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Water resources and water management in north-western Indian Himalayas (NWIH)

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INTRODUCTION

Civilisation, land and water go together. Gaining control over land and water and husbanding these two critical resources for food, fabric, fuel, fodder and shelter has been among the greatest achievements of man. In the NWIH land and water admittedly are two of the most critical resources that determine the socio-economic life of the people of the region as also its environmental situation.

Mountains, as is well Known, are water towers of the world that nourish lands within and outside their bounds. It is common knowledge that most of the river systems in northern India emerge from the Himalayas and these are of utmost Significance to the food security of the country.

The North-Western India Himalayas (NWIH) comprise a region of high energy environment. The diversity of terrains and topography here is bewildering. From sub-tropical to arctic all kinds of climates can be found in an altitude gradient of just about eight kilometres. The region is characterised by remoteness isolation, fragility of environments, poverty and shrinking resource bases (shrinking vis a vis incessantly growing demographic pressures). The industrial and commercial activities have very limited presence in these areas. More than three-fourths of the people living here depend on primary occupations for employment and subsistence. Much of the land is snow covered, rocky, barren, unculturable and non-usable. Much of the rest is covered by forests (a large proportion of which are degraded, scrub lands or even blanks). Agricultural land is limited. In the region, per capita availability of agricultural land is only 0.1 ha based on demographic figures of 1991 census. Since then this availability has stumbled further down by nearly twenty percent.

Water sustains life. Its efficient, and cost-effective management is critical for meeting the growing demands of population, irrigation, energy generation, recreation, fishing, urbanization and industrialisation. Himalaya, being "the tallest water tower in the world", that is characterized by a great diversity of micrometeorological conditions, needs careful study of the geographic, climatic, hydrological and ecological aspects in different drainage basins and sub-basins, at different locations and altitudes and in the cascades of nesting micro, meso and macro-watersheds with a view to ensure balanced and optimal use of water. Local, regional and international factors come into play while considering the development and management of the Himalayan river systems in a manner as would meet the competing, multiple needs and demands of different stakeholders in a fair and equitable manner, at the same time ensuring the environmental integrity of this important resource in a sustainable way.

NATIONAL WATER POLICY - 1987

The National Water Policy document was brought out in 1987. It underlines the importance of water for human and animal life, its criticality in maintaining ecological balance and its essentiality for economic activities and development. The increasing scarcity of water is recognized. Water is to be treated holistically as a part of the larger ecological system. It is important to develop, conserve the4 utilize it efficiently and economicall6y. Stress has been laid on evolving a well-developed information system (data banks, networking and info-exchange). The strategy has advocated, " maximising retention and minimising losses". Water planning is to be basin or sub-basin based. Recycling and reuse stand emphasized. It is suggested that water projects should provide, firstly, for drinking water and, then, irrigation, flood-mitigation, hydro-power generation, pisciculture, recreation (wherever possible) and industrial and other purposes. In implementing such projects the " preservation of the quality of environment and ecological balance should be a primary consideration". Integrated approach should also address the issues of catchment treatment, rehabilitation of the affected people and command area development. The document further states, "The planning of projects in hilly areas should take into account the need to provide assured drinking water, possibilities of hydro-power development and proper approach to irrigation in such areas in the context of physical features and constraints such as steep slopes, rapid run-off and incidence of soil erosion". The policy document clearly spells out that there should be "close integration of water-use and land-use policies" and, that, "water rates should be such as to convey the scarcity value of the resource to the users and foster motivation for economy in water use". Every effort should be made to involve farmers in water management at the field level. Water zoning should guide economic activities. Conservation must be promoted through education regulation, incentives and disincentives. For mitigating severe flood impacts soil conservation, catchment area treatment, increased afforestation and building of check dams has been suggested. Training and use of latest technologies are listed as important needs for scientific water development and utilization. The document has not attempted a bench mark evaluation nor has it laid down any quantitative targets for future. It may be added here that water (except for inter-state rivers, river valleys, and national waterways) is a state subject under the constitutional division of powers and, therefore, most of action in its management gets taken at the State level and below. Many of the prescriptions listed in the national policy remain unimplemented. Inter-state water disputes subsist in absence of effective mechanisms to resolve these. Water rates have not been rationalized giving rise to heavy and mounting burden of subsidizing irrigation on the one hand and promoting waste on the other. A volumetric approach to pricing water for irrigation is missing. Water conveyance losses are heavy. Drainage problems continue. Appropriate policies for rehabilitation of displaced persons in large multipurpose projects are required to overcome public resistance to such projects. Some progress has been made in enlisting community participation in distribution of water. In mountain areas, traditionally, communities have been performing this role. Water harvesting in hill regions is yet to become a wide based programme. Similarly drip and sprinkler irrigation in water scarce areas has yet to make a headway, particularly in the NWIH.

SITUATION IN THE NWTH

Land and water comprise two of the most significant natural resources. In mountain areas this combination is indispensible for both growth and sustenance. Water regimes affect soil regimes and the reverse is also true. Himalayas do not constitute a river divide. They are unique in the sense that all rivers emerging from them ultimately travel down to the Indian ocean. It seems that the see-saw battle between the rising of the mountains and the deepening of gorges was finally won by the rivers.

Land in hills cannot be possibly considered as a resource in isolationfrom water. The important rivers represent vital drainage paths in the NWIH. The region is well drained by different river systems, the most important being, (1) The Indus System (2) The Yamuna System, (3) The Ganga System and (4) The Kosi System. From the hydrological point of view they present a paradox. They constitute the cardinal components of NWIH's water resources. Yet, our knowledge of mountain hydrology is far less extensive, reliable and precise than of other physiographic regions like the plains. "Some authorities consider that mountain regions represent, in practical terms " the blackest of the black boxes in the hydrological cycle". Only their output is known is any degree of exactitude" (Bandopadhyaya, et.al, 1997).

Indus system

It has a large catchment area of 468,068 sq. km. upto Indo-pak border. All the major rivers flowing in J&K are tributaries of the Indus - the two important ones being Jehlum and Chenab. The average annual flow of water is 207.8 billion m3 for Jehlum, 29 billion m3 for Chenab and 8 billion m3 for Ravi (Bhagat, 90). Consequent upon its flow in steep-sided deep valleys the erosive activity of Indus is very high and it carries about one million tonnes of suspended matter each day (Spate & Learmouth-1984). Beas and Sutlej are the other two rivers which rise near Rohtang and Darma passes, respectively, pass through Himachal Pradesh before flowing down the plains of Punjab. Beas join Sutlej at Harike. Sutlej enters Pakistan near Sulemanki and confluences with Indus further downstream.

Yamuna system

The Yamuna originates at Yamunotri glacier in Uttarkashi district (U.P. Hills), flows into H.P., debouches from the hills near Tajewala and, then, follows a longish passage touching Delhi, Mathura and Agra and, finally, confluencing with the Ganga at Triveni, Allahabad. Its catchment area in hills is 2320 sq. km.; its main tributaries are Tons, Giri and Bata.

Ganga system

In the NWIH, Ganga mainly drains the Garhwal Division of U.P. Hills (excepting western parts of Uttarkashi and the western parts of Kumaon). Its two main tributaries, Alaknanda and Bhagirathi, rise from the opposite sides of Chakhamba peak and meet at Dev

Prayag to form Ganga. Ganga has many other tributaries like Pindar, Mandakini, Nandakini,etc.

Kosi system

It is a small system that drains the eastern part of Kumaon Division. It is not snow fed and, therefore, its flow fluctuations from month to month are severe.

In addition to the river systems the NWIH is endowed with many glaciers (eg. Gangotri, Milam, Pindari, Siachin, etc.) and lakes like Hemkund, Rupkund, Vasuki, Kedarnath and Satopanth (glacial in origin) and Wullar, Dal, Mansar, Surinsar and Pagong (J&K) and the famous group of Kumaon lakes (Nainital, Bhimtal, Naukuchia, etc.). The region has also a very large number of perennial springs and, in some areas, even artesian wells.

The following table gives information about the potential and utilizable water resources for the important basins and sub-basins that are related to the NWIH and the position that subsists for India as a whole :-

Table 1. Potential and utilizable water resources for the important basins and sub-basins

Sl. No.	Item	Indus Basin	Ganga Sub-Basin	All - India Total
1.	Water resources Potential (cu. Km.)	73.5	525.0	1869.3
2.	Utilizable Surface Water (cu. km)	46.0	250.0	690.0
3.	Ground Water Potential (cu. km.)	25.5	171.7	452.2
4.	Per Capita avail-Ability of water (cu. metres)	1757	1473	2214

SOURCE : Central Water Commission of India - 1993

Since total availability normally oscillates in a narrow range there is a limit to which the potential can be realized. The above table gives a macro level picture. The water flows in mountain areas have the characteristics of sharp seasonality and rapid flows. The availability, within the mountain regions, remains very limited on account of these and many other geographical constraints. Thus, irrigation is limited and, even for fulfilling other water needs, the costs are high. The NWIH, in theory, has sufficient fresh water but there are problems like unequal distribution of rainfall, pollution, erosion and land degradation. Water, in the past was freely and plentifully available for the reason that needs were much less than these are now. By tradition water has been an open access resource. It was used and misused with little concern for its intrinsic cost or for its contribution to value-addition. As it becomes increasingly scarce it goes, as experts have held, mainly to those who have political power and economic capital to appropriate it by controlling the sources. Unfortunately water is also grossly under-priced and this tends to encourage its misuse and waste. It needs to be priced reasonably (in difficult hill regions it may need to be subsidized as it already is in many areas) so that it becomes accessible but not wastefully so. It also needs to be placed under the local control of communities.

MANAGEMENT ISSUES

In the mountain regions of NWIH incremental additions to irrigation are possible in many ways, namely, through the setting up of environmentally safe water storages, through water harvesting, through extension of gravity flow systems where possible, through the use of hydrams and also through pump irrigation (this being a very expensive proposition). The other important approach would be of water conservation for which there is a whole spectrum of possibilities available. Here, we inevitably face several water-related environmental issues. It is true that not much can be done about the given geomorphological factors like rugged terrains, steep slopes, etc. To a very limited extent terrains can be managed by measures like terracing or the impounding of water (both very costly propositions). Infiltration can be encouraged. Water run-off can be reduced by creating biotic as well as engineering impediments to the free flow of water so that it may get a better chance to percolate into soil and sub-soil strata. Other steps are also possible like increasing bio-mass cover, adopting those agronomic and silvicultural practices and cropping patterns that are less water intensive, reducing water conveyance losses, setting up of simple water harvesting structures (e.g. polythene lined shallow tanks), use of hydrams and adoption of drip/sprinkler irrigation systems where possible.

Water has many competitive uses in mountain areas. It is required for drinking, for domestic uses, for animals, for agriculture, forestry, horticulture and all biomass growth, for energy production, for industrial purposes and for a host of other purposes. Therefore, the policy for its management and uses has to be carefully worked out and balanced. A protective and regenerative approach is necessary. Pricing must address both accessibility and the need to conserve water and eliminate waste. Any successful planning of water in NWIH should ensure optimal percolation and sub-surface flow with a view to achieving the recharging of ground water and regeneration of water springs and water points to improve round the year availability. When water resources are harnessed the hydrological cycle is sought to be altered through various structures and means to divert water, distribute it, clean it and, then, to carry it away for its return to the natural system. These steps become highly problematic in mountains. In these areas we come across enhanced precipitation (barring in cold, arid regions), greater incidence of clouds, run-off efficiency (which can work both to advantage and disadvantage) and the production of sediment. This hydrological heterogeneity attracts people but it also is the source of a great number of hazards like erosion, flooding, loss of life and property and land loss. Of late, mountain areas in the NWIH have been subjected to intensive pressures from human activities. These pressures have resulted from :-

(i) Rise in human and animal populations
(ii) Expanding agricultural activities (including horticulture and floriculture)
(iii) Establishment of transportation corridors (roads, bridges, tunnels culverts, etc.)
(iv) Mining of minerals and gravel
(v) Construction of storages, multi-purpose projects and artificial channels

(vi) Heavy tourist/pilgrim traffic
(vii) Increasing urbanization
(viii) Deforestation and overgrazing

WATERSHED MANAGEMENT APPROACH

Most of the pressures listed above act on the hydrological cycle to change both the quality and quantity of water yields in adverse ways. A strategy is therefore, needed for ensuring the health of water regimes and this demands an integrated watershed management approach. The core strategy necessarily has to be a combination of protection, regeneration and production. In hill areas a watershed is a natural physio-geographic unit which can also be the effective unit of integrated planning in the areal context. Of course villages are the smallest human agglomerations where many collective decisions get taken, where community discourse is possible and social concern can be achieved. But, the geography of mountains is such, that, if the integrity of a watershed is lost or neglected, there is a strong possibility of the advantages of development getting cancelled out if the programmes do not have a **'spatial fit'** in the catchment context. Most mountain areas are rainfed and, here, integrated areal development should focus on balanced and sustained use of resources in a growth mode and must include production from individual holdings, regeneration of common lands and the promotion of household production systems.

PEOPLE'S PARTICIPATION

If the strategy of integrated watershed management is both rational and advantageous, the question that follows is what is the best way to implement it and make it succeed. The adoption of this strategy will obviously bring many changes in the uses of land, water, trees, animals, technology, skills and economic relations. Hill societies have been traditional in outlook historically and traditionalism is difficult to overcome in comparatively static societies. The hill farmers generally try to produce their needs of different types (to the extent possible) namely, crops, fuel, fodder, fruit, etc. A change means to them getting away from this little wholeness. Secondly, the cycle of subsistence may get disrupted if a fresh (even more profitable) land use causes returns to flow in a longer time frame. Thirdly, scientific land use involves rotational closures of forests or grazing lands which is often not acceptable to local people. Fourthly, such changes are, many a time, looked upon by the rural poor as attempts aimed at depriving them of current access to resources in the hope of better returns in some distant, uncertain future. Thus the problems that arise are not merely of rationality, technology or economics. These are problems of education, of persuation through informed discourse, of social mobilixation and even compensatory actions where changes may involve temporary loss of income or curtailment of resource drawals (examples : shifting from steep-slope agriculture to agroforestry or horticulture, and rotational closure of grazing lands). The need, therefore, is to stimulate collective initiatives and action in institutional contexts so that communities get organized, motivated and facilitated for planned action. This desirable approach is essential for holistic resource management that would naturally include land, water and biomass. In this collectivities have a crucial role to play. In other words empowerment, motivation, institutional development at the grassroot level and capacity building are required to fully and successfully enlist people's participation in integrated watershed management. NGOs can play facilitating, communication bridging and model-building roles to good effect in these contexts.

IRRIGATION COVER

Irrigation cover in the three sub-regions of NWIH is limited though it is better than in some of the North-Eastern Himalayan Status.

J & K

In 1996-97 the net area sown was 732.8 thousand ha while net irrigated are was 313.26 thousand ha i. e. 42.78. The sources of irrigation were : -

(i)	Canals	:	284.25	Thousand ha
(ii)	Tank	:	2.57	Thousand ha
(iii)	Wells	:	1.42	Thousand ha
(iv)	Other sources	:	25.02	Thousand ha

The gross irrigated area was 4,47,000 ha which means that area irrigated more than was 1,34,000 ha (Digest of Statistics, J&K - 1996-97). The ground water potential of J&K in 1984 was estimated by the Central Water Commission at 3.7 cubic kilometres/year while the draft was only 0.050 cu. km/year. Thus only 1.35% of the ground water had been developed by then. The ground water potential is still very substantial.

Himachal Pradesh

In 1994-95 the net sown are was 5,72,000 ha while the net irrigated area was about 1,00,000 ha (i.e. 17.5%). The sources of irrigation were :-

(i)	Canals	:	6,473 ha
(ii)	Tanks	:	N.A.
(iii)	Wells/Tube wells	:	11,100 ha
(iv)	Other Sources	:	81,937 ha

The gross irrigated area was 1,71,000 ha implying thereby that area irrigated more than once amounted to about 71,000 ha. (Dir. Economics & Statistics : Department of Agriculture GOI). According to the Central Water Commission (1985) the ultimate irrigation potential in H.P. was 385000 ha but less than half of it had been created by 94-95. Similarly the ground water potential was estimated at 0.29 cubic kilometres but only one fourth of this potential had been utilized upto 91-92.

U.P. Hills

In 1993-94 the net sown are of this net irrigated are was 231673 ha (i.e. 34.8%). The figures of source-wise irrigated area are not available but it may mentioned here that the irrigation system comprised of 5822 kms of canals, 387 state tube-wells and 6298 private tube-wells. The gross irrigated area was 389613 ha indicating that in area of 1,57,940 ha was irrigated more than once.

SOME TRADITIONAL WATER-USE INGENUITIES

Some unique irrigation systems have been evolved in the NWIH, for example, in Himachal Pradesh, we have the 'Kuhal' system under which diversion channels are utilised to carry water from glaciers to villages over long distances. In Kashmir valley the canal system is centuries old and there is considerable local participation in the distribution of irrigation water. In Uttaranchal the participation of local communities in water distribution and water use varies from area to area. In the cold desert areas of Ladakh water is brought through channels from glacial melts for irrigating the fields. Flooding the fields with the glacial water for improving crop productivity is also common.

DRINKING WATER

The total number of villages is 6477 and number of villages covered under piped water supply was 6457 in 96-97 (99.69%) that benefited 99.69% of the rural population.

Himachal Pradesh

Total No. of Villages	16807
Villages covered by Drinking Water Programme Upto 1994	87%

U.P. Hills

Total No. of Villages	15806
Villages covered by Drinking Water Programme Upto March 96	99.5%

The drinking water figures in terms of the percentages of villages covered may look very bright but the ground level situation is different. Many drinking water schemes are non-functional; in many others water yields have fallen sharply while some water sources tapped for this purpose have altogether dried up. The problem of reduction in natural spring yields is quite serious in some hill areas like, for example, the Gola catchment in Kumaon. Some springs gave altogether dried up.

NATIONAL WATERSHED DEVELOPMENT PROGRAMME

Dryland farming on scientific basis is not a new idea. It was recommended even by the Royal Commission on Agriculture in the early years of the 20the century. Some systems were developed then but with poor rates of success. The nineteen-fifties witnessed emphasis on soil conservation in India. Then come the Integrated Watershed Management approach in the seventies. The National Watershed Development Programme for Rainfed Areas (NWDPRA) was launched in 1990-91 as a national project. It covered 10,000 villages with an area of 3.7 mha (15 million people)

It covered 10,000 villages with an area of 3.7 mha (15 million people) which also included mountain uplands. It was based on the farming systems approach. Detailed guidelines were issued that covered surveys, project preparation laying of nurseries, demonstration management of common lands, livestock development, people's participation and involvement of NGOs. In-built provisions existed for research, monitoring and review. Emphasis was on making use of every resource available and on building up on local knowledge. The main planks of the programme projected were affordability, replicability and sustainability. A World Bank Project was launched in U.P. Hills in the eighties. It had, at best, very limited success. It did not mesh with the already on-going development programmes in the project area. A second WB project for this hill area was initiated in 1990-91. Three European Commission Assisted projects were also started in the degraded ecosystems of U.P. Hills. This time the implementation was somewhat better essentially on account of the adoption of PRA techniques. But, frankly the criteria of neither sustainability nor replicability seem to have been met. Most of these programmes are donor-driven and patterns of implementation vary in nuances and emphasis. NWDPRA relies largely upon water conservation technologies where greater use of biological means is attempted to control erosion, use of organic manure is promoted to improve in situ moisture and effort is made to integrate diversified production systems e.g. mixed farming, agro-forestry, water harvesting, dryland horticulture and livestock development. Self Help Groups are set up and Friendly Farmer's For a established (SHGs for women, too, are seperately set up). Of the net income, 10% is transferred to the village development fund while 15% is earmarked as a revolving fund to be utilized by the SHGs for common lands development. The remaining 75% is to be shared by the beneficiary group. The results of NWDPRA are at best mixed but it is a beginning that needs to be pursued and built upon with purpose and determination.

WATER STORAGES IN MOUNTAIN AREAS

The precipitation pattern in the NWIH is informed by acute seasonality. This seasonality becomes less acute as we move westward. Even so, it is a dominant feature of the incidence of annual rainfall. Floods in recent decades have become more acute and incessant in India. Most of these are caused by the Himalayan rivers. In the year 1998-9, in India, 258 districts were visited by floods, heavy rains, cyclones, landslides, etc. involving 55366 villages. The area affected was 96 lakh ha and population that suffered these ravages was 5.07 crores. The loss of human life was 4331, of animals, 86724. Over 1.1 million houses/huts were damaged or destroyed.

Floods

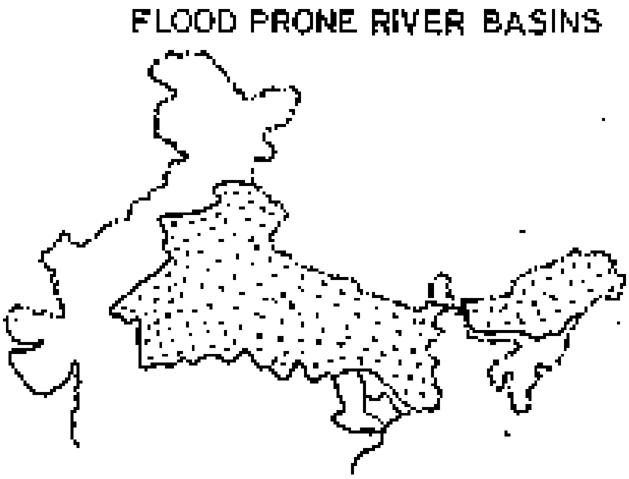
On an average, between 1953 and 1990, the land area affected anually has been a little under eight million ha and the population, 32 million. The peak flood years have imposed much greater toll in terms of land and population affected as also loss of life and property. For example, in 1978, the area flooded was as high as 17.5 mha and the population affected over seventy million. Similarly, while the average loss of human life from 1953 to 1990 was 1532 a year, in the year 1977, as many as 11316 people perished in the floods. Damage to crops has averaged Rs. 448 crores a year; in 1988 the loss was a colossal Rs. 2510 crores. The worst years reported are reflected in the following Table No. 2 :-

Table 2. Worst flood years in India impacts & losses (1953-90).

Sl. No.	Item	Worst Impact	Year
(a)	Area affected	17.53 mha	1978
(b)	Population affected	70.45 million	1978
(c)	Damage to crops	9.96 mha	1978
(d)	Value of crops damaged	1425 crore rupees	1985
(e)	Homes damaged	3.51 million	1978
(f)	Cattle lost	6.2 lakhs	1979
(g)	Human Lives Lost	11316 nos	1977
(h)	Total damage to crops, houses and public utilities	4059 crore rupees	1985

SOURCE: Centre for Science & Environment New Delhi 1991

Figure no. 1 shows the most flood prone basins in North India while Figure no. 2 shows the trends in annual area affected by inundation.

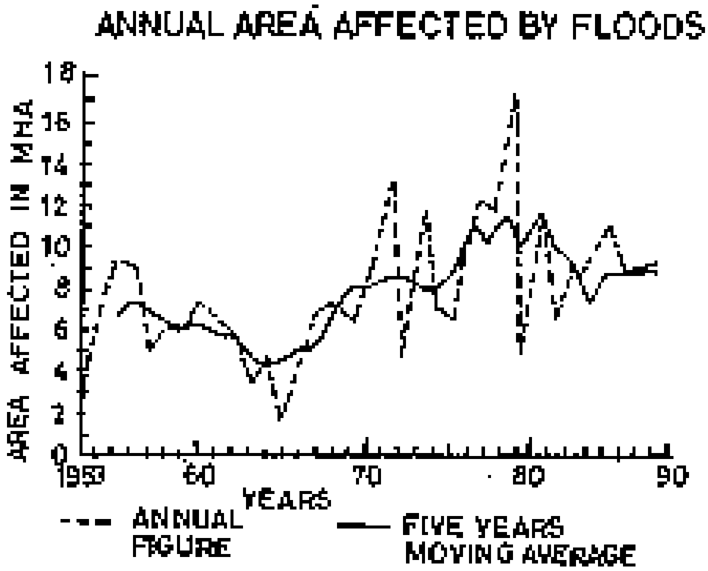


Source: Centre for Science and Education, New Delhi, 1991

Figure 1. The most flood prone basins are those of the Ganga in Uttar Pradesh, Bihar and West Bengal and Brahmaputra in Assam followed by those of Daitarni, Brahamni and Subarnarekha in Orissa.

Floods cannot be eliminated. But, floods can be moderated. Unfortunately the major thrust of control programmes has been on the channel phase of floods, namely, river training, construction of spurs, embankments, bunds, barrages and channels. This strategy is somewhat lop-sided.

The land phase of floods has not received the attention required, namely soil conservation, afforestation, soil binding grass cover, land treatment and, of course water storages. This, last, is admittedly a controversial issue but demands patient, thoughtful and cautious consideration. Building dams (especially large ones) has many negativities, but in the background of the monsoon precipitation cycle, the need for improving supplies of water for divers requirements like drinking, agriculture and industry in non-rainy periods and need of tempering of floods, this option has to be considered seriously.



Source: Centre for Science and Education, New Delhi, 1991

Figure 2. The annual area affected by floods rose from 6.40 mha to over nine mha between the 1950s, and the 1980s.

One other issue is of critical importance in this context, namely, production of hydel energy which is so badly required for meeting the existing acute shortages of electrical energy and, much more so, of peaking power. Dam construction in the mountain regions must be made safe and environmentally secure. This can be done by carefully selecting locations, sizes and designs, by giving priority to catchment area treatment and by adopting humane and generous rehabilitation policies in favour of those who are displaced. It is essentially trade-offs that have to be brought about with imagination, boldness and deep sympathy.

DATA GAPS

There are serious data gaps about water regimes in the Himalayan regions. This makes the task of planners difficult. The dimensions of water balance in mountains are much larger than in the plains. Here, the gradients are steep and loads of transported material much heavier. So, degradation of basins proceeds more rapidly. The measures required to be taken demand accurate information about precipitation, evaporation, river, stream and rivulet sediment loads, snow cover, etc. Unfortunately, in these areas, the data gaps are glaring and need to be filled up. The measurement problems are complex. There is an urgent need to have densities of instrument networks appropriate to each physiographic unit.

LAND USE – WATER USE SYNERGY

It is clear that land and water – use planning will have to proceed hand-in-hand in mountain areas. Watersheds have to become planning units. "With a watershed perspective, water resource professionals, land owners and users, water users, planners politicians, democratically elected local institutions, people's groups and public have better opportunities to visualize interaction between upstream and downstream, sources and sinks, land and water, slopes and valleys, waste disposal and water intake, and human actions and natural processes" (Bandopadhyaya, et. al, Through watershed planning, management and assessment it is possible to determine the level of degradation in water regimes, identify contributing land-use practices and suggest remedies. In this endeavour full and active involvement and empowerment of local communities is crucial and essential.

PRIORITY ISSUES THAT NEED TO BE ADDRESSED

From the above discussion emerge many important issues that need to be addressed in water resource management and water use contexts. Some of these could be, illustratively listed below :

(i) Estimation of the water resources and constraints of availability for different uses - water budget analysis;
(ii) Existing Water Management Systems - the need for Basin Plans;
(iii) Data gaps and ways and means for filling these up and making access to information easy for users, institutions and governments. Monitoring and gauging of water flows;
(iv) Water related environmental issues and health aspects. Aesthetic uses of water;
(v) Future water demand and ways and means for meeting the requirements;
(vi) Water conservation;
(vii) The problems of quality - supply of clean water for drinking and other purposes;
(viii) Issues relating to building of dams in the hill areas. Water and production of energy;
(ix) Water harvesting and uses of economically effective systems like hydrams, sprinklers, drip irrigation etc.;
(x) User participation and awareness for economic uses of water. Community management of water resources at micro-level;
(xi) Need formulating national/regional master water plans;
(xii) Human resource needs for scientific water management;
(xiii) Legal framework; and
(xiv) Institution building

CONCLUSION

Water is a critical resource. No one c an deny that. It is a pivot of the life support system and, in its uses we have to find ways which will help us to move away from the highly water intensive components of economic development. We have to learn to husband this resource in natural ways, such as storing water in soil profiles, vegetative cover, threes and aquifers. Through such methods water can be stored and conserved. Simultaneously, there is the need to conserve water in all possible ways including appropriate policing of it, education and change over to water-economic ways of production.