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Hydrological hazards, need of large dams and environment management in Indian Himalayan region – a critical overview

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Abstract
India has $1/3^{rd}$ of its territory drought prone and $1/8^{th}$ of its territory liable to flooding. About 80% of the surface water of the rivers goes to the sea unutilised while the country reels under the flood-drought-flood syndrome. Himalayan ecosystem faces frequent natural hazards due to it's unique topography, climate, geology and hydrology. This article presents an overview of crucial aspects of hydrological hazards, water resources development and environment management in the Himalayan region. It has been stressed that creating scientific public awareness and involvment of stakeholders in water resources development and management of hydrological disasters is of vital interst not only for achieving sustainable development but for minimizing the effects of such disasters**.** The peculiar requirements and scope of soil conservation measures in the catchment areas of river valley projects, have also been reviewed. It is to be underlined that catchment area treatment and watershed management are development projects in their own right and should be planned and executed as such independently without putting undue financial burden on water resources projects. At best, treatment of directly draining highly degraded sub-watersheds along the reservoir rim could be charged to the cost of the reservoir project.

INTRODUCTION

Himalayan ranges are the largest source of surface water resources in the Indian Subcontinent. The main river system originating in the Himalayan ranges comprises Indus, Ganges, Brahmaputra - Meghna system. These great Himalayan river systems are perennial since they are fed by the melting of snow and glacier in late winter as well as summer and are fed by rainfall-runoff, surface flows during monsoon and other seasons. In terms of water utilisation, almost all utilisable water resources of Indus basin has been utilised for irrigation, power generation and flood control. In Ganga subsystem, almost all-utilisable water resources are committed for developmental use and further demands are growing fast on the limited water resources. The population within Ganga-Brahmaputra-Barak system is likely to exceed 625 million by the year 2000 and may double again before population stabilises by the middle of the next century. On the other hand, Brahmaputra-Meghna system presently poses great flood hazard in eastern and north eastern India. Such situation calls for an integrated approach for the development of the water resources of the Himalayan rivers system.

Indian Himalayan Region ranging from Jammu & Kashmir to Northeastern states of India, has a geographical area of about 2,50,000 sq. km and due to its unique topography, geology and climate etc., faces many types of hydrological disasters. India has 1/3rd of its territory drought prone and 1/8th of its territory liable to flooding. About 80% of the surface water of the rivers goes to the sea unutilized; while the country reels under the flood-drought-flood syndrome. In a slow onset disaster such as drought, the problem created by scarcity of water are compounded by long standing problems as deforestation, rural poverty, soil erosion and inefficient land use and tenure pattern. One disaster often lead to another like landslide which causes environmental degradation and alter the ecosystem by increasing the potential for soil erosion and water runoff and thus increasing the regions to vulnerability to other disasters. Clean drinking water is not available in most of the villages and small towns Pollution of both surface and ground water is on the increase. In some regions, over-exploitation of ground water has led to salinity ingress and severe depletion of ground water accentuated by low recharge capabilities.

Loss of top soil with the runoff from precipitation, loss of generated biomass by way of grazing, pilferage of firewood and brushwood for fuel etc. has been taking place and continues to take place each year. Reduction in vegetative cover by uncontrolled grazing and felling of trees makes the topsoil more vulnerable to the action of wind and rain. With the loss of topsoil, chances of survival of grass, herbs, shrubs, bushes and trees on the uncultivated land appreciably reduce, thereby exposing the soil to further degradation.

HYDROLOGICAL DISASTERS IN INDIAN HIMALAYAS

Disasters in Himalayas arise as a result of heavy rainfall, steep slopes and high seismisity and the conditions further worsen due to increase in population, rapid urbanization and ill effects of water potential remaining unutilized. Indian Himalayas region faces flash floods during monsoon, mass movements and landslides as frequently occurring disasters; often resulting in substantial environmental degradation, economic losses and great suffering to people, cattles and wild animals.

Cloud bursts cause major natural hazards in Himalayas which are characterized by extreme hydro-meteorological conditions leading to flash flood and devastation like landslides, loss of life and property and environmental degradation. It strikes at random and at a lighting speed generally lasting for a limited time and leaves behind a trail of devastation. This phenomenon depletes the natural resources of critical importance to people of the region and also have far reaching effects viz. landslides, loss of life and property, soil erosion, flooding, debris flow, siltation in down stream and habitat destruction

A huge mass of snow sliding down the slope with great speed is generally termed as avalanche. Avalanche occurs because of instability of snow pack, which looses its strength due to slope gradient, wind, precipitation and temperature gradient and comes down in the form of an avalanche. Avalanches generally originate on the slope between 30^0 to 40^0 and causes great loss of life and property and effect communication routes, installation like power line, settlement, buildup, pasture land and forest etc. The awareness of danger and identification of endangered areas is the first step toward hazard mitigation. Avalanche forecasting, artificial triggering, structural control and afforestation are the commonly practiced methods of mitigation of hazard. Avalanches can be controlled at starting zone by using snow bridges, snow rakes, snow nets and by using snow drift structures, at avalanche path by guiding and diverting it using Gallery/ Tunnel, Guide walls, Diversion wall etc. and at Run out path using checkdams and retaining wall etc .

Floods are the most costly of all natural hazards in terms of loss of life and properties and the land. Causes of floods are heavy rainfall, snowmelt, ice jam and dam failure. Flood occurs during the month of June to September, which is the principle rainy season for the country, accounting for 80 % or more of annual rainfall. The Ganga and Brahmaputra along with their numerous tributaries (all originating from Himalayas) are the major flood prone rivers. Area just below Indian Himalayan Region, such as Jammu & Kashmir and Punjab, Uttar Pradesh, Northeastern states etc. experience the flash flood. The problem of flood is more severe in Northeastern part of the country due to high rainfall in the region as a whole. Forest cutting followed by abusive agriculture practices and grazing may aggravate flooding. Throughout South Asia as a whole, river floods damage about 4 million ha. of land and crops and effect lives of over 17 million people every year (Smith, 1989). Most vulnerable landscape setting for floods are low-laying parts of active flood plains and river estuaries, small basins subjected to flash flood and low laying inland shorelines. In addition to mortality from drawing, less tangible losses occurs as a result of illness after the floods. Much post - flood illness is created by endemic proportions.

Primary causes of floods are climatological factors and secondary causes are flood intensifying conditions which tend to be extra drainage-basin specific. Human and natural causes of floods are urbanization, deforestation, construction of bridges on river, inefficient drainage system especially in construction zone and deposition of silt in river bed due to soil erosion / landslides etc. with reference to Indian Himalayan Region, large scale forest degradation worsens the condition in plain and delta area of Ganga and Brahmaputra. As per CWC data, the average annual losses due to flood damages amounts to Rs 937.56 crore and major causes of such natural calamities is environmental degradation. In the mountain districts, landslides and floods have a close association. Landslides causes sudden flood. Water resources development projects are required not only to solve the water crisis for various uses, but also for modulating the flood peaks. Without storing flood flows at available dam sites during monsoon, the rivers cause floods havoc in plain.

SEDIMENTATION, LIFE OF RESERVOIRS AND RELATED DISASTERS

If water resources projects are not built, silt gets transported unchecked and gets deposited towards the sea thereby gradually flattering the slopes of river in their lower reaches with a consequent tendency to diminish their flood discharging capacity. This, in turn, results in frequent and severe flooding of the lower alluvial tracts. Reservoirs positively control both silt and flood. Several fears have been voiced regarding silting of the Indian reservoirs due to increase of sediment flow in the river. Siltation is a natural process and can be reduced but cannot be eliminated. The reservoirs by themselves have not accelerated the rate of silting. Due to very steep gradients in Himalayan rivers, the run of river and small dams get choked due to boulders as well as coarse sediments. On this account the high dams keeping exclusive provisions for dead storage have an advantage. For example, the Maneri Dam on Bhagirathi (39 m high) and Ichwri Dam (60 m high) on the

River Tons – Yamuna were designed and filled upto crest by sediments during construction. The storage space for sediment is determined while computing the life of reservoirs, say 50 or 75 or 100 years on the basis of standard reservoir types ranging from lake to gorge. Sediment distribution is assessed to determine new zero elevations for positioning of the outlets for withdrawal of water for various uses. The statements on increased sedimentation in earlier constructed Indian reservoirs should be understood with the precaution that sedimentaton rates in those designs were based largely on assumptions and thumb rules in the absence of field observations. It is to be realised that the rate of sedimentation decreases with the age of the project and becomes asymptotic. Moreover soil conservation works, water-shed treatment and afforestation are being undertaken in the catchment to reduce the sediment flow.

MYTHS AND REALITIES ABOUT RELATIONS OF HYDROLOGIC ELEMENTS

It is widely believed that deforestation causes floods by reducing infiltration and augmenting run-off.The following findings of India's environment – a Citizen's Report, 1991 on "Floods, Flood Plans and Environmental Myths", Centre for Science and Environment, are eye opening while considering this widely prevalent belief.

"Floods are nor not to the Indo-Gangetic plains. During the 3500 years of recorded human settlement in the Ganga basin along, there have been many floods of gigantic proportions. Run off and silt tend to move out of the Himalayan region in explosive ways. Landslides seem to be a major contributor of deposits of soil to the rivers. Himalaya rivers have constantly changed their course long before deforestation began. The forests can tolerate minor and medium floods but the human society will have to learn to live with the major floods. Afforestation has a limited impact in terms of changing hydrological conditions. It is interesting to note that deforestation as a cause of floods has come to be cited only recently. The District Gazetteer of Poornia and Saharsa regions in the last century though concerned about the high silt load of the river Kosi, have never eluded to deforestation as a contributor factor. Instead their recurrent occurrences was on the geological instability of the rivers' upper catchment. To understand the problem of increasing floods in the Indo-Gangetic plains, it may be more instructive to study the logical changes that have taken place in the flood plains themselves. Natural factors contribute more to floods in Assam, than de-forestation or shifting cultivation. Tributaries of the Brahmaputra come from more forested areas than the southern ones and yet create more floods. Natural erosion processes in the Himalaya are so intense that they dwarf the changes posed by deforestation. Afforestation will help the local economy but will not large floods in the Himalayan regions. The deep gorges of Himalayan rivers seem sufficient to transport excess rainwater. Surprisingly, this is not true. Floods have been taking place in the Himalayan plains since time immemorial: The breathtaking photograph of the landslide that blocked the Bhagirath showed a densely green hillside had come tumbling down. Was it the fragile Himalayan geology or deforestation that was the main trouble? While reviewing this report, the New York Times, New York, reported "So this report takes little known fact; the impact of environmental degradation on floods in densely populated Assam and the Indo-Gigantic plains". So this report takes on a very big myth: that floods in the plains are forced by deforestation in the Himalayas. An Indian environmentalist has touched off a furious debate by challenging the environmental view that deforestation in the Himalayan hill is a primary cause of devastating seasonal floods".

It is believed that forests mitigate drought by storing water and releasing it over time through more even stream flows. This is only related to the point of saturation storage. We also should account for the loss due to evapotranspiration by the forest, which drinks up water for its sustenance. Forest interception of rain can also enhance evaporation loss from leaves. The net water balance will vary in accordance with conditions and circumstances. Forests are also believed to create or induce rain. There is no conducive evidence of this belief. This is not to denigrate soil conservation, watershed management and forests or afforestation in the slightest but to caution against being diverted too far along what could false trails. We have to avoid large generalisations on limited data.

WATER RESOURCES POTENTIAL IN HIMALAYAN REGION

Himalayan system plays the most predominant role in the management of water resources since nearly 60% of the Nation's river flow is carried out by the Ganga-Brahmaputra-Meghna basin which occupies only 33% of the country's geographical area. Brahmaputra sub-basin alone carries 28% of the total river flows while occupying only 6% of geographical area, low population density and cultivable area. The utilisable surface water in Brahmaputra sub-basin is only 5% of its potential. The Ganga sub-basin on the other hand carries about 28% of the river flows having 26% geographical area of India. It is one of the most thickly populated and cultivated regions of the world. About, 36% of the total Indian utilisable surface waters lie in Ganga sub-basin and another 6% in Brahmaputra basin. The figures of potential and utilisable water resources with related important parameters for these basins (CWC Publication-Reassessment of Water Resources Potential of River Basins of India - March 1993) are presented below:

Sl.No.	Item	Indus Basin	Ganga Sub-basin	Brahmaputra Sub-basin	Meghna Sub-basin	All India Total
1.	Water resources potential (Cu.km.)	73.3	525.0	537.2	48.4	1869.3
2.	Utilisable surface water (Cu.km.)	46.0	250.0	24.0		690.3
3.	Ground water potential (Cu.km)	25.5	171.7	27.9	1.8	452.2
4.	Per capita annual availability of water (Cu.m)	1757	1473	18417	7646	2214
5.	Per hectare of culturable area annual availability of water (Cum.)	7600	8727	44232	43447	9353

It is to be highlighted that about 21% of Ganga basin flows in India come from the non-Himalayan rivers and nearly two thirds from rivers with catchment in Nepal. India has so far constructed or is constructing storages with a gross capacity of 57.2 Cu.km. on the Ganga system and 1.60 Cu.km in the Brahmaputra-Barak-Basin. The additional gross storages proposed from planned projects would be of the order of 8.90 Cu.km. and 61.50 Cu.km. In the two basins respectively. The North Eastern part of India is endowed with enormous water wealth. The annual flow of Brahmaputra-Brark rivers before outfalling into Bangladesh is 585.6 BCM which is the highest among all river basins in the country constituting about 31% of the country's total surface water potential. The per capita and per hectare annual water availability is 16500 cum and 44180 cum respectively, again the highest in the country. This also includes about 35 BCM of the replenishable ground water resources in the region as assessed by Central Ground Water Board.

PECULIER FEATURES OF HIMALAYAN REGION

The topography, types of soils, pattern of precipitation, surface and sub-surface water resources etc. vary from not only state to state in Himalayan region but also from district to district and even one sub-basin to other. Their rivers are perennial in nature and flow is largely rainfed with some melted snow. Large sediment load by erosion of relatively young Himalayan ranges cause large-scale geomorphologic changes in the region. Meandering, aggradation and degradation, erosion of banks, cut-offs, islands and highly braided patterns of flow are usual features of the Brahamaputra basin. Frequent landslides and earthquakes in the region keep on disturbing the stability of hill slopes and add to the sedimentation problem. The practice of Jhoom cultivation with considerable decreased cyclic periods is accelerating the erosion and floods in the region. According to the Forest Survey of India, the rest of the country gained 276 sq.km of forest cover during 1993 to 1995 while the northeastern States suffered a net reduction of 783 sq.km. In the earlier remote sensing survey, the loss of forest cover in the region was indicated as 1481 sq.km between 1989 and 1993. Only Tripura and Nagaland have been able to balance the loss by bringing more area under afforestation. The Sweden farming practised in the sloppy land also contributes to loss of forests. The average soil erosion in NorthEastern Region is about 28 ton/ha/year. This contributes high sediment load and is responsible for morphological changes into the river channel causing inconvenience of various kinds to people living in the floodplains close to wandering watercourses.

NEED OF CONSTRUCTION OF LARGE DAMS IN INDIA

Primary reasons behind water becoming scarcer in India can be traced to the increase in population, which has led to higher consumption; tapping of available and easily exploitable sources of water; environmental activism which inevitably causes time and cost over-runs and the increase in per-capita consumption due to growing human activities. The last factor has also added to the contamination of water sources. It has now been acknowledged by various experts that the health of national economy and the well-being of citizens would increasingly depend on the successful harnessing of our water resources in the coming days.

However, the inadequacy of our present efforts can be best exhibited in light of the amount of water we will be requiring the coming years. Exhaustive studies by the Central Water Commission (CWC) concluded that about 500 cubic km and 700 cubic km water demands would have to be met by the surface water system in the year 2000 and 2025 respectively. Utilizable surface water potential of Indian river basins has been estimated around 690.3 cubic km. The last figure does not include the water recycling and inter-basin mega-transfer, which will further enhance the potential significantly. Further, 75 out of 99 drought-prone Indian districts have higher water resources potential (with 75% dependability) than their requirement. A flood-prone area of the country, assessed by the

Rashtriya Barh Ayog (2980), is 32 million ha. (less than 10% of the total area). Out of the total flood-prone of area of 32 mha only 13.8 million ha. have been adequately protected till the end of the Seventh Plan. Water's role in the energy sector was identified at a very early stage of our planning. It was acknowledged that the hydropower was the cheapest of all available power generation sources. Nonetheless, its share in the overall mix has declined from 50% in 1963 to a mere 25% now. Detailed studies on the future demands for drinking industrial and cooling water requirements for thermal / nuclear power plants upto 2000 A.D. have clearly indicated that without undertaking speedy construction of large dams, even the absolute minimum demands cannot be met.

In India references to dams are found in the Rig-Veda, Yajurveda and Atharva Veda. The earliest known masonry dam was that of Lake Sudarsana (300 B.C.) in Gujarat. From the rock inscriptions near Anataraja Sagar tank (14^{th} C.A.D.), we learn about the twelve requisites and six prohibitions in the selection of a good dam site. A hydrologist, hard foundation, a minimum course of 40 km from source of River carrying fresh water, the abutments devoid of fruit-bearing lands and fertile command in the neighbourhood are some of the requisites. Some of the prohibitions are: saline soils, vicinity to strategic frontiers and scanty water availability but extensive command/ abundance of water but dearth of command. The above reflects the realisation of the people of ancient and medieval India of the necessity of dams and their concern for environment and ecology. In modern times the visual experience of rehabilitation and resettlement problems related to number of large dams constructed in the post-independence era in our country and the environmental awareness activities abroad have given rise to presumptive apprehensions about the environmental and ecological disturbances due to large dams.

Large dams are an economic necessity to meet the water and power needs of the nation. The Green Revolution and the phenomenal industrial development in the post-independence era vouch for this. Small dams are a social necessity to ensure drinking water, irrigation, groundwater recharge and climatic moderation in various parts of the country for the overall development (without regional imbalances) of the predominantly agrarian economy of the country. Both large dams and small dams are equally important for macro/micro hydel power generation. A negative bias towards either of them will thwart the very purpose of Integrated Planning of Water Resources Development in the country. India is predominantly an agricultural country depending on monsoons during the four months of the year for replenishment of flows in the river basins, which will have to be used judiciously to cater to various needs for the balance period of the year. This warrants necessarily construction of reservoirs to store flows during monsoon for use during the other period to meet the various demands. A chain of multipurpose reservoirs was constructed especially immediately after independence in various river basins which has facilitated self-sufficiency in food production.

India has severe limitations with regard to availability of suitable dam sites for storage reservoirs. Although hydropower is the cheapest renewable and non-polluting source of energy, more than 85 per cent of hydropower potential remains untapped. Therefore all feasible projects whether big or small, surface or groundwater, including catchments protection and water conservation works should be taken up for integrated development. Small and large dams have their own place in contributing to the prosperity and well being of the nation. Construction of such reservoirs involves in some cases, acquisition of forest lands, rehabilitation of people facing displacement due to submersion of villages besides effect on flora and fauna, etc.

The growing environmental pseudoism by self styled environmentalists and novelists against the river valley and hydropower development need to be curbed since the large sums of amount invested on relief during frequent disasters can be utilized for sustainable harnessing the water wealth but also to blend the issues of environmental management. Availability of cheap hydropower on subsidized rates to the hilly inhabitants would retard deforestation by meeting the demands of cooking and heating through electrical energy. The ‘Rashtriya Barh Ayog’ had also given emphasis on building storage reservoirs for moderation of peak flows. Storage dams are essential not only to conserve flood waters for various demands of irrigation, hydropower, drinking water and industrial supplies but also for flushing the lean season effluents in our steams.

The navigable length of north-eastern rivers alone is about 3880 km and there is further scope to divert a sizeable traffic to inland navigation for which the water ways have to be sustained by improving the braided and unstable river reaches, increasing the draft during lean season and reducing the high velocity (sometimes as high as 7 to 9 km/hr) in the navigable routes. The viable long term measure for improving the river navigation is by construction of storage dams which can increase the draft in lean season, reduce high velocity during flood peaks, arrest silt, stabilise river channel, reduce bank erosion and check formation of shoals and sands and sand bars. The prospects of improving navigation are thus closely linked with irrigation and hydropower development.

ASSESSMENT AND MANAGEMENT OF ENVIRONMENTAL IMPACTS

There was no proper mechanism for assessing the environmental impacts of the river valley projects in India till 1978. The Central Water Commission and the Planning Commission had indicated the broad-lines for the preparation of the detailed project report and clearance of the Projects. The Department of Environment and Forests (DOEF), Government of India in 1978 prepared the guidelines for environmental impact assessment of river valley projects. It was aimed in these guidelines that each river valley project should be subjected to rigorous assessment of their environmental impacts so that necessary mitigative measures could be incorporated in the project right at its inception stage. These guidelines for site selection as well as incorporation of mitigative measures were prepared and circulated among the project authorities through the Planning Commission. It was made imperative to analyse whether the adoption of environmental measures is going to result in any short or long term social and economic benefits or not. Special emphasis was laid on the health effects, plant genetic resources, aquatic life, water logging, salinity of irrigated soils, deforestation and soil conservation for considering the techno-economic viability of the project. It was made mandatory in the DOEF guidelines that ecological considerations should be incorporated at every stage of planning and construction.

Aspects recommended for consideration in site selection included immediate and long-term impacts on human settlements, flora and fauna in the vicinity, impacts on monuments and mineral resources, ground water levels, etc. The items mentioned in the Guidelines include most of the important effects on the environment such as (i) involuntary settlement of project affected persons, (ii) sedimentation, (iii) water –logging, (iv) salinity, (v) monuments / shrines, (vi) submergence of flora and fauna, (vii) aquatic life, (viii) health, (ix) climate, (x) water quality, etc.

Later, in 1980, the Forest Conservation Act was passed by Indian Parliament. Under this Act all the proposed river valley projects are needed to be cleared before commencement of construction by MoEF, in case any submergence or deforestation of forest land is involved. The Ministry of Environment and Forests (MoEF) prepared a list of the type of data and basic information on the environmental impact studies in Jan.'85 which were sent to the project authorities along-with the Guidelines for Environmental Impact Assessment of River Valley Projects.

Central Water Commission has published "The guidelines for sustainable Water Resources Development and Management (Sept. 1992)" to meet the Indian requirement for data collection and analysis, impacts assessment and management plans. Together with EIA, for water resources projects, Environmental Management Plan (EMP) is also essential to ensure sustainable development and to limit the stress /load on the system within its carrying capacity. Special attention has to be given for the aspect of rehabilitation and resettlement, compensatory afforestation and catchment area treatment (of directly drainage areas) in preparation of EMP.

The author has recently edited three prestigious publications each containing over 30 invited state of art like articles on well focused subjects from eminent experts, chief executives of water & power development agencies, academicians, researchers, apex professional institutions and credible NGOs. These Volumes have been published under the titles " Hydropower and River Valley Development - Environmental Management, Case Studies and Policy Issues", "Environmental Impacts Assessment of Water Resources Projects - Concerns, Policy Issues, Perceptions and Scientific Analysis" and "Environmental Management in Hydropower and River Valley Projects - Techniques of Management, Case Studies, Policy Issues & Application of Scientific Tools", all the three books have been published by M/S Oxford & IBH Co. Pvt. Ltd New Delhi.

The overall effort while publishing such guidelines and books for the study and management of environmental impacts in various river valley projects is in the direction of rapid economic development on a sustained basis with due care for safeguarding the environment. Sustainable development considers an equitable balance between these 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 the stress / load on the system is within its carrying capacity. While deciding carrying capacity the supporting and assimilative capacity should be considered. The management plan for water resources sustainability aims at maintaining live storage capacity of the reservoir and enhancement of water availability in the command area. For maintaining live storage capacity on a long-term basis, appropriate sediment control measures in the catchment area should receive priority attention.

TAGGING OF CATCHMENT AREAS TREATMENT WITH RIVER VALLEY PROJECTS

Loss of top soil with the runoff from precipitation, loss of generated biomass by way of grazing, pilferage of firewood and brushwood for fuel etc. has been taking place and continues to take place each year. Reduction in vegetative cover by uncontrolled grazing and felling of trees makes the topsoil more vulnerable to the action of wind and rain. With the loss of topsoil, chances of survival of grass, herbs, shrubs, bushes and trees on the uncultivated land appreciably reduce, thereby exposing the soil to further degradation. With or without the reservoir, degradation of catchment continues to take place. With the reservoir, what one has to account for is the effect of such degradation on the functioning of the reservoir during its lifetime. At the time of preparation of Project Reports for river valley projects, any irrigation project, effect of estimated silting on the reduction in the live storage capacity of the reservoir and its effect on the economic viability of the project over a period of time is taken into consideration.

It is observed that cost of catchment area treatment measures taken to prevent entry of silt into the reservoirs is generally much more than the cost of creating storage for equivalent capacity. Hence, for the purpose of economic viability of these measures, benefits from soil and water conservation are to be treated as primary objectives and reduction in silting of the reservoirs are to be taken as incidental benefits. Engineering as well as non-engineering measures, to a certain extent, are essentially labour intensive works. Their employment generation potential is very high, which makes such schemes best suited for a country like India, where seasonal unemployment of landless labour is very common. Unemployment of landless labour for major part of the year is also not uncommon in drought prone areas, whenever drought conditions prevail. All these measures are considered as productive works and are given first priority for the type of works to be undertaken under the ‘Employment Guarantee Scheme’ followed in the Maharashtra State. Hence, providing productive work to the labourers becomes primary but ephemeral objective, though on completion, such works act as measures to prevent degradation of catchment areas.

The Committee of Secretaries, Government of India, after considering all aspects, has decided as under :

High and very high categories of erodable areas in direct draining sub-watersheds, along the reservoir rim, should be treated as per soil conservation norms and guidelines already available in Ministry of Agriculture as well as in Bureau of Indian Standard (BIS) like IS: 6748 B (Part-I)-1973 Code for Recommended practice for “Watershed Management Relating to Soil Conservation” and IS: 6518-1992 Code for Practice for “Control of Sediment in Reservoir”.

The treatment would generally be for improving land to prevent movement of soil. It would also improve its hydro-geological behaviour. In general, it would prevent degradation of land, increase productivity and also improve ecological balance between land, water and the plant and animal life in the watershed directly draining into the reservoir.

This improvement of direct draining areas should be carried out alongwith the construction programme of the project.

If sub-watershed in the Direct Draining Areas along the rim of the reservoir has very high and high category erodable areas, such areas need to be treated to reduce direct silt inflow into the reservoir and to improve the environment in the vicinity of the reservoir. Geographical diversity precludes precise definition of such watersheds and standardised package for their treatment. Such areas and their treatment will necessarily be project specific. However, to avoid undue burdening of the project with general land improvement activities, only direct draining sub-watersheds upto 2500 ha in extent need to be considered for treatment at project cost.

SEISMICITY AND LARGE DAMS

Doubts have been raised about the safety of large dams due to seismic forces. There is however little proof of this hypothesis. The International Symposium on “Earthquake and Dams” held in May, 1987 in China had, however, concluded that “Dams designed by modern techniques and built according to the latest specifications have considerable reserve strength to resist severe earthquakes. They have been shown to resist earthquakes well compared to other manmade structures. The World’s highest Dam is NURECK of Russia which is a 305 m high earthen Dam. This dam is situated in a highly seismic region but has safely withstood a very high seismic shock of intensity over 7 on the Ritcher scale. There are thousands of dams in the world of over 150 m height but there is hardly any damage to them due to earthquakes. It has been scientifically established that the dams using modern methods of design and construction can safely withstand high intensity earthquakes, while dams not using these techniques can be damaged even with earthquakes of quite a low intensity. It is also said hypothesis that impounding of water in large reservoirs induces seismicity (RIS). There is however little proof of this hypothesis. The Bhakra, Ramganga, Pandoh and Tarbela dams have all been constructed in the Himalayan region but have neither caused RIS nor any increase in seismic activity after their construction. The failure of large dams due to earthquake is only a fear which is unncessarily being projected manifold. Any way RIS can never be larger than the magnitude of seismicity due to tectonic activities.

IMPROVEMENT IN WILDLIFE

The Case Study by the Author for Ramganga Dam Project(UP) clearly shows that there has been substantial increase in the numbers of tigers, panthers, elephants and Cheetals (Countings by Wildlife Preservation Organisation, UP forest Deptt.) in the famous National Corbett Park due to availability of green fodder, plentiful availability of clean water throughout the year and environmental security among animals and improved climatic conditions after construction of the 127.5 m. high Ramganga Multipurpose Dam Project; even though 55 sq. kms. of the Corbett Park has been either submerged or affected by this reservoir. It is also found that rare species of birds flock there after the reservoir construction. This phenomenon of an increase in birds and wildlife has also been observed around the Rihand and Matatila reservoirs which were previously barren lands. Some of the best tourist places of India like Ukai tourist resort, Periyar wild life sanctuary, Shalimar garden, Brindavan garden, Pinjore garden, Kalindi-Kunj, Matatila Garden, Dhyaneshwar Udyan and the Ramganga Udhyan are the bye-products of river valley projects. Significant increase has also reported in the number of species of wild animals after construction of many water resources projects.

MULTIPLIER SOCIO-ECONOMIC BENEFITS OF LARGE DAMS

The detailed Case Study by the Author for the 127.5 m. high Ramganga Multipurpose Dam Project amply proves that large infrastuctural facilities including bridges, metalled roads, telecommunication & postal services, large scale employment opportunities, UP State Engineers Academy & Handicrafts Training Institute in the project colony, soil conservation & afforestation in 42,000 ha., assured power and water for agricultural and industrial purposes have resulted in tremendous direct and indirect socio-economic benefits; due to the multiplier chain effect of benefits by water resources projects. The headquarters of Ramganga Project, Kalagarh is being seriously considered for siting the capital of new Uttranchal State due to availability of all facilities and infrastucture by construction of this project. Similar benefits are clearly visible after construction of Bhakra, Pong, Beas and Indira Gandhi Canal Projects in the states of Punjab, Haryana and Rajasthan.

It is unfortunate that the furious overtones by novelists and pseudo-environmentalists could not have allowed the construction of even the most beneficial projects like Ukai, Bhakra, Hirakud, Ramganga and DVC reservoirs; if these schemes were executed during the present decade. Can we realize the hunger and thirst of 1000 million Indians in the absence of these projects ? Still our elite novelists, freedom fighters and few activists are spreading fantasies, built around unfounded data, while repeating the same stuff in hundreds of articles and media interviews, speedily followed by battles on railway platforms, rallies against against water resources projects, threats of Jal Samarpan and endless crude methods. They must pose and bother for the multiplier effects of hunger, thirst, unemployment, poverty and low productivity levels in the absence of such vital river valley projects.

PUBLIC AWARENESS AND STAKEHOLDERS PARTICIPATION

Before taking up any large project, awareness programmes in the project area need to be taken up for educating and convincing the people of the project, its objectives in serving larger local and national interests. Few people may be knowing that large portion of drinking requirement of Delhi is met from Bhakra and Ramganga. Rajasthan canal has turned desert into green land and benefited lakhs of people. Unfortunately misinformation and negative aspect sell more and get more publicity in an environment which lacks public / mass awareness. The project authorities should therefore set up special Information Cells to continuously educate the people, create awareness among the masses and counter negative/ adverse propaganda and propagate the positive benefits.

It has been recognised in India that people’s participation and development of local level institutions is more vital for effective water resources management. Institution building at the local level is defined as the process of establishing or transforming an organisation into an integrated and organic part of a community in a way that will help the organisation play a production role in projecting of new values be user-friendly and become an agent of change in the community. Two roles are thus identified for such institutions viz;

pro active and transformational. The voluntary agencies and other local level institutions need to be encouraged and mobilised for enlisting public participation. The government's role may be limited to technological, training and financial aspects. Field functionaries in water resources management need to change their attitudes. The attitudinal change at different levels can be achieved by dissemination of information about success stories, visits to such locations and by making efforts to replicate success stories.

It is not enough to provide funds, technology and materials for water harvesting. It is much more important that the water users should be trained in issues of water conservation, economic use of water, quality of water, cost effective operations we well as maintenance of irrigation equipment. Similarly, knowledge about the changes required in cropping patterns and agronomic practices also must be communicated to farmers to sensitise them about the constraints of water supply and motivate them to use it carefully and efficiently. In this respect agricultural universities, ICAR research stations and non governmental organisations can play an important role.

Management of natural disasters and water resources development are inter-disciplinary sectors involving many sectors of society- scientists, engineers, administrators, policy planners, professional societies, local leaders, NGOs, insurance and health professionals and social as well as charitable organizations. It is utmost necessary that proper scientific awareness is created about the cause-effect relationship and their specific roles in different situations. Educational institutions, professional societies, retired experts, social service and charitable agencies should be encouraged to share their responsibilities foe effective preparedness, mitigation and management of natural disasters and accelerated water resources development.

CONCLUSION

India has 1/3rd of its territory drought prone and 1/8th of its territory liable to flooding. About 80% of the surface water of the rivers goes to the sea unutilised while the country reels under the flood-drought-flood syndrome. Social tensions, political instability and street fights are already on the horizon; due to stoppage and slowing down the construction of almost all major dams; ignoring the bulging demands of water and power for municipal uses in metro cities, Saurashtra and Kutch regions and such a large industrial belt; by few environmental activists and novelists; without professional analysis. Why did America, France, UK, Italy etc. have constructed large and high dams for storage in the range of three to four times of percentage storage in India; even though they are blessed with round the year rains and very little population in sheer contrast to India. Strangely, this looks as well thought game of environmental politics at the cost of poor, illiterate and downtrodden Indians; to counteract the justified questions against them about responsibility for acid rains, disturbance related to ozone layer, climatic changes, Chernobyl and Union Carbide disasters through their technology and high tech Kuwait war. The socio-economic development in India is dependant on sustainable conservation of water wealth, which the Himalayan region has in abundance. We have to act very fast in a decisive manner to accelerate the water resources development in Himalayan region due to fast emerging crisis of water for urban use, production of food and power on account of bulging population in India.

The peculiar requirements and scope of soil conservation measures in the catchment areas of river valley projects, have been reviewed in this article. It is to be underlined that catchment area treatment and watershed management are development projects in their own right and should be planned and executed as such independently without putting undue financial burden on WRD projects. At best, treatment of direct draining sub-watersheds along the reservoir rim could be charged to the cost of the reservoir project.

It is essential that the process of planning and operation of water resources projects and management of natural hazards are rightly taught at different levels of education as well as to the experts of different disciplines. Another important fact remains that participation of people is a must in the management of water. Unlike in other branches of engineering, the people are an integral part of the water management system. The community is to be made not only water conscious, but also to be integrated to participate in the planning and management of such projects and management of natural hazards.

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