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Environmental Impact Assessment of Water Augmentation Project – A Case Study

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Abstract: ***Environmental impact assessment of water augmentation in a coastal region forms an important part in the context of safeguarding environment. Keeping this in view, an attempt has been made to assess water scarcity, its resource potential and augmentation in a coastal region projecting for a considerable period of sustenance. Here in an attempt is made for an environmental impact assessment study regarding install of deep borewells in a coastal region and analysed. Based on the literature studies, collection of data and analysis, the positive and negative impacts are discussed and resulted using Leopold matrix.***

Keywords: Environmental impact assessment, water scarcity, water augmentation projects, impact prediction, Leopold matrix

1. Introduction

Water is a vital and precious element for mankind, under diverse ecosystems on which we depend, for domestic, agriculture, industry, transport, power generation, recreation and ecosystem maintenance, water supply must be in sufficient quantity and quality to support the different uses. Freshwater is therefore a key strategic resource for sustaining the environment and economic growth. Because of human and natural causes, the resource has been changing both in quantity and quality. Groundwater is a highly vulnerable and important resource for both humans and the environment; therefore, it is essential to understand the environmental implications of groundwater overexploitation. Overexploitation in coastal region is a threaten to groundwater resources, with serious consequences for human welfare and the environment. It highlights the environmental consequences of groundwater overexploitation.

2. EIA in India

The EIA notification was first issued in 1994 by the Government of India (Ministry of Environment and Forests (MOEF) in exercise of its power to protect and improve the environment as provided under Section 3 of the Environment Protection Act, 1986. It introduced a process for prior environmental approval of projects. Three significant changes were initiated through the 2006 amendment that superseded the 1994 notification. First, the decentralization of regulatory functions to State level Environment Impact Assessment Agencies (SEIAAs). SEIAAs are to oversee smaller scale projects (Category ‘B’) and the MOEF would continue to regulate larger projects (Category ‘A’). Second, although the final regulatory approval would be decided by the MOEF or the concerned SEIAA, they in turn are to base their approvals on the recommendations of the State Expert Appraisal Committee (SEAC) and the Expert Appraisal Committee (EAC) functioning in the MOEF. Third, the State Pollution Control Boards (SPCB) or the Union Territory Pollution Control Committee (UTPCC) are given the responsibility on conducting the public hearing, taking responsibility away from the project proponents. These three changes are designed to make the appraisal process more streamlined, transparent and independent of politicking.

3. Process of EIA

There are two ‘tiers’ of assessment process which should be applied to the project before proceeding with a full scale EIA, Screening and preliminary assessment. The most important step in the process of obtaining environmental clearance under the EIA notification is for the project proponent to conduct an environmental impact assessment of the project. The first tiers of assessment are a regulatory requirement; the developer normally does the work and submits the results to the regulatory agency.

The agency may then decide whether there is anything to be concerned about or whether the evaluation should proceed to the next tier.

3.1 Screening

Screening is the basic and simplest process in project evaluation. It decides if the project needs EIA or not. The government rules categorize projects into two categories, A and B based on the spatial extent of the impacts, effects on human health and the effects on the environment. Category-A projects are looked into by the Central Government whereas Category-B projects go to the State Government. Category B projects are further sub divided into Category B1 and Category B2. B1 require a public hearing for EIA, B2 don’t require. Screening basically screens out the projects that don’t require EIA process.

3.2 Preliminary assessment

The screening would help clear a project or hold it for further stages. If it is held for next stage, the developer will have to take Preliminary Assessment, which involves sufficient research, review of available data and expert advice in order to identify the key impacts on the project at local environment. This study will predict the extent of the impacts and would briefly evaluate the importance for decision makers. After the preliminary assessment, the competent authority would review it and would decide if there is a need for comprehensive EIA or Rapid EIA. Then, the developer will have to prepare the EIA report.

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3.3 Scoping

Scoping is yet another stage before the main EIA process begins. The EIA study team which was organized after preliminary assessment would get engaged into discussions with developers, investors, regulatory agencies, scientific institutions, local people etc. It would study and address all issues of importance and the concerns raised by various groups. Then the team would select the primary impacts for main EIA to focus and determines detailed and comprehensive Terms of Reference (ToR) for the main Environment Impact Assessment (EIA).

3.4 Main EIA

After "scoping", the main EIA begins. The EIA attempts to answer five questions basically:

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

The EIA becomes a cyclic process of asking and further asking the first four questions until decision makers can be offered of workable solutions.

3.4.1. Identification:

Identification means the answer to the first question, i.e. "what are the changes that happen as result of the project?" If a preliminary assessment has been done it will have broadly reviewed the projects effect, and scoping will have focused the study on the most important issues for decision makers. Taking these findings in to account the full EIA study now formally identifies those impacts which should be assessed in detail. This identification phase of the study may use these or other methods-

1) Compile a list of key impacts.
2) Name all the projects sources of impacts.
3) Identify impacts themselves through the use of checklist, matrices, networks, overlays, models and simulations.

3.4.2 Prediction

As a next step, prediction determines the extent of the changes caused due to abstraction of groundwater in coastal zone. As far as practicable, prediction scientifically characterizes the impacts causes and effects and its secondary and synergetic consequences for the environment and the local community. Prediction follows an impact within a single environmental parameter in to its subsequent effects in many disciplines Prediction draws on physical, biological, socioeconomic and anthropological data techniques .In quantifying impacts, it may employ mathematical models, physical models, socio cultural models, economic models, experiments or expert judgments.

All prediction techniques by their nature involve some degree of uncertainty. So along with each attempt to quantify an impact, the study should also quantify the predictions uncertainty in terms of probabilities or margins of error.

3.4.3 Evaluation

The third question addressed by the EIA – "do the changes matter" is answered in the next step. It evaluates the predicated adverse impacts to determine whether they are significant enough to warrant mitigation. Thus judgment of significance can be based on one or more of the followings;

1) Comparison with laws, regulations or accepted standards.
2) Consultation with the relevant decision makers.
3) Reference to preset criteria such as protected sites features of species.
4) Acceptability to the local community or the general public.

3.4.4 Mitigation

A wide range of measures are proposed to prevent, reduce, remedy or compensate for each of the adverse impacts evaluated as significant. All mitigation measures cost something and this cost must be quantified too. These various measures are then compared, trade-offs between alternative measures are weighed. The action plan includes technical control measures, an integrated management scheme (for a major project) monitoring, contingency plans, operating practices, project scheduling, or even joint management (with affected groups).

3.4.5 Documentation

The EIA document itself is a technical tool that identifies, predicts, and analyses impacts on the physical environment, as well as social, cultural, and health impacts. If the EIA process is successful, it explores alternatives and mitigation measures to reduce the adverse impact of a proposed project.

3.5 Public participation

Public participation is necessary for minimizing or avoiding public controversy, confrontation and delay, and can make a positive contribution to the EIA process. Clark (1994) suggests that public participation in EIA has a critical role to play in helping to integrate economic, social and environmental objectives. At every stage of EIA, public participation is necessary.

4. Water Scarcity

Water scarcity can be measured by per capita availability. One of the most frequently referenced indicators of water scarcity definitions stems (Falkenmark & Widstrand, 1989). They offer a measure of water scarcity based on a ratio of population and the total annual natural water supply, or available water, in a country. The study used estimates of national water availability and population to calculate annual per capita water availability, and ranked water scarcity levels according to per capita water availability thresholds.

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4.1 Forecasting Water Scarcity

A good grasp of how present population pressures and human activities affect today's water scarcities is a necessary starting point for a well-informed discussion on how pronounced water stress in certain areas may affect population in different areas in the future (Kirstin Dow et al, 2005). Water scarcity is not a static phenomenon; rather, it depends on how well local, regional and even global demands are balanced with respect to limited natural supplies, and possibly augmented with additional technical supplies such as desalination or virtual water imported into a region in the form of grain or other products. Any such assessment of future water situations will rest on assumptions about future water use practices and demands for water quantity and quality and how these relate to a variety of key parameters such as changes in population, economy, technology innovations, and behavior. There are great uncertainties on the natural supply side, mainly due to global warming and possible climate change trends.

Coastal region with a population of 9,46,600 is taken as case study. The water demand is 127 MLD and water availability is 117MLD that results in scarcity of 15MLD. The population of region is predicted using incremental increase method, thereby calculating water demand and its scarcity.

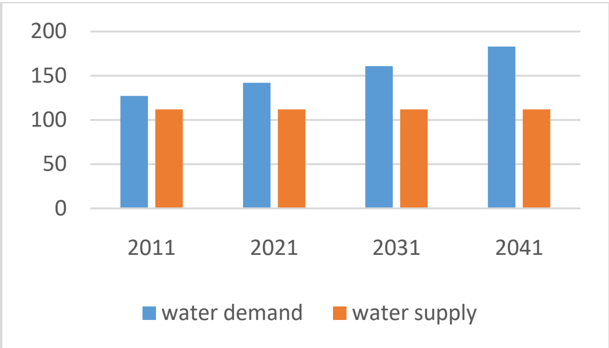

Figure 1: water Demand - Supply

Table 1: Scarcity (2011-2041)

Year	*Scarcity*
2011	15
2021	30
2031	49
2041	71

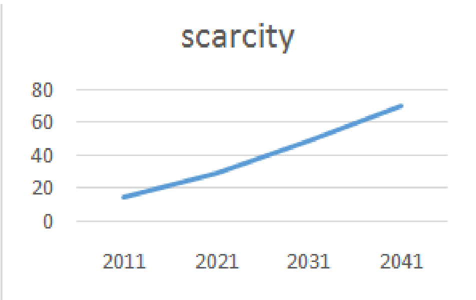

Figure 2: Graphical representation of scarcity

5. Water Augmentation

From the population and water demand prediction made, it is very much clear that the coastal region is highly prone to water scarcity in the future years. In order to meet up with the scarcity, it is necessary to propose water supply augmentation projects.

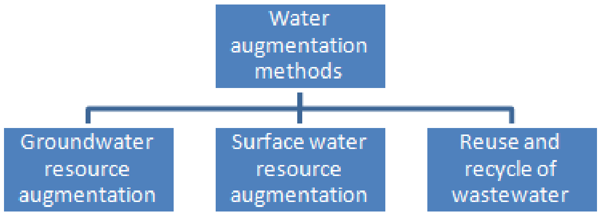

Figure 3 water augmentation methods

6. EIA Using Leopold Matrix

According to the Leopold matrix method, EIA should consist of three basic elements: a) a listing of the effects on the environment that the proposed development may induce, including the estimate of the magnitude of each of the effects; b) an evaluation of the importance of each of the effects; and c) a summary evaluation, which is a combination of magnitude and importance estimates. For the analysis of possible impacts of certain activities and procedures during the construction is made.

Impact factors have been evaluated separately for each environmental component relevant for the scope of this study, and scored on a scale from 0 to 5 for impact magnitude, according to the following scale:

0 – no observable effect
1 – low effect
2 – tolerable effect
3 – medium high effect
4 – high effect
5 – very high effect

In Table 2, the activities in the phase of installing borewells well as possible impacts during the period of exploitation is made.

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Table 2: Magnitude of Impact

Project activities / Environmental parameters	Land requirement	Labour requirement	Drilling wells	Trench digging	Collection tank construction	Laying of pipes	Pumping water	More use of water	disinfection	Sum of IF values	Average
Surface water quality	1	0	1	1	0	0	0	1	1	5	0.5
Surface water quantity	1	1	2	2	1	1	2	2	0	12	1.3
Flora (Tress and Plants)	3	1	3	3	2	2	3	4	1	22	2.4
Ornitho fauna (Birds)	1	0	1	0	0	0	0	1	0	3	0.3
Chiropteran fauna	0	0	1	0	0	0	0	1	0	2	0.2
Terrestrial wildlife habitat	2	0	2	2	1	1	1	2	0	11	1.2
Rare /endangered species	2	0	4	2	1	2	3	4	0	18	2.0
Highways/railways	1	0	2	2	1	2	0	0	0	8	0.8
Water supply	0	1	0	0	0	1	1	3	1	7	0.7
Agriculture	4	0	3	4	2	2	4	5	2	26	2.8
Housing	1	0	2	2	1	2	2	3	1	14	1.5
Health	0	1	0	0	0	1	2	1	3	8	0.8
Socio-economic	1	3	1	0	1	0	1	2	0	9	1.0
Groundwater quality	1	0	2	3	0	2	3	4	0	15	1.6
Groundwater quantity	0	1	3	2	0	2	4	5	0	17	1.8
Aquifer pressure	1	0	1	2	0	2	4	5	0	15	1.6
Soil	2	0	1	2	0	2	3	4	0	14	1.5
Noise	0	1	1	0	0	0	0	0	0	2	0.2
Aesthetic	1	0	1	0	1	0	2	4	0	9	1.0
Land use	3	1	2	3	3	2	1	1	0	16	1.7
Cumulative values of IF according to environmental parameters	25	9	33	30	14	24	36	52	9		
Average	1.2	0.4	1.6	1.5	0.7	1.2	1.8	2.6	0.45	**I. F**	**1.3**

7. Impact – Result and Discussion

Water availability problems occur when the demand for water exceeds the amount available during a certain period. They happen frequently in areas with low rainfall and high population density, and in areas with intensive agricultural or industrial activity. Apart from problems in providing water to users, over-exploitation of water leads to the drying-out of water courses and wetland areas as well as saline-water intrusion in aquifers. Groundwater is the dominant source of freshwater. Often water is being sucked from beneath the ground faster than it is being replenished through rainfall. To augment supplies of high-quality fresh water humans have increasingly turned to groundwater, and advances in drilling and pumping technology have made it convenient and economical to do so. Groundwater taping is large but it is not an unlimited natural reservoir. Its sustainability ultimately depends on balanced withdrawals with rates of recharge. The results are sinking water tables, empty wells, higher pumping costs and, in coastal areas, the intrusion of saltwater from the sea which downgrades the groundwater. Lack of groundwater and depletion in water table affects the surface water. Loss of surface water has impacts on biodiversity-plant and animal life.

One of the potential problems with groundwater is that it is low in dissolved oxygen but high in total dissolved gas concentration that affects the ecological balance of the environment. Unregulated groundwater extraction leading to over exploitation of the groundwater resources with resultant increase in concentration of the fluorides in the groundwater was under scanner in much litigation. Because of saline intrusion, groundwater can no longer be used for domestic consumption or irrigation purpose. It has Impacts on the hydrologic fundamentals which involve groundwater flow system, controlling aquifer in responses to exploitation, and surface water-groundwater interactions.

The average assessment of effects of cumulative impact factors on environmental components is 1.3 (Table 2). This impact factor value is between the low effects and tolerable effect.

Augmenting water from groundwater resource by installing borewells especially in coastal region tends to affect the environment that includes:

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7.1 Diminishing Surface Water

Surface waters are affected by falling water tables. In various wetlands, for instance, the water table is essentially at or slightly above the ground surface. Dropping water tables results in such wetlands drying up, with the imbalanced ecological results. Further, as water tables drop springs and seeps dry up, diminishing streams and rivers even to the point of dryness. Thus, excessive groundwater removal leads to the same effects as diversion of surface water.

7.2 Land Subsidence

Over the ages, groundwater has leached cavities in the Earth. Where these spaces are filled with water, the water helps support the overlying rock and soil, but as the water table drops, this support is lost. Then there may be a gradual settling of the land, a phenomenon known as land Subsidence. Another kind of land subsidence, the occurrence of a Sinkhole, may be sudden and dramatic. A sinkhole results when an underground cavern, drained of its supporting groundwater, suddenly collapses. Sinkholes may be upto 300 feet (91 m).

7.3 Saltwater intrusion

Another problem resulting from dropping water tables is Salt water intrusion**.** In coastal regions, springs of outflowing groundwater may lie under the ocean. As long as a high water table maintains a sufficient head of pressure in the aquifer, there is a flow of fresh water into the ocean. Thus, wells near the ocean yield fresh water. However, a lowering of the water table or a rapid rate of groundwater removal may reduce the pressure in the aquifer permitting salt water to flow onwards into the aquifer and hence into wells. Saltwater intrusion is problem at many locations along U.S. coasts (**Source:** Environmental Science, Sixth Edition, Bernard J. Nebel, Richard T. Wright. Page No. 279 to 282).

7.4 Mitigation measures

An important groundwater management goal in developed areas is the prevention or reduction of land subsidence. Land subsidence can impact infrastructure, roads, buildings, wells, canals, stream channels, flood control structures (such as levees), and low-lying coastal or floodplain areas. Actions to monitor and manage subsidence may include monitoring changes in groundwater levels, precisely surveying land surface elevations at periodic intervals to detect changes, installing extensometers to measure the change in thickness of sediments between the land surface and fixed points below the surface, recording the amount of groundwater extracted, recharging the aquifer to control subsidence, and determining when extraction must be decreased or stopped. These management actions could be coordinated with groundwater/land subsidence modelling to predict future under various water management scenarios. An action plan like "Mission Kakatiya" of Telegana would redeem lost water bodies.

8. Conclusion

It is concluded that overexploitation of Groundwater not only results in aquifer depletion and water-quality degradation, but also impacts the ecological integrity of streams and wetlands and results in significant losses of habitat and biodiversity. It is necessary to recognize that the water resources are finite and vulnerable, and find ways to reconcile the demands of human development with the tolerance of nature. The essential first step for making water use sustainable is awareness and knowledge of human on the environment. Environmental impact assessment of water augmentation is made concluding with mitigation measures. Adequate water supply is power to human race. Apart from its political and economical scenario, water is an ingredient of woman empowerment. Thus with no iota of compromise a better and stricter EIA be adopted.

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