

Proceedings of the national workshop on 'RESERVOIR PLANNING AND OPERATION', (19th December, 2007) organized by Civil Engineering Department, Assam Engineering College, Guwahati-781013 Under the DST sponsored project 'Planning for Optimal Utilization of Water in Three Proposed Reservoirs in North-East India'.
Editor: Dr. Bibhash Sarma

International Journal of Innovative Technology & Adaptive Management (IJITAM)
ISSN: 2347-3622, Volume-1, Issue-3, December 2013

Reservoir Project in North-East India: Scope and Constraints

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Abstract

Northeastern part of India, though said to have enormous water resources, is not enjoying its water rather suffering a lot from devastating flood and erosion. Reservoir project can improve the water resources utilization scenario and can moderate the flood if planned and operated properly. On the other hand augmentation of flow by a dam always induces some disturbances to the environment. This paper addresses the issue of conflict between water resources development and environmental conservation. While water resources development is very much required for economic development of a developing country, measures must be taken for minimizing environmental disturbances induced by a dam. Proper planning and some innovative measures can help minimizing environmental disturbances. Need of planning Water Resources Project in Northeastern part of India giving due consideration to the environmental issues has been critically analyzed in this paper. A judicious compromise between development and conservation is needed for a better future of a developing country like that of India.

Introduction

Northeastern region of India accounts for about one third of the total water resources potential of the country. However, development of this huge water resource potential has remained limited so far and on the other hand the region is suffering from disastrous flood almost every year. The high degree of temporal and spatial variations of available water makes the problem of harnessing water resources quite complex and calls for strategic planning and management. This part of India is the best example of the reality that merely having huge amount of water cannot help and can rather hamper the development. More important is the amount of utilizable water and not the available water in a year. It is interesting to note that out of 586.60km^3 of yearly available water of the Brahmaputra Basin only 24.0km^3 has been assessed as utilizable. This is basically due to the fact that out

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of the available water, 477.5km³ of water flows through the river system during the monsoon period, making it difficult to be utilized with the technology presently under practice. Therefore it is the high time that we should think deeply on this issue and should try to evolve some practical strategies so that the water resources of this region can be utilized not only for the benefit of this region but also for the benefit of the country as well. A country like India can achieve significant economic development through development of its agricultural and industrial sectors. Water is an essential commodity for development of both these two sectors. With the present state of art we cannot even think of any revolutionary development in industrial sector in India without development of electric power. Water Resources Development can help in this regard. Similarly, green revolution in agricultural sector will remain a dream without enhancement of irrigation facility. Therefore, water resources projects are very much necessary for economic development of our country.

Conflict Between Development and Conservation

It has been observed that conflict between Engineers and Environmentalists is becoming quite common whenever a large project related to water resources development is proposed in India by the planners, which include experts from various disciplines. Looking in to the present scenario of such conflicts, we may raise two questions for ourselves: first, should we destroy our environment for our economic development? Second, should we remain under developed to protect world's environment? I am sure that the answer to both these questions will be a "BIG NO" as majority will prefer to live in a well developed country having good environment. Answer to the first question will be NO, because people of India were always very much concern about their real dwelling place, i.e., the environment. Proverbs written in Assamese language (popularly known as *Dakar Bachan*) in the fifteenth century on the conservation of forest and water body clearly demonstrates awareness of people of the Northeast India regarding need of conserving these vital elements of our environment. Similar examples are there in various part of our country. Answer to the second question will also be NO because majority would prefer to have comfort and facilities similar to that of the developed country, which is possible only through economic development.

Considering the above a compromise between Water Resources Development and Environmental Conservation is a must. Therefore, Engineers will have to design such mega projects giving due consideration to the environmental issues. Construction of dam becomes unavoidable for any major water resources project, as better utilization demand minimization of temporal variation of the water availability during the year, which can be

attempted only through creation of storage. Increasing ground water storage through catchments treatment can marginally improve the present disadvantageous temporal distribution scenario, but cannot help much in power generation. Therefore, construction of dam is inevitable in water resources project. On the other hand the major objection to any water resources project is towards construction of dam, as it can cause some environmental problems. While some obvious impact of dam at upstream such as submergence of land, loss of flora & fauna and displacement of people residing upstream have been well identified, impact of dam at downstream are yet to be assessed comprehensively. Wohl and Rathburn (2003) found that the sediment entering the reservoir, creating sediment-depleted conditions at d/s leading to channel adjustment in the form of bank erosion, bed erosion, substrate coarsening, and channel plan form change. Ecological problem caused on river ecosystem due to hydro power project has been pointed out by Maiolini et al. (2005). Riggsbee et al. (2007) presented the impact on d/s of the dam due to dewatering or removal of the impounded water behind the dam. Recent study conducted (Sarma 2008) on d/s impact of Subansiri dam has revealed that even in run-of the river scheme diurnal variation induced by the dam operation can be quite significant depending on the operating policy. The effects of diurnal variation due to release made by turbine in the d/s of the reservoir can be sedimentation, reservoir stratification, erosion, supersaturation, changing water levels, and change in habitation. The degree, however, to which any project affects a river, varies widely. Let us analyze the major and immediate environmental issues related to a dam construction and let us explore the possibility of minimizing these. Following are some of such environmental problems.

Environmental Issues and Possible Mitigation Measures

1. *Submergence of land and existing flora, fauna:* This problem can be minimized by selection of a suitable site. Care should be taken so that disturbances to human being are less. With the advancement in GIS and Remote Sensing Technique, now it is possible to make preliminary site investigation in several alternative sites in a much more convenient way. Depending on the gradient of the stream and shape of the basin, dams in series may reduce effective submergence. An attractive rehabilitation scheme can change mindset of people and can even improve their living standard. Social scientist should play their responsibility by suggesting correct package so that socioeconomic condition and other prevailing customs of such society are given due consideration while deciding on the rehabilitation package.
2. *Disturbances to the aquatic system causing adverse effect on the aquatic life:* Arrangement like Fish ladder, Divide wall, Under-sluice etc. can be made to maintain

required temperature and to facilitate upstream movement of fish so that least disturbance can be made to their breeding and other natural processes.

3. *Diurnal variation of downstream flow*: Dam constructed in a hydel project need to meet the peaking demand of hydropower and this leads to significant diurnal variation of flow in the downstream, particularly during lean period. Author has recently analyzed scope of minimizing such variation by introduction of a small storage downstream of the power plant for storing sediment free water released from the turbine during peaking hour. The analysis has shown encouraging result. Of course this aspect must be kept in mind while selecting the site itself so that the required head can be maintained even after creation of such downstream storage. Operating policy can also be modified to minimize variation of downstream flow, of course with a compromise with peaking hour production.
4. *Possibility of downstream flow becoming devoid of nutrients*: Though finer fraction of sediment, carrying nutrients, normally passes thorough the overflow spillway, depending on the sediment size and spillway type, some fraction of important nutrient still may not reach downstream due to obstruction of flow. Design of spillway, under-sluice etc. can be made by considering all these factor so that the most important fraction of nutrient carrying sediment can be passed to the downstream or to the irrigation channel so that agricultural field can get the benefit of natural nutrients.
5. *Possibility of flood due to sudden release of water*: This may happen due to erroneous planning and operation of a reservoir, particularly when the prime objective of the dam remains as power production. On the other hand high flood, which is a regular hazard of Northeast India, can be minimized significantly if planning and operation of the reservoir is carried out giving due consideration to flood moderation.
6. *Catastrophic flood due to sudden failure of Dam*: A rare chance of catastrophic dam break flood always remains associated with dam. However, Dam break analysis and a well-planned disaster mitigation plan can always ensure least damage if such rare dam failure occurs.

Environment Conservation Measures: National and International Status

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Some of the above measures are generally taken up in any water resources project. For example flood moderation has now been proposed in the Debang dam through modification in the reservoir operation. However, scope of having a better operation strategy is always there. Similarly flood-cushioning storage has been kept in the Pagladia dam project. In the developed country many such mega water resources projects have been designed/modified to address the environmental issues. A three-phased project taken up in the year 1998 for modification of Folsom dam, a concrete dam constructed in the year 1955 at Sacramento, California, is an example in this regard. The project aims at reducing the risk of flooding, providing cooler water at downstream automatically when spawning salmon requires it, and plantation of native species to maintain ecosystem. Proposal of introducing movable spillway in the dam of the lower Snake River to minimize any negative effect that a dam may have on salmon fish is another example. However, it must be noted that high initial investment and high recurring expenditure is necessary for incorporating such innovative measures in a water resources project.

Judicious Compromise Between Development and Conservation

A country with strong economy can only afford such high investment. On the other hand water resources project are necessary for raising the economy of our country. With strong economy US has created greenery in the Phoenix, a city located in a desert area. Thus we are facing a *Chicken and Egg* problem. Without water resources project it is difficult to have significant economic development in a country like India, and without economic development it is difficult to address environmental issues to the level that developed countries are doing. Thus, breaking this dilemma is becoming a major responsibility of the Water Resources Engineers and Environmentalists. They will have to join their hand to design and operate such water resources project to achieve optimal benefits with minimal ecological disturbance. Such project will also have to address major environmental hazard of this region like flood and bank erosion. Apart from solving the flood and erosion problem by storing the surplus water during flood time, release of water from a reservoir in crucial period can bring better agriculture, better water transport and better water supply. Dam sites located anywhere in the world always become a tourist spot as its beauty and clean environment always attract people to its heart. Borapani Lake of Meghalaya, which in fact is a reservoir, created by dam construction, is an example towards scope of enhancing natural beauty by dam construction. People of Northeast region can have all these benefit of dam, provided the water resources of this region is not exploited only for power production. No one will agree to accept submergence of land, risk of dam break flood and to some extent disturbances to the aquatic system if they cannot enjoy the benefit to be derived from it. We take the risk of staying in a high-rise building in this earthquake

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prone NE region, as we are ready to take the risk to have the benefit of staying in these buildings. Every one may become ready to take some amount of risk if they find the benefits they will enjoy are enormous.

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