to continue his 'business as usual' activities, if not an improved lifestyle.

6. Need for R&R plan

R&R plan is essential because of the following:

- Though the land is acquired for different interest, the acquisition is involuntary. The affected person faces forcible eviction and has no choice, but to accept the consequences. The affected person therefore needs support to regain his previous levels of standard of living.
- Improper resettlement and rehabilitation is the root cause of discontentment and alienation among Project Affected Persons (PAPs). No project can be successfully implemented without the cooperation of the local population.

7. Basic issues involved in framing a Rehabilitation Action Plan (RAP)

Acquisition of land induces a large scale change in land use patterns and can destroy the economic base. The RAP is to be formulated so that after a reasonable transition period the displaced persons improve or at least regain their previous standard of living, earning capacity and production levels. The transition gap is to be reduced to a minimum.

8. Categories of PAPs and RAP Entitlements

For R&R purpose it is necessary that the PAPs be classified into different categories. PAPs cover the following:

- A person whose entire land is acquired.
- A person owing land which is not economically viable after acquisition. In some states the minimum amount of land considered economically viable is 2 ha, adjustment needs to be made depending on local conditions such as soil fertility, access to water (irrigation) and other factors.
- A person whose homestead only is acquired.
- A person whose homestead and land is acquired.
- A person (tenant tiller) who is in actual possession of land which is acquired.
- A person (agricultural labour) who does not have legal title to the land which is acquired but earns his living principally through manual labour on that land.
- A tribal residing or deriving livelihood from the forest land which is acquired.
- A landless person cultivating on the government land which is acquired.
- Persons dependent upon the land either directly or indirectly and having a client relationship with the displaced community.
- In a joint family or joint holding, a person (major) who has a share in the land or homestead.

- A permanent resident of the area which is acquired but not defined above.
- A person (absentee land owner or absentee homestead owner) who is not in actual possession of land or homestead for 5 years prior to the date of notification under the LA Act.

*Eligibility Status*

The resettlement and rehabilitation entitlements for various categories of PAPs are given in the table below.

**Resettlement and Rehabilitation entitlements for various categories of PAPs**

| S. No. | Category of PAPs | Resettlement/Rehabilitation Entitlements |
|---|---|---|
| 1. | Person losing entire land | Land for land or self-employment or shop or award of petty contract or job (after accounting for compensation legally due under land acquisition act) – **(Set-A)** |
| 2. | Person left with land not economically viable (less than 2 ha.) | Set-A |
| 3. | Person whose homestead is acquired | Alternate house site along with community infrastructural facilities and other rehabilitation assistance – **(Set-B)** |
| 4. | Person whose homestead and land is acquired | Both Set-A and Set-B |
| 5. | Person (tenant tiller) in actual possession of land | Set-A when no claim made by original landlord |
| 6. | Agricultural laborer without legal title of land | Self-employment or shop or award of petty contract or job – **(Set-C)** |
| 7. | Tribal residing or deriving livelihood from forest land | Set-C and Set-D. Tribal will receive special attention to restore their income |
| 8. | Landless person cultivating government land | Set-C |
| 9. | Person having client relationship with displaced community | Assistance to establish the type of facilities lost on account of land acquisition. Assessment in such case will be separately carried out by working department and/or the State Administration with PAPs – **(Set-D)** |
| 10. | Permanent resident of land not covered above | Set-D |
| 11. | In a joint family or joint holding, a person (major) who has share | Set-B |

**Homestead**

The eligible PAP will be given compensation for his existing homestead (structure and appurtenant land) on the basis of evaluation done under the L.A. Act.

**8.5.14.9. Monitoring and Evaluation**

The R&R scheme will be monitored and evaluated periodically after the completion of the land acquisition process. A separate group, both at the project (site group and corporate centre group) would be constituted for implementation of the RAP, monitoring and evaluation of the RAP with respect to time and cost frame.

**In the proposed project only one family is likely to lose both homestead and land and the balance 107 families are likely to lose land only.**

## 8.6 Environmental Management Plan (EMP)

The EMP enumerate set of measures to be adopted to minimize the adverse impacts. The measures include mitigation or enhancement measures in this project as

- control of pollution from labour camps during construction phase
- environmental management in road construction
- muck disposal
- quarry slope stabilization
- restoration and landscaping
- greenbelt development
- control of pollution in project colony
- health management system
- fishery management
- wildlife conservation
- seismicity considerations
- noise control measures

- control of landslides

### 8.6.1 Control of pollution from labour camps during construction phase

The various issues covered are

- facilities in labour camps
- sanitation & sewage treatment facilities
- solid waste management
- provision of community kitchen

The labour camp site should have ventilation system, water supply and community latrines. One community latrine can be provided per 20 persons. For each 500 persons, one septic tank should be provided. The effluent from these septic tank can be disposed off through soak pits. Drinking water facilities and waste disposal sites will be located away from each other. Make a clause mandatory in the contract of every contractor involved in project construction to provide supply of fuel to their labourers, so that trees are not cut for meeting their fuel demands.

### 8.6.2 Environmental management in road construction

In hilly area landslides are often triggered due to road construction, which can largely be controlled by provision of suitable drainage. The other erosion hazard is that of surface erosion of the bank, which is best controlled by vegetation.

### 8.6.3 Management of muck disposal site

Muck generated is to be disposed in a planned manner so that it takes a least possible space and is not hazardous to the environment. In hilly area dumping is done after creating terraces. Suitable retaining walls shall be constructed to develop terraces. In-between terraces catch water drain will be provided. The terraces of the muck disposal area will be ultimately covered with fertile soil and suitable plants will be planted.

### 8.6.4 Restoration plan for quarry sites

The quarry sites need to be properly stabilized after excavation of construction material is completed. Following measures are taken

- construction of concrete guards check the soil erosion of the area
- the pit formed after excavation be filled with small rocks, sand and farmyard manure
- grass slabs will be placed to stabilized and check the surface runoff of water and loose soil.

### 8.6.5 Restoration and landscaping of project sites

The construction of the project would disturb the existing topography and physiograohy. It is proposed to landscape the area so that it integrates with the natural surroundings and the beauty of the area is restored. Accordingly it is proposed to develop small gardens and viewpoints at few locations along the periphery of the water spread area and power house site. The landscaping plan involves:

- garden complex
- view points

### 8.6.6 Greenbelt development

Forest loss due to various project appurtenances has been compensated as a part of compensatory afforestation. However in addition to afforestation it is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along the periphery of water spread area.

### 8.6.7 Public health delivery system

Malaria could be the major water related vector-borne disease. The suggested measures to control malaria are:

- The site selected for habitation of workers should not be in the path of natural drainage.

- Adequate drainage system to dispose storm water drainage from the labour colonies should be provided.
- Adequate vaccination and immunization facilities should be provided for workers.
- The labour camps and resettlement sites should be at least 2 to 3 km. away from the main water body or quarry sites.

### 8.6.8 Control of air pollution

The air pollution is basically generated due to primary crushing and dust. It should be mandatory for the contractors involved in the crushing activities to install cyclone in the crusher to control dust generated while primary crushing. The fine aggregate stacked should be regularly sprayed with water. Water is to be sprayed on unpaved roads regularly.

### 8.6.9 Control of water pollution

The sewage generated from various labour camps should be treated in septic tank and disposed by discharging into river Dhauliganga. The septic tank should be located so as not to pollute the drinking water sources. The effluent from crushers needs to be treated through settling tanks before disposal.

### 8.6.10 Fish management

Release of minimum flow through barrage is to be maintained.

## 8.7 Establishment of an Environmental Management Cell

It is recommended to establish an environmental management cell at the project site with requisite manpower. The task of the cell will be to coordinate various environmental activities, to carry out environmental monitoring and to evaluate implementation of environmental mitigatory measures.

## 8.8 Catchment Area Treatment Plan (CAT)

The Catchment Area Treatment plan pertains to preparation of a management plan for the treatment of erosion prone areas in the catchment area. Watershed management techniques are used. The overall objectives of watershed management programme are to:

- increase infiltration into soil
- control excessive runoff
- manage & utilize runoff for useful purpose

Following Engineering & Biological measures have been suggested for the CAT.

1. Engineering measures
   - Step drain
   - Angle iron barbed wire fencing
   - Stone masonry
2. Biological measures
   - Development of nurseries

     Plantation/afforestation

     Pasture development

     Social forestry

The basis of site selection for different biological and engineering treatment measures under CAT is as below:

**Basis for selection of CAT measures**

| Sl.No. | Treatment measures | Basis for selection |
|---|---|---|
| 1. | Social forestry, fuel wood and fodder grass development | Near settlements to control tree felling |
| 2. | Contour Bunding | Control of soil erosion from agricultural fields |
| 3. | Pasture development | Open canopy, barren land, degraded surface |
| 4. | Afforestation | Open canopy, degraded surface, high soil erosion, gentle to moderate slope |
| 5. | Barbed wire fencing | In the vicinity of afforestation work to protect it from grazing etc. |
| 6. | Step drain | To check soil erosion in small streams, steps with |

| | | |
|---|---|---|
| | | concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current |
| 7. | 1:4:8 Stone masonry | Steep slopes, sliding surfaces, less vegetative cover and silt erosion is high |
| 8. | Nursery | Centrally located points for better supervision of proposed afforestation minimize cost of transportation of seedling and ensure better survival. |

## 8.9 Environmental Monitoring Programme

With the implementation of WR Project a new environment is created. It is very difficult to predict with complete certainty the exact post-project environmental scenario. The environmental monitoring programme has following objectives:

- Assess the change in environmental conditions if any during construction and operation of the project.
- Monitor the effective implementation of mitigatory measures
- Warning of any significant deterioration in environmental quality so that additional mitigatory measures may be planned in advance.

**Environmental monitoring programme during project construction phase**

| S. No. | Item | Parameters | Frequency | Location |
|---|---|---|---|---|
| 1. | Effluent from septic tanks | pH, BOD, COD, TSS, TDS | Once every month | Before & after treatment from each septic tank. |
| 2. | Water related diseases | Identification of water related diseases, Control & curative measures | Three times a year | Labour camps and colonies |
| 3. | Noise | Equivalent noise level ($L_{eq}$) | Once in three months | At major construction sites |
| 4. | Air quality | SPM, RPM, $SO_2$, and $NO_x$ | Once every seasons | At major construction sites |
| 5. | Meteorological aspects | Wind direction & velocity, temperature, humidity, rain | Once every seasons | At one of the ambient air quality sampling sites. |

**Environmental monitoring programme during project operation phase**

| S. No. | Items | Parameters | Frequency | Location |
|---|---|---|---|---|
| 1. | Water | pH, temp., turbidity, TDS, Ca, Mg, total hardness, chlorides, sulphates, nitrates, DO, COD, BOD, Iron, Zinc, Manganese | Thrice a year | - 1 km u/s of barrage site<br>- Water spread area<br>- 1 & 3 km d/s of tail race discharge |
| 2. | Effluent from sewage treatment plant (STP) | pH, BOD, COD, TSS, TDS | Once every week | Before & after treatment from sewage treatment plant |
| 3. | Erosion & Siltation | Soil erosion rates, stability of bank embankment, etc. | Twice a year | - |
| 4. | Ecology | Status of afforestation programmes of green belt development | Once in two years | - |
| 5. | Water related disease | Identification of water related diseases, sites, adequacy of local vector control measures, etc. | Three times a year | Village adjacent to project sites |
| 6. | Aquatic ecology | Phytoplanktons, Zooplanktons, benthic life, fish composition | Once a year | - 1 km u/s of barrage site<br>- Water spread area<br>- 1 & 3 km d/s of tail race tunnel discharge |
| 7. | Land use | Land use pattern using satellite data | Once in a year | Catchment area |
| 8. | Soil | pH, texture, organic matter | Once in a year | Catchment area |

## 8.9 Conclusion

We can conclude that by adopting EIA properly, there is negligible public protest against the project. Ecology of the project affected area is less disturbed. Socio-economic and cultural aspect of the region is kept intact. Living standard of the region has improved. The project is well accepted by the environment and the people residing there.

## 8.10 SELECTION OF EIA METHODS

From the present case study, it can be concluded that among the various methods used in impact prediction of environmental parameters in WR Projects, best methods are:

1. Decision Support System
2. Matrices Method
3. Simple Checklist Method
4. Decision-focused checklist

## 9.1 CONCLUSIONS:

1. **Ecology of the project area is less disturbed, Socio- economic & cultural aspect of the region is kept intact with EIA.**
2. **To satisfy the environmental activists, EIA of a project is an efficient tool.**
3. **From the case study it is observed that *Decision Support System* and *Matrices Method* are best methods for impact prediction in WR Projects.**
4. **For timely completion of WR Projects, and hence reduction in cost overrun, proper EIA study is essential.**

## 10.1 Scope of Further Study

Despite ample evidence to support the usefulness of EIA, its effectiveness and efficiency are being increasingly questioned. Criticisms leveled against EIA include:

1. Tokenism
2. Unrealistic time constraints
3. Failure to accommodate uncertainty
4. Poor coordination and poorly stated objectives
5. Inadequate research
6. Limited use of protective techniques and limited study of indirect and cumulative consequences and
7. Being too descriptive and voluminous

Aim of further study is to reduce/eliminate as much as possible the above criticisms. Use of Artificial Neural Network (ANN) as an methodology for impact prediction of various project activities. ANN is different from Expert System. ANN supports non-linearity whereas Expert system do not supports non-linearity, it is rigid.

Up till now in EIA, we deal the impact predictions mostly in qualitative terms. Further scope of study is to quantify these environmental parameters.

During the filling of reservoir, large forests are generally submerged. During initial period of submergence there is release of huge amount of undesirable gases like methane etc. It is desirable to remove all the forest wood from reservoir and then fill the reservoir to avoid emission of undesirable gases, but in actual practice this do not happens. Further scope of study is to solve this submergence problem.

# ANNEXURE-1

## QUESTIONNAIRE FOR ENVIRONMENTAL APPRAISAL
*(FOR RIVER VALLEY AND HYDROELECTRIC PROJECTS)*

QUESTIONNAIRE FOR SITE ASSESSMENT OF RIVER VALLEY AND HYDROELECTRIC PROJECTS

## 1. General Information

A. Site Information

B. Geographical Location

| Village/s | District/s | Tehsil/s | State/s |
|---|---|---|---|
| | | | |

C. Latitude

D. Longitude

E. Elevation above Mean Sea Level

F. Total Area proposed for the Project (in ha.), if any

Forest area (in ha), if any

G. Nature of Terrain

H. Technical Classification of Soil (loam, sandy etc./aerial extent (ha.)

## II. Existing land usage of the proposed project site area (in hectares)

| | | Total |
|---|---|---|
| i)Agriculture<br>a) Irrigated<br>b) Unirrigated | | |

| | | |
|---|---|---|
| ii)Homestead | | |
| iii)Forest | | |
| iv)Grazing | | |
| v)Fallow | | |
| vi)Water bodies | | |
| vii)Marshes | | |
| viii)Others(Pl. Specify) | | |
| Total | | |

**Alternate sites considered from the environment angle.**

A. _____

B. _____

C. _____

D. _____

**Reason for selecting the proposed site from the environment angle.**

**Details of site**

A. Seismicity

1. Whether the proposed dam site fall in seismically active area

Yes ☐ No ☐

**If yes**

2. What is the seismic zone?

3. Whether any major landslide occurred in the past?

*If yes,*

(a) Frequency of occurrence/decade

(b) Area affected (ha)

(c) Population affected (nos.)

B. Sites likely to be submerged

1. Mineral bearing

| S. No. | Name of the Mineral |
|---|---|
| | |

2. Archaeological sites/monuments

| S. No. | Sites/Monuments | Antiquity |
|---|---|---|
| | | |

3. Place of worship

| S. No. | Place | Period of construction |
|---|---|---|
| | | |

## Objective of the project

A. Irrigation(ha)

B. Power generation (MW)

C. Drinking water supply (cumecs)

D. Industrial water supply (cu.m. /day)

E. Flood control (area to be protected, in ha)

F. Others (pl. specify)

## In case of Irrigation projects –

1. Existing Cropping pattern

| S. No. | Crop | Existing Area (ha) | Productivity (tonnes/ha) |
|---|---|---|---|
| | | | |
| | | | |

2. Water logging (ha)

3. Infiltration rate (cms /hour)

(at least for two locations in each of the major soil groups identified)

| Major soil group | | | | |
|---|---|---|---|---|
| Infiltration rate | | | | |

4. Saturated hydraulic conductivity for major soil groups (m/day) using in-situ auger hole/inverse auger hole method depending on depth of water table from the ground level within 2 meter or above 2 meters

**VIII.**

1. Sedimentation (hectare meter/sq.km/year)

Present rate

2. Length of river course which is likely to dry up due to impoundment (km)

3. In case of project where flow of water will be reduced due to withdrawal of water in between head race tunnel and tail race tunnel

i) Length (metre) [ ]

ii) Flow rate in river (m/sec) [ ]

**IX. Whether any of the following exist within 7 km. of the project site. If so please indicate aerial distance from the periphery of submergence of the site and the name of the site.**

| S.No. | | Name | Aerial Distance (in Km) |
|---|---|---|---|
| 1. | National Park | | |
| 2. | Sanctuary/Tiger Reserve/Elephant Reserve | | |
| 3. | Core Zone & Buffer Zone of Biosphere Reserve | | |
| 4. | Habitat for migratory birds | | |
| 5. | Lakes/Reservoir/dams | | |
| 6. | Stream/Rivers | | |
| 7. | Estuary/Sea | | |
| 8. | Mountains/Hills | | |
| 9. | Archaeological sites | | |
| 10. | Archaeological sites listed in notification | | |
| 11. | Defence Installation | | |
| 12. | Industries/Thermal Power Plants | | |
| 13. | Municipal Corporation/Municipal Council/Nagarpanchayat (by whatever name it is known in the state) | | |
| 14 | Mangroves | | |

| | | | |
|---|---|---|---|
| 15 | Airports | | |
| 16 | Railway lines | | |
| 17 | National Highways | | |

X. Description of the vegetation (a) within project site (b) within 7m Km from the periphery of project site under following headings

A. Agricultural crops_____

B. Commercial crops_____

C. Plantation_____

D. Natural Vegetation/Forest Type (provide details)_____

E. Grass lands_____

F. Endangered species_____

G. Endemic species_____

H. Others (Please specify)_____

XI. Description of fauna within 7 Km under following headings.

A. Rare and endangered species

B. Species which require management

C. Species of economic significance

D. Species of special interest to local population or tourists

E. Aquatic fauna of commercial/recreational value and migratory fish species along with their spawning ground

F. Migratory route of terrestrial, aquatic as well as avi -fauna.

## XII. In case of temporary construction

A. Length of roads to be built

B. Temporary sheds & Quarters

C. Temporary office & residential buildings

D. No. of people to be engaged

XIII. **Annual average rain fall (in mm)** _____

XV. Water Balance (cumecs)

1. Minimum flow observed over a period of time, and

2. Maximum flow observed over a period of time

XVI. **Present Water use downstream. (cubic meter/sec)**

| S. No. | Usage | Present Consumption | |
|---|---|---|---|
| | | Surface | Ground |
| 1 | Irrigation | | |
| 2. | Industry | | |
| 3. | Drinking | | |
| 4. | Other (Please specify) | | |
| | Total | | |

**XVII. Physico chemical analysis of Raw Water**

XVIII. Pollution sources.

| S.No. | Source | Around the periphery of submergence | At a distance of 7 Km from the pepriphery of submergence zone | In the catchment area | Within 7 Km in the stretch in which the river is likely to dry up |
|---|---|---|---|---|---|
| 1. | Industry | | | | |
| 2. | Municipal waste/sewage | | | | |
| 3. | Mining | | | | |
| 4. | Beneficiation plants | | | | |
| 5. | Tail pond dams | | | | |
| 6. | Run off from ash ponds | | | | |
| 7. | Others (Pl. specify) | | | | |

## XIX. Human settlement

**Aerial distance from the periphery of the reservoir**

| | **Upto 2000m from periphery of the reservoir** | **2000m to 5000m from periphery of the reservoir** | **5000m to 10000m from the periphery of the reservoir** |
|---|---|---|---|
| Population | | | |
| Number of houses | | | |
| Present occupational pattern | | | |

## XX. Expenditure on Environmental Measures proposed at the time of survey and investigation

LIST OF DOCUMENTS TO BE ATTACHED WITH THE QUESTIONNAIRE IN RESPECT OF RIVER VALLEY AND HYDROELECTRIC PROJECTS.

| | | |
|---|---|---|
| 1. | **Topographic map of the main project site indicating contours (1:2500 scale)** | |
| 2. | **Topographic map covering 7 Kms Radius indicating main features, ecologically sensitive areas, area to be submerged, main canal net work (in case of irrigation projects only), archeological sites, migratory route of wild animals** | |
| 3. | **Contour map of location of dam indicating submerged areas** | |

## References:


1. Arquiaga M.C. (1991) Generic health impact prediction and assessment methodlogy for Environmental Impact Studies, Ph.D. thesis, University of Oklahoma, Norman.
2. Bindu N. Lohani, Asian Institute of Technology, Bangkok, Thailand, Alastair M. North, Asian Institute of Technology, Bangkok, Thailand (1984), Environmental Quality Management, South Asian Publishers, New Delhi.
3. Cahill L.B. and Kane R.W.(1996), Environmental Audits, Government Industries, Inc., Rockville, Maryland.
4. Chanlett E.T. (1988), Environmental protection. Mc.Grawhill book New Delhi.
5. Cheremisinoff Paul N. and Morresi Angelo C.(1992), Environmental Assessment & Impact Statement Handbook, ANN Arbor Science Publishers Inc. New York.
6. G. N. Pandey, Institute of engineering & Technology , Lucknow, G. C. Carney, Bristol Polytechnic, Bristol (1992), Environmental Engineering, Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. IS 15442 : 2004, Parameters for Environmental Impact Assessment of Water Resources Projects.
8. Larry W. Canter (1996) University of Oklahoma, Environmental Impact Assessment, McGraw-Hill, Inc. New York.
9. Prasad Kamta, Goel R. S. Environmental Management in Hydro Electric Projects Proceedings of the international seminar held at W.R.D.T.C. University of Roorkee (12-14 December, 1985) , volume I, II, III
10. Prof. Y. Anjaneyulu, Jawaharlal Nehru Technological University, Hyderabad, Prof C. A. Sastry, Indian Institute of Technology, Chennai (2002), Environmental Impact Assessment Methodologies, BSP BS Publications, Hyderabad.

11. Robert A. Corbitt (1989), Standard Handbook of Environmental Engineering, McGraw-Hill Publishing Company, New York
12. R.J.Bennett, R.J.Chorley (1978), Environmental System Philosophy, Analysis and Control, William Clowes & Sons Limited, London.
13. S. Edmunds and J. Letsey (1973), Environmental Administration, McGraw-Hill, New York.
14. Wainwright John and Mulligan Mark (1976), Environmental Modelling Finding Simplicity in Complexity, John Wiley & Sons Ltd. New York.
15. Weiner Ruth F. and Matthewa Robin A.(1981), Environmental Engineering, Butterworth Heinemann, New York.
16. Yacov Y. Haimes, David A. Moser, and Eugene Z. Stakhiv (1991), Risk-Based Decision Making In Water Resources, American Society of Civil Engineers, New York.