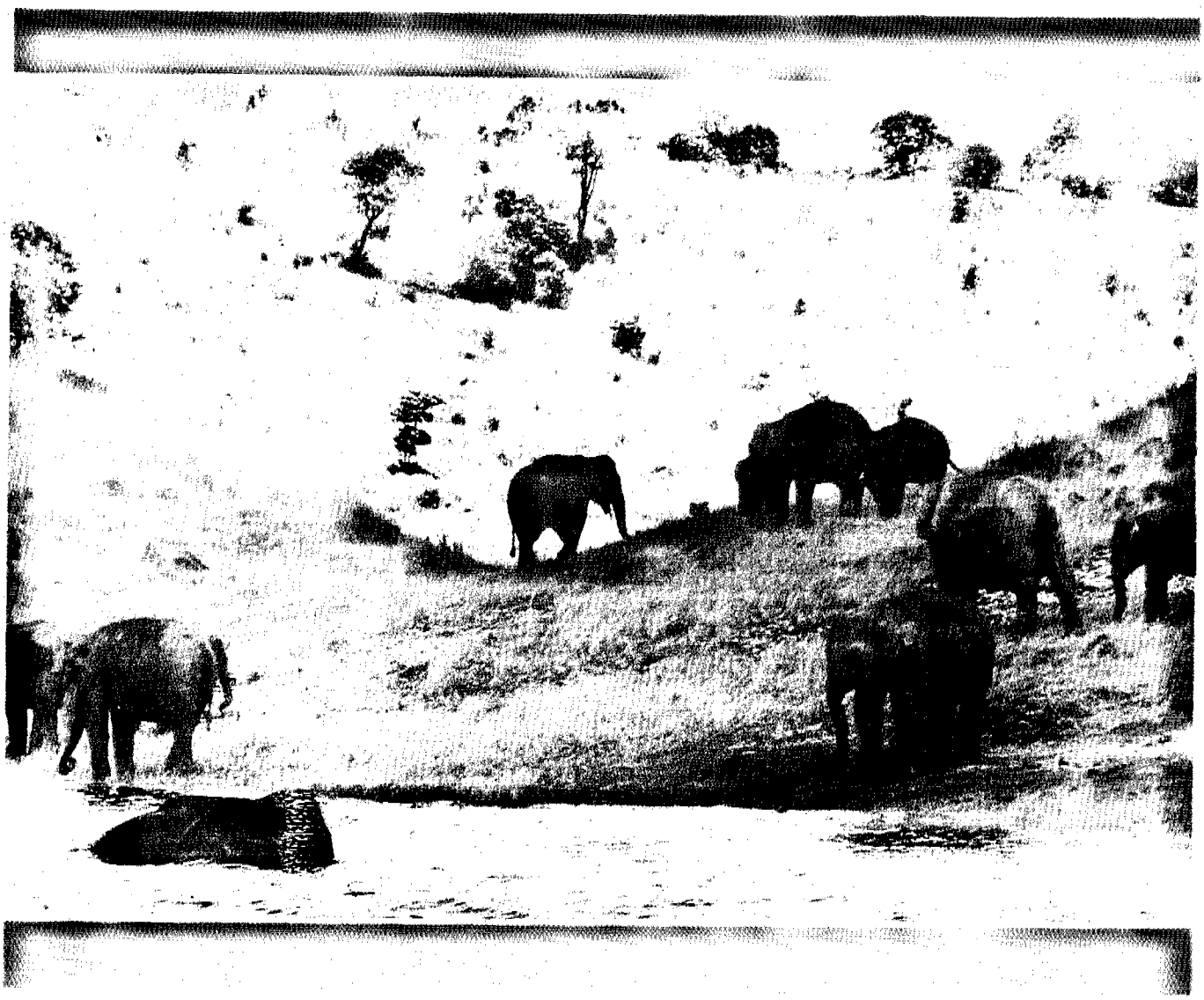
जल संसाधन विकास एवं उनके प्रबन्ध में पर्यावरणीय पहलू

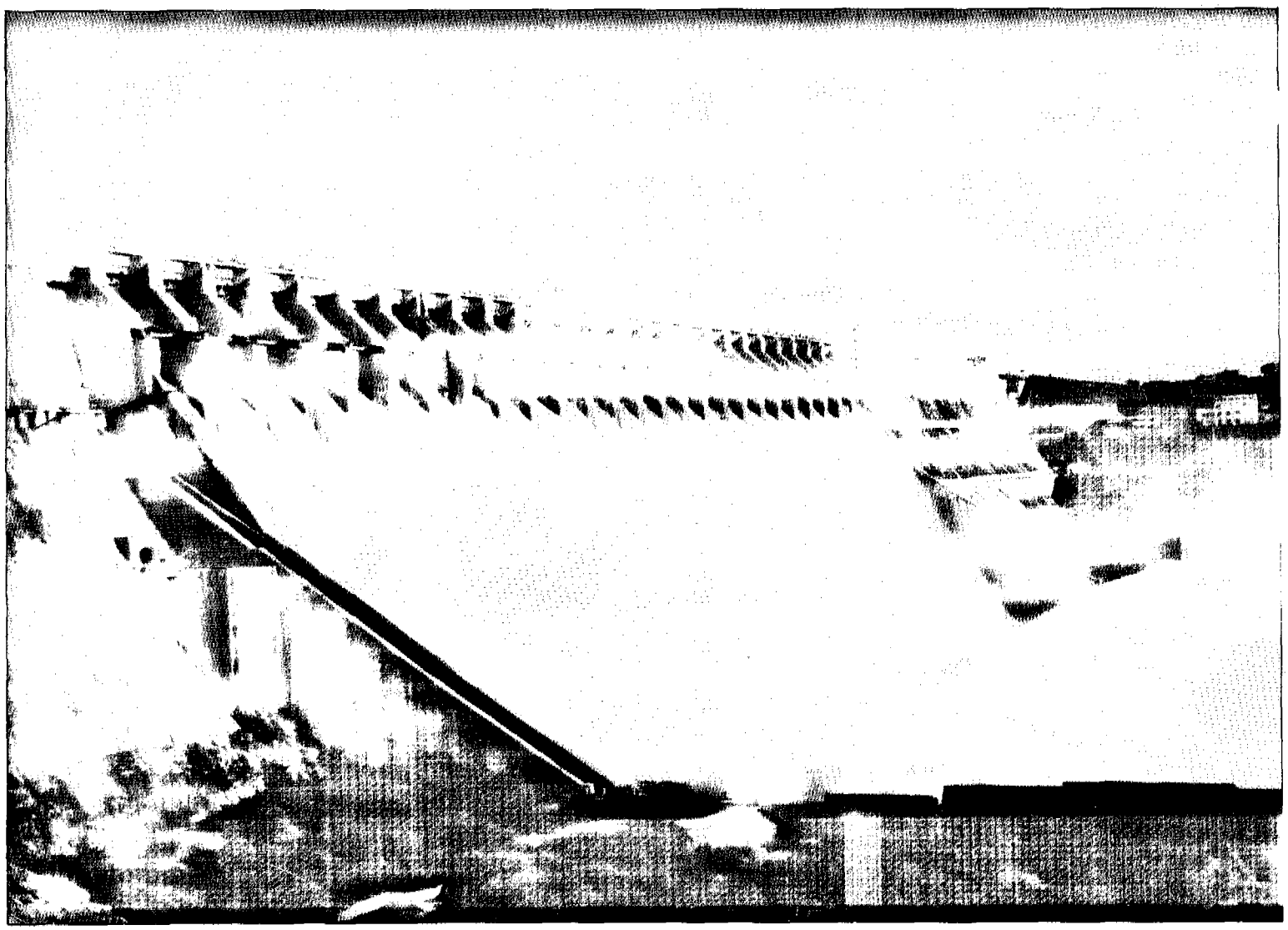
ENVIRONMENTAL ASPECTS IN WATER RESOURCES DEVELOPMENT AND THEIR MANAGEMENT



भारत सरकार
केन्द्रीय जल आयोग
नई दिल्ली

GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION
NEW DELHI

अप्रैल 1989
APRIL 1989



A view of Nagarjunasagar Dam

Cover Page:
Wild Life Sanctuary at Periyar Lake

CWC PUBLICATION NO. 48/89

भारत सरकार
केन्द्रीय जल आयोग
GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION

जल संसाधन विकास एवं उनके प्रबन्ध में पर्यावरणीय पहलू
ENVIRONMENTAL ASPECTS IN WATER RESOURCES DEVELOPMENT AND THEIR MANAGEMENT

अप्रैल, 1989
APRIL, 1989

FOREWORD

Water Resources Projects are modern temples of the country and the sign posts of development. Even in the ancient days the prosperity of any kingdom was measured in terms of its wealth of water resources structures. By providing assured water supply for irrigation, municipal and industrial requirements, production of hydroelectric power and many more purposes, the water resources projects contributed significantly towards the improvement in the standard of living and quality of life for millions of the country.

No development is feasible without altering the surroundings to a certain extent. Water resources projects are no exception to this principle. Water resources projects bring in immense benefits with a few impacts on environment. Many of these impacts are manageable if proper measures are taken at the planning and implementing stage. It has, therefore, become necessary to plan the water resources schemes duly incorporating the environmental issues at the project formulation stage itself.

The National Water Policy evolved by the Government of India has laid emphasis on the need for planning, implementing and operating the projects duly preserving the quality of environment. It has been suggested that the adverse impacts, if any, on the environment should be minimised and should be offset by adequate compensatory measures. Further, the National Water Policy has also emphasised the need for adopting integrated and multidisciplinary approach to the planning, formulation, clearance and implementation of projects including management of environmental aspects.

In recent times the water resources projects have been under constant attack from some quarters. Environmental aspects are being blown out of proportion. The criticism levelled against the water resources projects in most of the cases is neither based on scientific data nor on established facts. An attempt has, therefore, been made to bring out both the positive and negative aspects of water resources projects in this publication in a balanced manner. It is hoped that the information contained in this publication would be useful and clarify many issues. This publication is not claimed to be an exhaustive treatise on environmental impacts for water resources projects. Subsequent treatment of this vital subject may, therefore, be necessary with the updated information.

I would like to place on record our appreciation for the commendable work done by Sarvashri R.V. Rao, Director and P.K. Sharma, Deputy Director of the Environmental Management Directorate, C.W.C. in bringing out this publication. The printing of this document has been through the funds of WRM&T project.

(Y. D. Pendse)
Member (Water Planning)
Central Water Commission

New Delhi
APRIL, 1989

1.0 PREAMBLE

1.1 The enquiry made by Rishi Narada, the great Indian writer of polity, in the court of Yudhisthra, great Pandava King was:

कच्चिद्राष्ट्रे तडागानि पूर्णानि च महान्ति च।
भागशो विनिविष्टानि न कृषिर्देवमातृका॥

महाभारते सभापर्वणि पंचमोध्यायः

श्लोकः ६७

"I hope your realm has reservoirs large and full of water; located in the diferent parts of the land, so that agriculture does not depend merely on the caprice of rain god"

Mahabharata, Sabhaparva
Chapter V, Stanza 67

1.2 Since the times of Rig Veda irrigation has been practiced widely in India. Kautilaya's Arthashastra, the most acclaimed treatise on the ancient political economy of India, states that King shall construct reservoirs for providing a perennial water supply and to those private individuals who construct reservoirs on their own accord, the King shall provide sites, roads, timbers, etc. without any charge until the private owners realised profits of twice the initial expenditure incurred. Rishi Bhagirath is popularly known for his efforts towards diverting the waters of the river Ganga. Kashyapa's treatise on agriculture gives the comprehensive foundation to the ancient practices of building reservoirs. The passages on the selection of sites for reservoirs on the basis of the slopes, soil structures and the situation of human habitations are of relevance even today.

1.3 Indian history is full of descriptions of various irrigation and water works carried out from time to time by various kings to meet the agricultural and municipal demands of their kingdoms. The development of water control technology over the years has played a major role in the formation of complex social organisations in India. This technology helped not only in the advancement of agriculture, but also in developing adequate water supplies for the emerging towns and cities. The construction of water works, roads, etc., is a labour intensive activity and results in an increase in the social capital. New towns and cities thus developed according to their economic function within the overall political unit or state and not only in line with the subsistence value of their agricultural potential.

1.4 One of the reasons attributed to the rapid growth and expansion of the Vijayanagar Empire in the early 15th century in South India was the construction of irrigation works which brought new areas under cultivation and significantly enhanced central revenues through additional taxation. The building of a tank by Vijayanagar King, Krishnaraja, is referred to in his travelogue by Paes, a Portuguese traveller to his kingdom. Another Portuguese traveller, Nuniz, writes of a dam built across the Tungabhadra river. The dam that Nuniz talks about is actually a series of five or six small anicuts built across a branch of the main Tungabhadra river. The anicuts today feed a channel called the Turuttu (meaning swift) which irrigates the surrounding fields. The anicuts have been strengthened in recent times in some places but parts of the old granite and mortar structures are still visible. The canal constructed followed the contours of the hills and involved cutting of huge rocks. One of the tanks that must have been in use for irrigation since the Vijayanagar period is the Kamalapur tank. The most notable of the ancient irrigation works in Southern India is a masonary weir in the delta of Cauvery river known as 'Grand Anicut' (figure 1). The original work, constructed of stones laid in clay, is believed to have been built in 2nd century AD by Raja Kari Kala Chola. Some of the other irrigation works which are performing commendably even today are the old Jumna Canal, in north India, constructed by Feroze Shah Tughlaq at the end of the 14th century, the canal from the river Ravi constructed by Shahjahan, etc. These irrigation structures have stood the test of the time and served the local populace for centuries.

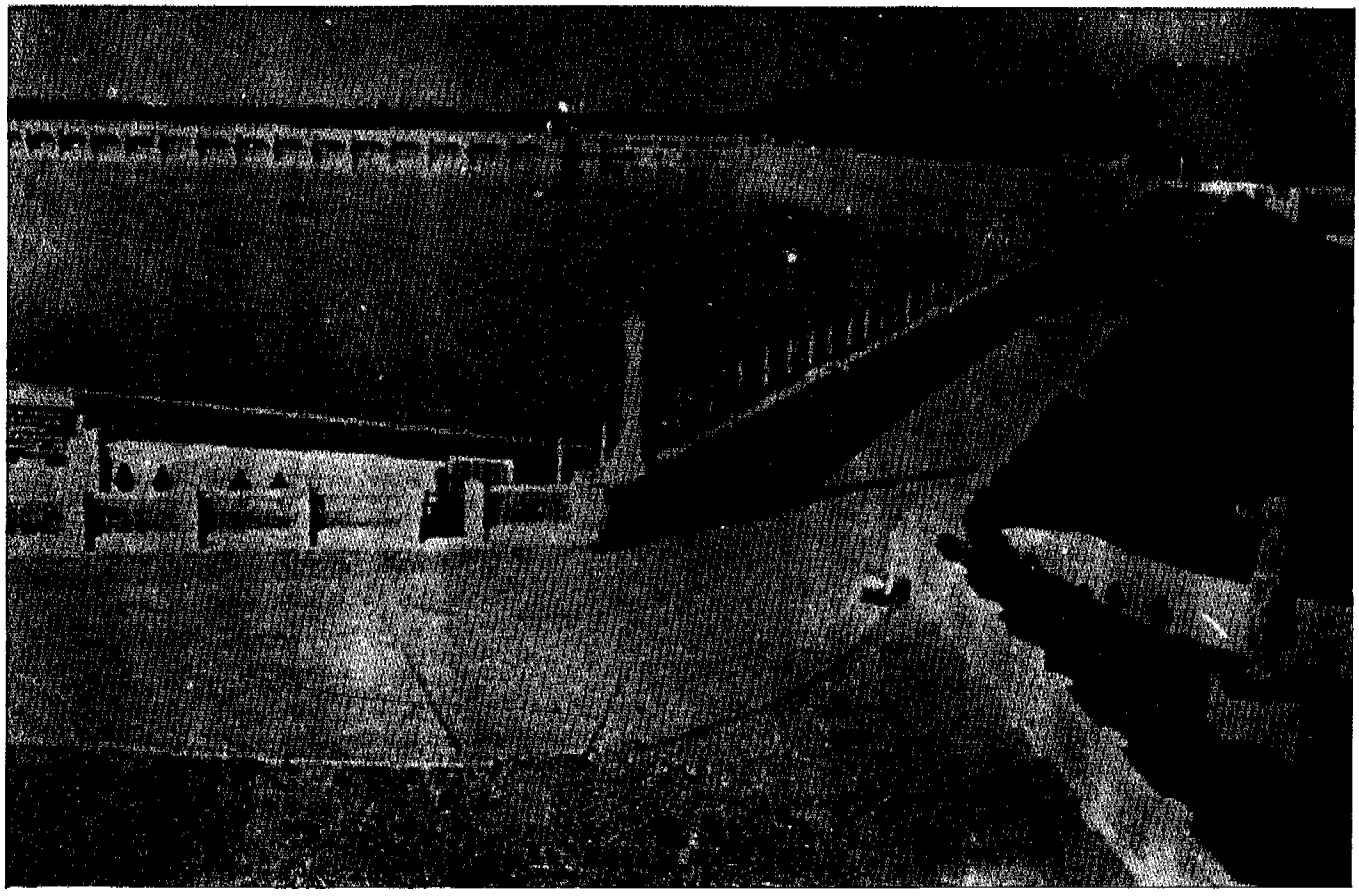


Figure 1 Grand Anicut

1.5 India has been predominantly an agriculture based economy in the past, and will remain so at least for the near future. Even today, about 65% of the population is dependent on agriculture. Water resources projects have played a dominant role in the past in the development of agriculture and in making India self-reliant in food grain production. This facilitated the diversion of precious foreign exchange reserves to pay for the import of other essential commodities required for national growth. The National Commission on Agriculture (Ministry of Agriculture and Irrigation, 1976) has projected that the country's population is likely to increase to 935 millions from the present level of 725 millions by 2000 AD and accordingly the demand for foodgrains is likely to increase to 225 million tonnes from the present level of 153 million tonnes. Such a large increase of 50% in demand can only be met if the tempo of agricultural production is stepped up. Further, when such a large population is depending upon agriculture, it is utmost necessary that this agricultural work force is provided year round employment in their fields. This can be made possible only by providing assured water supply for 2 to 3 crops in a year instead of a single crop during the rainy season.

1.6 During the 30 years period ending 1981 the net sown area has increased hardly by 20%. It is in this context that intensive land use will have to be practiced for stepping up the foodgrain production. Agriculture statistics from different States show that the yield from irrigated areas is much higher than that from the unirrigated areas as is evident from the Table 1.

1.7 The need for water resources projects is not only for irrigation but also for generating hydropower, providing flood control, meeting the municipal and industrial water supply requirements, navigation and water based recreation facilities. The installed capacity of hydropower in India has gone up from pre-plan generation of 560 MW to 17650 MW today—30 fold increase. It is difficult to imagine the power situation in absence of Bhakra (figure 3), Koyna, Sharawati and Hirakud Projects. As per the long term National Power Plan formulated by Central Electricity Authority, country's total installed capacity needs to be raised to about 174600 MW by 2000 AD. It means, an additional growth over 10% every year during the entire period would be

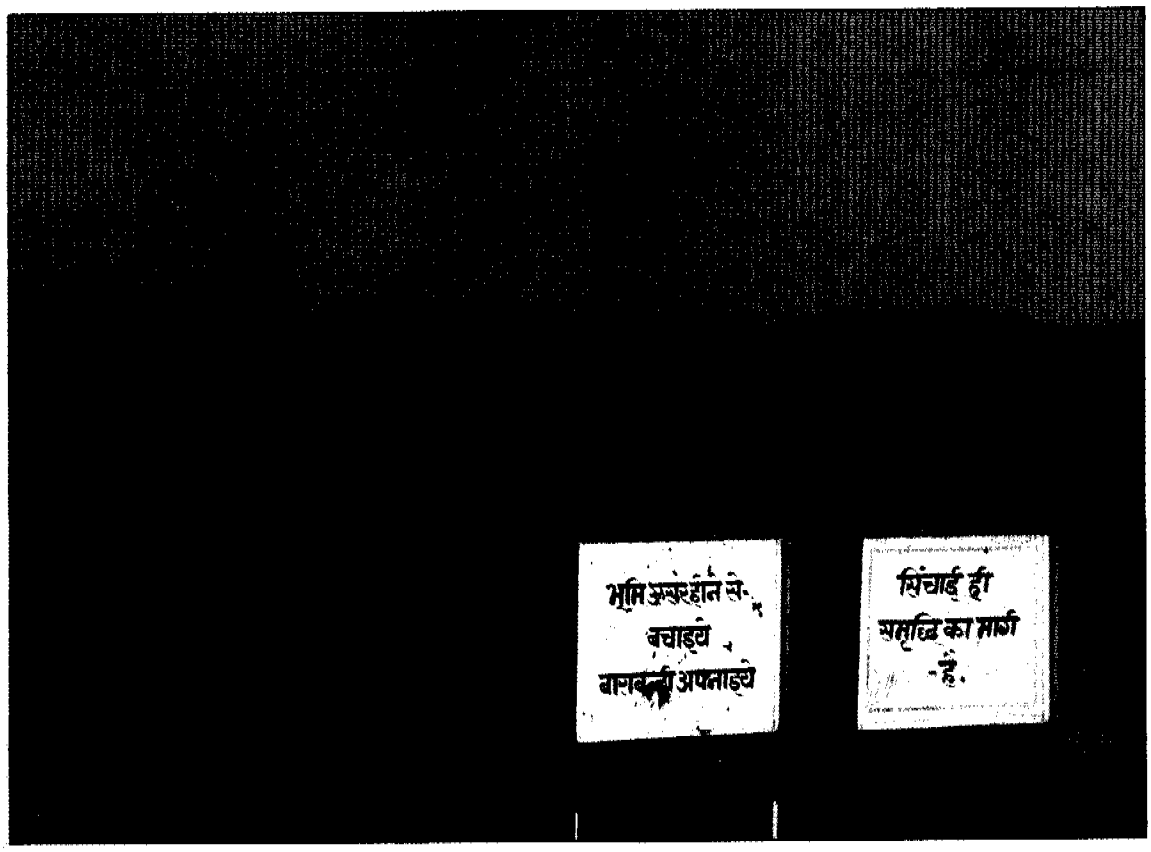


Figure 2 Prosperity through Irrigation

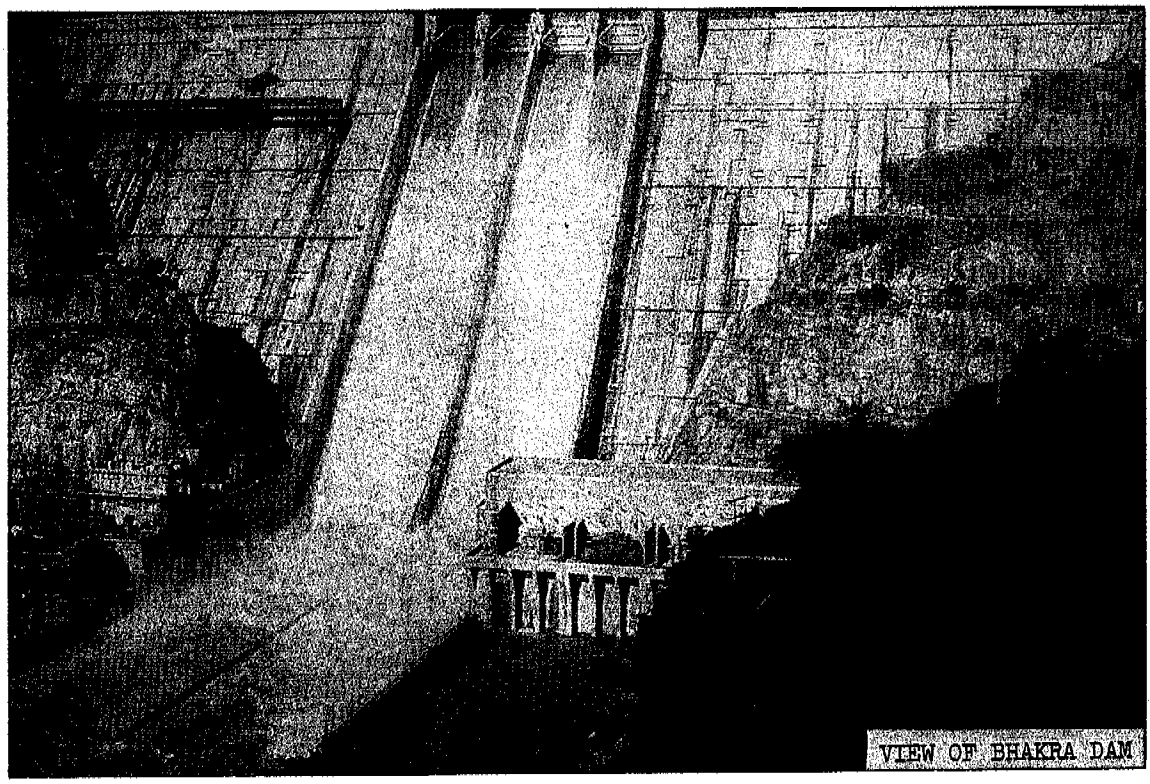


Figure 3 Bhakra Dam

Table 1: Productivity in Irrigated and Unirrigated Areas in India

Crop/State	Period	Average Yield (Kg/Hectare) Irrigated	Unirrigated	Difference
WHEAT				
Assam	1975-76 to 1982-83	1691	1118	573
Bihar	1968-69 to 1980-81	1144	812	332
Gujarat	1968-69 to 1983-84	2069	564	1505
Haryana	1968-69 to 1983-84	2162	1307	855
Himachal Pradesh	1968-69 to 1983-84	1482	1093	389
Jammu & Kashmir	1968-69 to 1979-80	1194	746	448
Karnataka	1968-69 to 1983-84	811	341	470
Madhya Pradesh	1968-69 to 1983-84	1399	723	676
Maharashtra	1968-69 to 1983-84	1060	502	558
Punjab	1968-69 to 1983-84	2619	1316	1303
Rajasthan	1968-69 to 1983-84	1443	780	663
Uttar Pradesh	1970-71 to 1983-84	1531	933	598
West Bengal	1968-69 to 1983-84	1502	981	521
RICE				
Andhra-Kharif	1968-69 to 1983-84	1685	762	923
Assam-Autumn	1969-70 to 1983-84	1379	816	563
Bihar-Autumn	1968-69 to 1980-81	955	541	414
Bihar-Summer	1969-70 to 1980-81	1080	585	495
Gujarat	1968-69 to 1983-84	1659	928	731
Himachal Pradesh	1968-69 to 1983-84	1452	1084	368
Karnataka-Kharif	1968-69 to 1983-84	1785	1355	430
Madhya Pradesh	1968-69 to 1983-84	1123	718	405
Orissa-Autumn	1968-69 to 1983-84	827	565	262
Orissa-Winter	1968-69 to 1983-84	1196	947	249
Punjab-Autumn	1970-71 to 1983-84	2510	1239	1271

Source: Indian Agricultural Statistics, Vol.II, Directorate of Economics & Statistcs Ministry of Agriculture.

necessary. The National Plan envisaged a mixture of hydro, thermal and nuclear projects in the ratio of 34%, 60% and 6% respectively. Considering that hydropower is best suited for peaking purposes, it has been found that additional capacity requirement during 8th and 9th Five Year Plans can be reduced by 11.69% by increasing hydropower share to about 43.5%. According to recent estimates the hydropower potential is placed at about 600 million units of firm annual energy and 84044 MW of firm power at 60% load factor, but of which only 13% has been exploited so far. With the completion of ongoing and sanctioned schemes, the potential exploited would be about 20%.

1.8 In India, the monsoon period is only for 3 to 4 months in a year and quantum of rainfall varies from very good to drought condition from year to year. Therefore, the need for water resources project does not require any emphasis, particularly to meet the demands during the non-monsoon months. Further, the additional storage facilities, are needed to store water available from good years to meet the deficit in drought years.

1.9 One of the important roles played by water resources projects is to provide municipal and industrial water requirements with a high degree of reliability. Most of the cities, towns and villages are dependent upon the supplies from various water resources projects. Further, due to rapid industrialisation the demand of water for major industries is increasing at a very fast pace.

1.10 Occurrence of flood is a natural phenomenon and man has had to live with it since very beginning. It is well recognised that floods will continue to occur as it is dependent on a combination of natural phenomenon and human interference. The various steps towards flood management include structural works such as storage reservoirs, embankments and nonstructural works such as flood plain zoning, flood forecasting, flood warning, etc. Reservoirs have played an important role in the managing of floods. The rivers like Damodar and Kosi, known as rivers of sorrow of Bengal and Bihar respectively, have been tamed by the construction of various water resources development structures. The construction of Ukai dam on river Tapi in Gujarat in the years 1972 has proved to be a boon to the people of Surat city. They have now totally forgotten that the river Tapi use to flood their city almost every year in the past.

Figure 4 A Village surrounded by Flood waters

1.11 No development project can have only benefits without having some negative aspects. The development and environment are two sides of the same coin. Some price is required to be paid for the economic progress achieved due to any developmental project. Water resources projects are no exception to this. This view has been considered in various forums and it is a growing consensus that given certain preconditions, economic development and environmental management can be pursued simultaneously. Developing country's view point was very rightly brought out by Late Prime Minister of India, Mrs. Indira Gandhi at the opening ceremony of the International Conference on Human Environment in 1972,

at Stockholm, by expressing her feeling as:

> "....the rich countries may look upon development as the cause of environmental destruction but to us, it is one of the primary means of improving the environment for living, of providing food, water, sanitation and shelter, of making desert green and mountains habitable...."

2.0 MANAGEMENT OF MAJOR ENVIRONMENTAL ISSUES

2.1 There is no doubt that water resources projects bring in immense benefits in the form of assured water supply for irrigation, municipal and industrial users, flood control, hydropower generation, navigation and increase in tourism. However, there are certain inherent environmental issues which need to be resolved and managed with utmost care, lest the water resources projects may become a cause of concern. Water resources planners have for centuries been aware of most of the environmental issues. The following paras present a brief discussion on the various environmental issues relevant to water resources development projects along with the mitigative measures that have been adopted in the past and being adopted today.

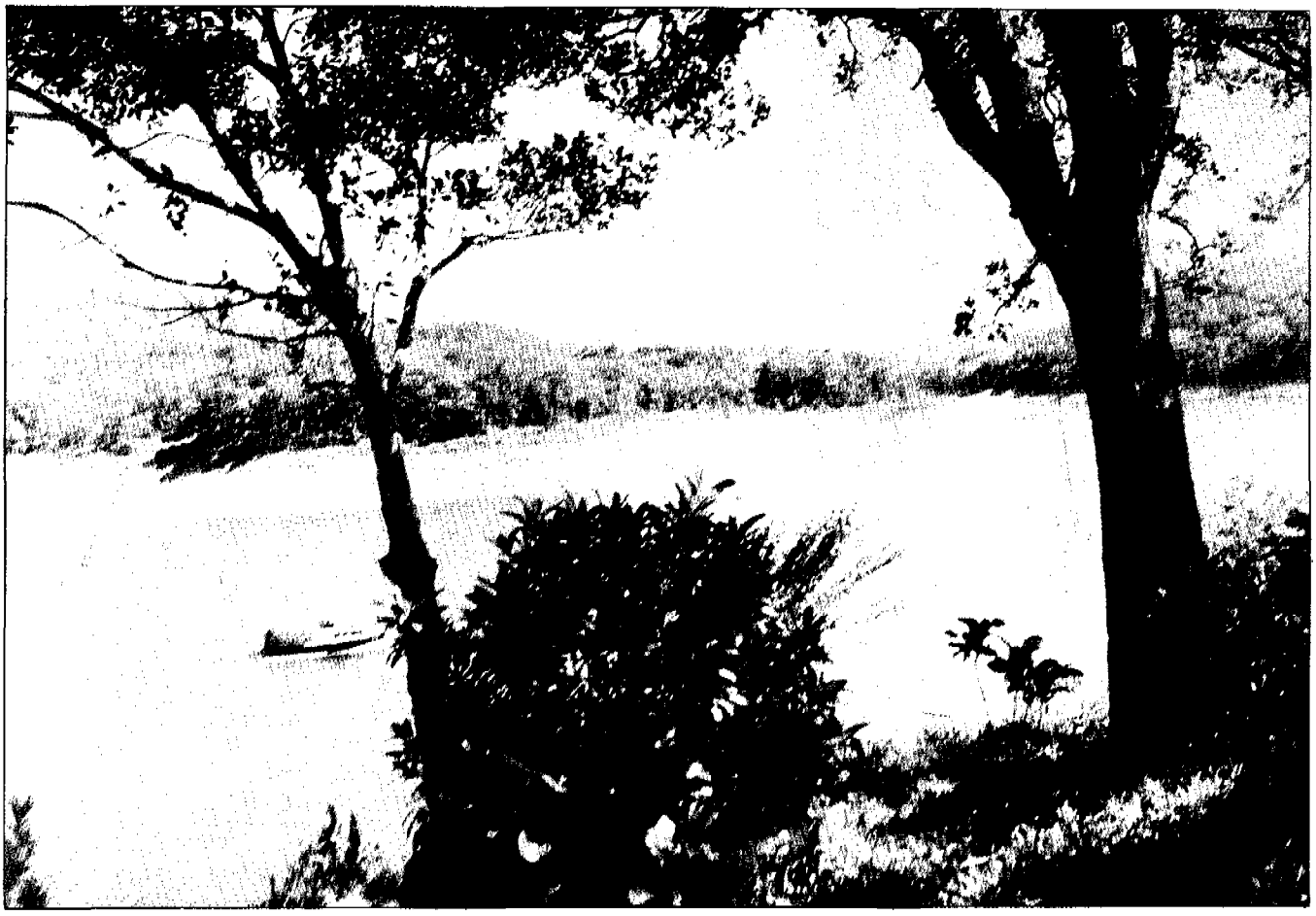


Figure 5 Recreational facilities in Periyar Lake

2.2 Rehabilitation of the project affected persons

2.2.1 The construction of dams involves resettlement of project affected families warranting their resettlement at some other sites. Early planners of India were well aware of the problems. Epigraphical report number 397 of 1909 mentions that whenever private lands were acquired for the construction of irrigation works, the owners were provided with other lands in compensation. The problem of resettling and safeguarding the interests of displaced persons continue to be considered even today. In fact most of the criticism that is being levelled against Government policies is not due to the faulty provisions in the policies but due to lack of implementation of these policies. A perusal of the various rehabilitation problems that are encountered in different water resources projects prove the point. One of the first major resettlement

operations is related to the evacuation of the Bilaspur town in Himachal Pradesh which was submerged by the Bhakra dam reservoir. Seven thousand people of the town, who had modern amenities like college, a hospital, markets and playgrounds were displaced. A new township was created on nearby high ground and displaced persons were given cash to build new houses. Today, the new Bilaspur is a flourishing town. For the displaced people at Ukai (Gujarat), new village sites have been provided with approach, internal roads, schools, wells, drainage, etc. (figure 6). Facilities have been given for seasonal cultivation and priorities were accorded in the jobs. Lift irrigation schemes and cooperative fishing was also introduced to help them.

Figure 6 A Rehabilitation colony of Ukai project with main road, bazaar and temple.

2.2.2 The Government of Andhra Pradesh (A.P) formulated its resettlement policy in 1959 which was implemented at the time of construction of Nagarjuna Sagar project. About 5100 families were resettled in 34 newly established villages. The people were provided with free housing sites and the families who had been dependant on cultivation of land for their livelihood for at least 3 years were given 5 acres (2 ha) of land free of cost. Liberal compensation, ex-gratia payment, loans and various facilities were provided at the new sites. After the enactment of the Forest Act, 1980, by Government of India, the rehabilitation policy was further modified to include cash compensation along with civic amenities at new sites. This newly formulated policy was implemented at Lower Maneru and Srisailam projects in A.P.

2.2.3 *Maharashtra Resettlement Act, 1976, provides for many amenities to oustees which include providing* free residential plots of size 370 sq.mt. to agriculturist families having less than 5 family members. Additional area of 185 sq.mt. for every three additional members subject to the ceiling of 740 sq.mt. is provided. To non-agriculturist families with less than 5 family members a plot of 185 sq.mts is given. Additional 92.5 sq.mts. for every three additional family members subject to a maximum of 370 sq.mts. is also given. Provision also exists for acquisition and reservation of 15% of command area for resettlement purposes. In the Bhima project, assistance was given to more than 50% of the project affected people by providing lift irrigation facilities on the periphery of the newly created reservoir. The project authorities have started earmarking sufficient funds in the project proposals for rehabilitation programmes, which include providing cash grants, reservations in

employment, training facilities, agricultural land, residential plots, colonies with schools, drinking water facilities, good roads, hospitals, etc. The matter of having a uniform rehabilitation policy applicable throughout the country is engaging the attention of Government of India.

2.2.4 Government of Karnataka have laid down detailed guidelines for the project affected persons. Each project had a rehabilitation committee to take care of the interests of the oustees. The committee selected the sites for the rehabilitation centers and land in those areas were acquired under the land aquisition act. Oustees were compensated for their houses and lands lost in submersion. All the infrastructure like schools, temples, mosques, community halls, wells etc. were provided. The Oustees of Malaprabha project lost their fertile lands under submersion. Almost all of them were rehabilitated on the higher contour areas where eight number of lift irrigation schemes were provided. (figure 7)

Figure 7 Typical residential buildings in rehabilitation centre, Malaprabha project

2.2.5 For Sardar Sarovar Project, under construction in Narmada river basin, Narmada Water Disputes Tribunal (1979) has laid down very liberal guidelines for rehabilitation of project affected persons. These include provision of free residential sites in the rehabilitation colonies having modern civic and community facilities like hospitals, panchayat ghars, schools, etc. Every displaced family from whom more than 25% of their land holdings is acquired would be offered irrigable land equivalent in area to the land acquired subject to prescribed ceiling in the State concerned and to a minimum of 2 hectares. Other measures proposed are cash grants, training facilities, employment opportunities, etc. Landless persons would be rehabilitated in agricultural or non agricultural sector, as the case may be and would be entitled to a stable means of livelihood in accordance with the objective set forth.

2.3 Sedimentation

2.3.1 Sediment flow in rivers is a natural process and water resources development projects do not contribute to increase in the sediment inflow in the rivers. Provision is kept in all reservoirs in the form of dead storage for trapping of sediments. It is a fact that in some of the projects constructed earlier the rate of inflow of

sediments has been observed to be more than the anticipated values. This may be due to the empirical relationships used for assessment of the silt load in the absence of adequate observed silt data. Now, with the advent of modern technology and equipment, rate of siltation can be estimated more accurately. Further, remedial steps to reduce the sediment flow in rivers such as soil conservation and watershed treatment have been taken up in a number of catchment areas of various projects.

2.3.2 During the third five year plan (1961-1966), soil conservation programme was initiated in 13 multipurpose river valley projects which during the successive plan period has been extended to more catchments. Presently, the work is going on in 35 catchments in 17 States besides DVC. After the floods of 1978 and 1979, a centrally sponsored scheme of Integrated Watershed Management was taken up in the Ganga basin. The scheme covered 240 watersheds in 8 catchments in the Indo Gangetic plain spread over 7 states and Union Territory of Delhi. It is reported that the soil conservation programmes undertaken in Kankedigedda, Pathalagedda and Onderuvagu watersheds in the catchment of Machkund Project have shown declining trends in soil erosion. Many soil conservation measures such as trenching, contour bunding, planting Vetiver grass are proving extremely beneficial and cost effective. Government of India formed a Reservoir Sedimentation Committee in February 1978 to make indepth study of sedimentation process, sedimentation transport and deposition mechanics, sedimentation sources and yields and to review the actual reservoir sedimentation situation and formulated recommendations for future sedimentation policies. The recommendations and observations of the Committee included the following.

i) There is a need for scientific and technical evaluation of soil conservation programmes which should be carried out by project authorities in consultation with agricultural universities and other academic institutes such as the Indian Institute of Technology.

ii) Comprehensive watershed management programmes provide multiple benefits at micro level resulting from small centres of intensive activity, generate larger income for the local people, greater employment opportunities and a more stable ecology. Therefore, it is recommended that soil conservation programmes should be interwoven with comprehensive watershed management plans.

2.4 Waterlogging

2.4.1 A notion prevails in some quarters that with each hectare of new area brought under irrigation through surface water resources projects there is a loss of equivalent area due to waterlogging. Apprehensions have often been expressed that canal irrigation leads to severe waterlogging and soil salinity in the command areas of large number of projects. Waterlogging results from the excess moisture due to frequent flooding of the irrigated land, overflow of runoff, seepage from canal, over irrigation, artesian water and impeded subsurface drainage condition. Under these conditions, the pores in the soil in the roots of the plants get saturated with water. As a consequence, osmotic pressure in the root system does not function properly affecting the growth and yield of the crops. Number of statistics are paraded in respect of waterlogging which are of questionable magnitude and relevance. Quite often the statistics that are cited are for the entire land area suffering from waterlogging and salinity without any separation of the area affected due to canal irrigation and due to other causes. In flat areas receiving high rainfall, lot of land is waterlogged. The problem in this area is further aggravated by the construction of roads and railways with poor provision for cross drainage.

2.4.2 Waterlogging is not something new to the Indian water resources planners. This was faced in some of the older projects like the Western Yamuna Canal and the Eastern Yamuna Canal. Western Yamuna Canal which was constructed in the 14th century faced waterlogging problem as no checks were imposed on irrigation and due to faulty design of the canal. This canal was remodelled in 1873 and the alignment was improved and drainage works introduced. These measures resulted in significant improvements and reclaiming of land. The canal remains in service even today. Number of acts were also enacted in the past for providing drainage and anti-waterlogging measures, for example, the Bombay Canal Act, 1879-80 was the principal legislation governing Irrigation in the then presidency of Bombay and Bengal Drainage Act, 1880 and Bengal Embankment Act, 1882 in the Eastern India.

2.4.3 It is true that in the recent years, some of the projects faced waterlogging conditions but the area of land waterlogged is generally small as compared to the irrigated area. The percentage of waterlogged land has been found to vary from 1.5% to 10% of the benefitted area in the various projects as is evident from the Table 2.

Table 2 Waterlogged areas in some projects

Name of Project	C.C.A. (ha)	Waterlogged area % C.C.A.
Nagarjuna Sagar	843596	6.70
Sri Rama Sagar	331033	6.04
Ghataprabha	317500	1.11
Ghod	24600	1.14
Krishna Canal	70000	4.70
Mula	96700	5.78
Sirhind Canal	1507504	4.35

2.4.4 In the Malaprabha project in Karnataka, waterlogging and soil salinity affected about 2460 ha out of a total irrigation potential of 121858 ha. The problem was caused during the initial stages of development of the command area. Water was supplied as and when demanded by irrigators and the cropping pattern was decided by individual farmers irrespective of the soil or the type of crop grown. The warabandi system was not introduced and field channels were not properly maintained. Steps have since been taken to reclaim the water-logged areas in three stages, namely (i) deepening the existing open drains and providing additional drains (ii) providing subsurface drainage by installing perforated pipes with open joints at 60 m spacing, and (iii) providing secondary subsurface drainage with drainage pipes at closer intervals. The waterlogged area in Ukai command, in Gujarat, before and after taking the remedial measures such as widening and regrading the drains is shown in figures 8 & 9 respectively. In Ghataprabha and Bhadra projects in Karnataka areas of the order of 2000 and 4300 ha out of a total command area of 148930 and 124000 ha respectively became waterlogged for the same reasons. A beginning has been made on similar remedial measures, and these have given encouraging results.

2.4.5 A number of surveys and studies carried out by the Govt. of Uttar Pradesh indicated that about 18000 ha of land had been rendered unfit for rabi irrigation in the entire command area of the Sarda Sahayak Project. Most of the land was, however, usable for rice cultivation. A major drive was launched, and new drains were built. Post drainage surveys conducted in 1985 indicated that only 6000 ha were now unfit for rabi cultivation-just 0.3% of the entire command area. The loss of annual benefits in monetary terms due to waterlogging has been estimated at Rs. 26.5 million against total benefits of Rs. 3070 million derived annually from the irrigated areas.

2.4.6 The introduction of canal irrigation has led to rise in the water table in both Haryana and Punjab states. At some places it has come within 1.5 to 2 m of ground level. About 286000 ha in Punjab and 180000 ha in Haryana have been identified as waterlogged areas which is 7% and 5% of the net sown area of the states concerned. These areas are being reclaimed through the lining of canals and water courses, vertical drainage through state and private tubewells and implementation of surface drainage works. Over a million shallow tubewells in Punjab and Haryana together have performed to task of vertical drainage in a very remarkable way. In fact, the extraction of water by such tubewells appears to be the appropiate technology in these two states for the reclamation of waterlogged areas and prevention of waterlogging. Various reasons adduced for the waterlogging in these states are:

i) seepage from unlined canals and from damaged portions of lined canal beds,
ii) blockage of natural drainage due to construction of a vast network of roads,
iii) poor working of the existing surface drainage system,
iv) very little utilisation of groundwater for irrigation,
v) internal flow of subsurface water from northeast to southwest and
vi) injudicious water management.

2.4.7. A number of short and long term measures have been proposed and are now being taken to reduce waterlogging. The average cost of reclamation of waterlogged areas works out to Rs. 3300/ha for projects in Karnataka, while for Haryana the cost of providing vertical and horzontal drainage systems has been Rs. 11000/ha and Rs. 12000/ha respectively.

2.5 Submergence of Mineral deposits and Archaeological Monuments/Shrines

2.5.1 At times mineral deposits, archaeological monuments or shrines are threatened by submergence due

Figure 8 Waterlogged area in Ukai Command

Figure 9 Remedial measures to reduce waterlogging

to reservoirs. It is possible to protect the mineral wealth and monuments falling in the shoreline zones by constructing ring bunds, etc. or even by exploiting the resources to the possible extent before inundation. Koteshwar lime stone deposits likely to be submerged to some extent by the Bansagar lake (Madhya Pradesh) are being fully protected by providing a protection bund around the quarries at a cost of about Rs. 180 million.

2.5.2 The Dargah at Goliakot was protected from submergence by a ring bund when the Kadana dam was constructed. The famous Nagarjunakonda valley, the seat of Ikshvakula Kings and the fountain head of Mahayana system of Buddhism consisting of valuable stupas, monasteries, inscribed pillars, sculptured slabs and other antiquities were excavated and shifted to a museum on the top of a nearby hill before impoundment.

2.6 Aquatic Life

2.6.1 One of the criticism levelled against the water resources projects is that dams pose barriers across the rivers to affect the migration of fish specie like salmon and trout. The provision of fish ladders, fish bye pass channels, artificial propogation facilities, etc. have successfully taken care of these problems at number of project sites. The reduction in the river fisheries can be compensated by rearing fish in the reservoirs. Many new species have taken firm hold in the newly created environment. The striking examples in this regard are fast growing gangetic carp in the reservoirs of Krishna and Cauvery in the peninsular India and in the Gobind Sagar in north west Himalayan region. Ukai project can be cited as an instance of improvement of fish production where no commercial fisheries existed in the river before impoundment. Now two fish farms with breeding, hatching and spawning units artificially controlled climatic and physio-chemical conditions have been established with encouraging results. At Mahi-Kadana project in Gujarat, the fish catch increased from 145 tonnes in 1983-84 to 250 tonnes in 1984-85. The tribal population affected by the dam started earning about Rs. 1000/- for 10 months on an average and this has become a source of additional income for about 700 families over and above their agricultural income. In Kerala State presently only 23% of the reservoir area of around 30000 hectares is available for scientific fish culture. The productivity in this area has now increased to about 30 to 50 kgs per hectare per year despite certain losses due to drought, etc. Studies have revealed that productivity in reservoirs in various states of India varies from 1 kg per hectare per year to 116 kgs per hectare per year. Such developments in fisheries are being implemented in other project areas also.

2.7 Submergence of Flora and Fauna

2.7.1 High head water resources projects are mostly located in high mountaineous regions and as such submergence of forest areas become inevitable. Construction of these projects result in flooding of forests, destruction of plant life, displacement of wild life and loss of breeding grounds. The growths can get destroyed not only in the storage areas but also due to the provision of roads and residential colonies necessary for the construction. There is now a conscious and concerted effort to reduce cutting of tree growth for roads and building necessary for project by providing the construction colonies and project facilities in the areas to be submerged later. Project sites endangering rare species of plants or animals have been abandoned to preserve the natural heritage, for example, Silent Valley Project was shelved as it was to affect the prime virgin forest and some of the rare species of animals and birds.

2.7.2 In the last three decades, 0.52 mha of forest land has been submerged by the construction of the reservoirs. This is only 12% of the total forest land lost in this period. On the other hand, there is a considerable tree growth that get supported along the reservoir shore line and canal embankments improving the vegetal cover in the project areas (figure 10 & 11) and compensatory forestry is an essential feature of all the new proposed projects. The Department of Environment of the Government of India has issued detailed guidelines for the diversion of forest land for non-forest uses. Some of the salient features of these guiedlines are as follows.

i) Comprehensive afforestation is one of the most important conditions stipulated for providing proposals for diversion of forest land to non-forest uses. Steps proposed to compensate for the loss of forest area, therefore, have to be specified.

ii) The norms laid down for compensatory afforestation are that (a) where non-forest land is available, compensatory afforestation should be undertaken over the equivalent area of non-forest land; (b) where non-forest land is not available, compensatory plantation should be undertaken in degraded forests over twice the extent of the area being diverted.

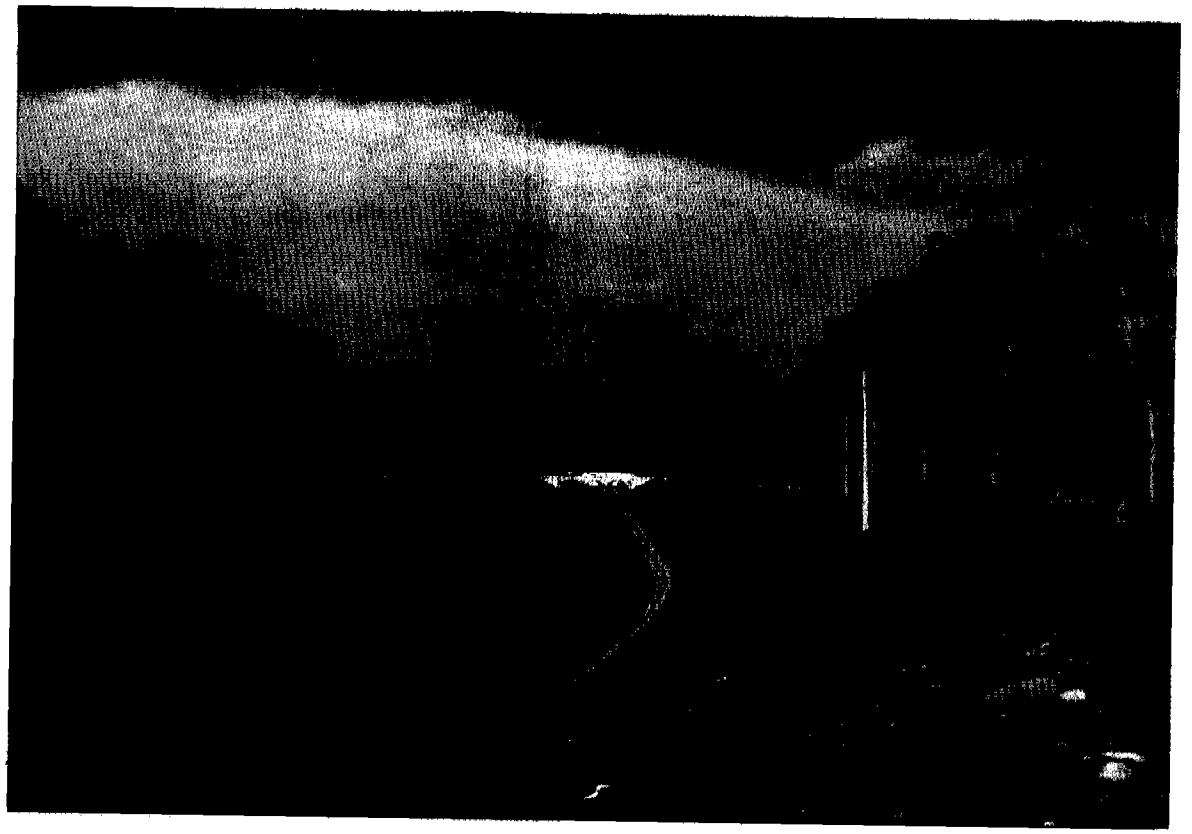


Figure 10 Power Channel of Yamuna Project

Figure 11 Power Channel of Yamuna Project

iii) Stipulation has been made for identifying the equivalent non-forest area or degraded forest land, the agency responsible for afforestation, the provision of funds, the monitoring mechanism, and the preparation of a detailed work schedule.

iv) Lands identified for compensatory afforestation are to be transferred to Forest Department.

2.7.3 The impoundment may also submerge wild life habitats and sanctuaries. This can be taken care of by relocating the sanctuaries at suitable places and by carrying out wild life rescue operations as was done at Dudhganga Reservoir (Maharashtra). The positive aspect of water resources development is the assured water supply for the wild life in all the seasons. After construction of Heran reservoir in Gujarat, population of wild life has shown a trend of increase and crocodiles which were on verge of extinction are now abundant in the reservoir, Periyar wildlife Sanctuary on fringes of Idukki lake, Sloth Bear Sanctuary proposed at Sardar Sarovar Project are some of the examples of steps to protect the wildlife. Pong reservoir is now acting as a resting place for migratory birds and number of rare species of birds have now been sited in these areas.

2.8 Health Impacts

2.8.1 Building of water bodies ensure perennial supply of water in the command area and the nearby towns thereby changing the life style of the people and also there is a marked improvement in the health of the people. The socio-economic surveys conducted for Rajasthan Canal Project and Mahi-Kadana Project reveal a general improvement in the health of the people.

2.8.2 Reservoirs generally have large water spread areas with shallow weed infesting shore lines, thus providing breeding grounds for disease carrying mosquitoes and snails. In order to mitigate the spread of water borne disases in waterlogged areas steps like spraying of DDT, nursing of predatary fish species, etc. are taken. Provision is kept in the project proposals for taking mitigative measures against the adverse health impacts. The Indian Standards published in 1967-68 for the preparation of River Valley Projects has laid down that the provisions for anti-malarial measures should be a part of the project estimates. Some of the diseases such as schistosomiasis which are attributed to the creation of large waterbodies and their network (e.g. Aswan Dam, Egypt) are fortunately not prevalent in our country as reported by National Institute of Communicable Diseases.

2.9 Water Quality

2.9.1 The riverine system plays an important role in transport of waste water, whether domestic or industrial, to sea. The enormous rate of population growth coupled with the rapid industrialisation and urbanisation and the need to be self sufficient in food grain production has exerted an unending pressure both on water requirement and waste water disposal. For all such activities, there exists an increasing awareness to utilise water of acceptable quality. The effluents resulting from municipal, industrial and agricultural use in recent years have alarmingly threatened the fresh water sources especially rivers which are the final repository or sinks in a basin. The rivers receive effluents both as a point source (either from a drain, industry, or municipal sewer) or as a non point source from the surface/sub surface runoff from agricultural fields. The nature of impact of waste water on the river water quality depends upon its characteristics and pattern of travel. The quality is usually determined by measuring the values of its physical, chemical and bacteriological characteristics or "Water Quality Parameters". The number of such parameters necessary to specify the water quality is so large that it may be infeasible/unrealistic to monitor all of them frequently. Even several trace elements including some dangerous heavy metals like lead, cadmium, mercury, arsenic, zinc and iron besides residues of pesticide and fertilizers washed from fields are found in the rivers.

2.9.2 Today water pollution is a problem to be reckoned with in many parts of the country. It is increasing by leaps and bounds with the effluents getting discharged directly into the river without any treatment. The pollution depends on the nature of the effluents and the condition of the river, river hydraulics and hydrologic characteristics, climatic conditions etc. It is necessary to monitor the quality of surface water before any suitable measures for controlling or abatement of pollution is contemplated. Realising its importance, CWC initiated monitoring of water quality parameters in 1960 through its network of gauge and discharge sites (at 270 locations). Water quality samples are analysed for few basic parameters such as pH, conductivity, total dissolved solids at the site and other parameters are tested in the 18 water quality research laboratories spread over the country which are equipped with required instruments and trained personnel to carry out such activities as per the Indian and International standards.

2.9.3 Initially water samples were analysed for 24 parameters on routine basis for the limited purpose of assessment of suitability of water for irrigation and industrial use. In 1978, under a special scheme, additional 22 parameters were monitored at 42 stations in the Ganga basin. The special study was completed in 1985 and the status report titled "Water Quality Study-Ganga System" was brought out, although monitoring work is continuing.

2.9.4 The pollution of water is not confined to surface water, but even ground water gets affected. The Central Ground Water Board (CGWB) regularly monitors the quality and quantity of ground water. Recently, the studies made by CGWB for Upper Yamuna basin indicated high concentration of nitrate in ground water in rural parts of Union Territory of Delhi (localised problem) probably due to indiscriminate use of fertilizers. Such high concentration of constituents present in water which have deletrious effect on irrigation can be utilised by proper land and water management practices.

2.9.5 In 1973, the Central Board for Prevention and Control of Water Pollution (CBP & CWP) was set up to promote basin wise pollution control strategies. CBP & CWP collects the information from various districts and collates it for the basin with the assistance of State Pollution Control Boards. Besides collection of information, CBP & CWP lays down standards for treatment of sewage and effluents and is responsible for suitable legal actions in case of non-compliance of standards. Recently, considering the lacuna in some of the existing Acts relating to pollution control, Govt. of India enacted the "Environmental Protection Act, 1986" which enpowers the Central Government or any authorised agency/authority constituted under the Act to take all measures deemed necessary including prosecution for the protection and improvement of quality of environment (this includes water, air, land and the inter-relationship between them and human beings, other living creatures, plants, micro-organisms, etc), prevention control and abatement of environmental pollution.

2.10 Impact on Climate

2.10.1 Water resources projects create a vast water mass changing the environmental conditions. A broad ribbon of water created due to the Indira Gandhi Nahar has transformed large tracts of desert in Rajasthan into a beautiful landscape. This area has now turned into a prosperous agricultural area with men and machines busy round the clock and has improved the quality of life. Fields of groundnut, cotton, millet, fodder crops and vegetables stretch for kilometres around. Investigation has shown that there is an increase in the moisture content of the surrounding areas leading to increase in humidity. The maximum temperature gets lowered for the simple reason that hotter the air, the greater is the evaporation from irrigated lands. In India, the major portion of the country has arid or semi-arid climate and under such conditions a drop in temperature and increase in humidity has favourable effect. Studies conducted at Beas Project by Himachal Pradesh Krishi Vishwa Vidhyalaya, Palampur in 1987 found that the variation between the maximum and minimum temperatures have reduced and maximum temperature became lower during the summer months and increased in the winter months.

2.11 Reservoir Induced Seismicity

2.11.1 It is often claimed that the impoundment of water in a large reservoir triggers earthquakes with their epicentres below or near reservoir. Koyna dam in Maharashtra is very often cited in this connection but there is no conclusive evidence about the correctness. The mighty reservoir like Bhakra and Ramganga, although located in earthquake prone areas did not influence seismicity since their impoundment. A study of 425 large dams in the world has shown that in case of 15 reservoirs only, the seismic forces were observed to have gone up after construction of reservoirs. In 10 of these 15 cases, the magnitude of earthquakes was less than 5 on Richter scale. There is thus a need for more data collection in this respect before conclusions can be drawn. In India, this is being done by IMD, CWPRS at Pune and School of Earthquake Engineering, Roorkee, who continuously monitor the seismic status of the area around some reservoirs.

2.12 Environmental Impacts during construction

2.12.1 The environmental impacts during construction of a dam are mostly direct and of short duration. The likely impacts are deterioration of water quality in downstream areas, increase in noise levels, reduction in forest cover due to encroachments by construction labour, for fuel wood and temporary construction requirements, spread of diseases among the large labour force with different strains of diseases attracted towards the construction site. Further, large areas are inundated due to excavation of foundations, diversion of water either through tunnels or diversion canals, landscape alterations due to excavation from borrow pit areas, deforestation and hill slope destabilisation on account of construction of approach roads, etc. Study

carried out to find the water quality effects of large scale construction and stream channelisation showed that specific conductivity, turbidity, colour, COD, total alkalinity, hardness, ammonia, phosphorus, sulphate, iron, lead, manganese increased by about 5 to 100%. Cases of accidental deaths due to destabilisation of hill slopes are not uncommon.

2.12.2 At Ramganga Dam in Kalagarh distt. in UP, a 'probably incomplete' list compiled by local newspaper cited 88 deaths and 501 injuries during construction. At Kanjhari medium irrigation project in Orissa, nine persons were killed in 1932, when a large mound of earth caved in. The impact on wildlife during construction could be due to increase in noise levels, encroachment on the wildlife habitats by construction labourers for colonies, borrow pit area requirements, poaching etc. At Ramganga dam site it has been reported by a study that there was a steep fall in birth rate of cheetal deer from 22.1 to 4.1 in three years time. This may indicate the stress conditions felt by wildlife.

2.12.3 Some of the aspects which need to be taken care of during construction are:

i) Construction activity may be restricted within the established limits of work without encroachments on nearby forests by the project authorities or labour force. This can be ensured by providing the labour force various forest produces and fuel wood at concessional rates by the project authorities by harvesting them from the area likely to come under submergence. Similarly, the temporary colonies for the project workers may be set up so as to save forests from denudation.

ii) equipments and machineries to be used should meet the environmental requirements such as spark arrestor system, air pollution control devices, etc.

iii) top soil may be stored separately from other excavated material in a manner to resist erosion and to be used subsequently.

iv) protection from erosion/downstream sedimentation through utilisation of appropriate control measures.

v) sound levels may be kept within specified limits. Blasting operations should not coincide with nesting period of birds as their reproductive success would be affected.

vi) effective dust control measure may be practised.

vii) distinct archaeological sites preserved and in case of any new finds of archaeological importance, the work may be stopped and archaeologists associated with further work.

viii) new equipment operators be trained on environmental requirements in conjunction with their safety briefings.

3.0 PLANNING POLICIES

3.1 Experiences across the world indicate that many of the problems of reconciling development and environment result from failure to consider them simultaneously and from adopting a compartmentalised approach to planning rather than a multidisciplinary and integrated approach. India's National Water Policy (NWP) adopted recently (Ministry of Water Resources, 1987) has once again emphaised the need for an integrated and multidisciplinary approach to the planning and implementation of projects, including catchment treatment and management, environmental and ecological aspects, rehabilitation of project affected people and command area development. The policy further stresses that common approaches and guidelines are necessary for issues such as environmental protection, resettlement of affected people and livestock, the public health consequences of water impoundment, dam safety, etc. in the planning and implementation of irrigation and/or multipurpose projects and in the study of their impacts. In the planning, implementation and operation of projects, the preservation of the quality of the environment and the ecological balance should be a primary consideration; the adverse impacts, if any, on the environment should be minimised and should offset by adequate compensatory measures.

4.0 CONCLUSIONS

4.1 In India, the most pressing demand now, is to provide basic amenities within the easy reach of people. Provision of inexpensive basic human needs should be a priority task for the policy makers and the officials responsible for implementing the policies, keeping in view the welfare of society.

4.2 The country is to contend with growing population and increasing demands of the people. In India, the situation is nearly same as in the most of the developing countries. To combat these problems we need

appropriate and affordable technology. It is also necessary to protect our environment from pollution and eco-degradation. Conserving our natural resources for sustainable development is an important aspect of environmental planning.

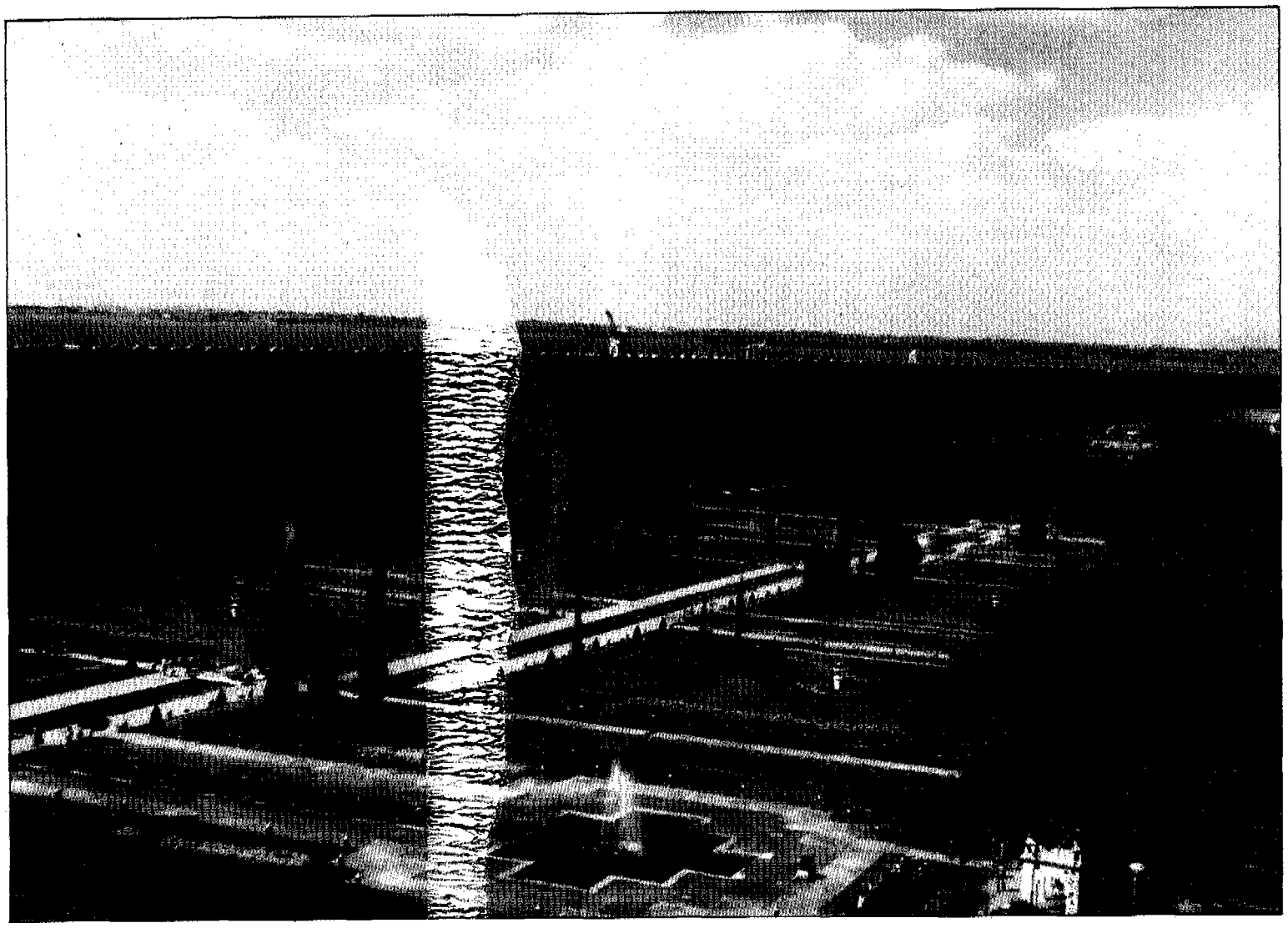
4.3 The development is not the cause of most of the environmental problems, but the cure. As was rightly said by late Prime Minister of India, Mrs. Indira Gandhi, at the Stockholm Conference, 1972, that the "Poverty is the greatest Pollutor". Developing countries cannot, therefore, but look upon planned development as an instrument to improve the quality of life particularly of weaker sections of the society.

4.4 The developing countries should plan their developmental projects in such a manner so as to minimise environmental degradation. Environmental issues must form an integral part of project planning of which conservation and protection of environment and eco-system should form the basic principles. While it is imperative to have water resources projects for raising the agricultural production and power for industrialisation, protecting the flood prone areas and in general for improving the quality of the life of the people, it is also necessary to incorporate environmental issues as an integral part of the planning and implementation process of these projects.

4.5 Environmental Impact Assesment (EIA) for evaluating the beneficial and adverse effects of developmental projects/activities and environmental systems including socio-economic/cultural and aesthetic concerns must be integrated into the water resources projects at the planning stage itself to ensure developmental activities in an environmentally acceptable manner.

References

1. Central Board of Irrigation and Power (1951), 'Irrigation in India through the Ages.'
2. Chitale, M.A. (1988), 'Environmental Management in Water Resources Projects—Indian Experiences of Irrigation and Power Project', Water Resources Development, Volume 4, Number 2.
3. Sarma, N.K. (1986), 'Large Dams—A necessary Development Choice', Bhagirath, Vol. XXXIII.
4. Pendse, Y.D. (1988), 'Reservoirs and the Environment—Experiences in Management and Monitoring', 16th ICOLD Congress, San Francisco, USA.
5. Ministry of Water Resources (1987), 'National Water Policy', Government of India, New Delhi.
6. Water and Power Consultancy Services (1987). Proceedings of the Regional Seminars on Water Resources Development—Environmental Issues and Solutions.
7. Workshop on Assessment of Environmental Impacts, their Integration for Planning Water Resources Development Projects and Water Quality Modelling (1986), Lecture Notes—Systems Engineering Unit, Central Water Commission, New Delhi.



Vrindavan Gardens

Quotes from NATIONAL WATER POLICY (1987)

★ Even the planning and implementation of individual irrigation or multipurpose projects, though done at the State level, involve a number of aspects and issues such as environmental protection, rehabilitation of project affected people and livestock, public health consequences of water impoundment, dam safety, etc. On these matters common approaches and guidelines are necessary.

★ In the planning, implementation and operation of projects, the preservation of the quality of environment and the ecological balance should be a primary consideration. The adverse impact, if any, on the environment should be minimised and should be off-set by adequate compensatory measures.

★ There should be an integrated and multi-disciplinary approach to the planning, formulation, clearance and implementation of projects, including catchment treatment and management, environmental and ecological aspects, the rehabilitation of affected people and command area development.

★ In view of the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds, and considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency.