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POSITIVE IMPACTS OF WATER RESOURCES ON ENVIRONMENT PROJECTS

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1988-89

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ABSTRACT

In recent years the effects of water resources projects on environment is being propagated in a negative sense in news media, papers etc., which is affecting the water resources development. However, the fact is that the water resources projects are necessary for economic survival of a country. There have been seminars, conferences, on these issues in past which have delebrated in-depth the issues on environmental effects of water resources projects. However, the positive effects of water resources projects on environment have not been published in a desired manner. With this in view and also recommended during past conferences, the Institute has taken up a study to compile the positive impacts of water resources projects on environment.

The study includes extensive collection of data and literature describing impacts of water resources projects on environment. A few completed projects have been choosen for study. An attempt was earlier made to review the various hydroenvironmental indices and a report was prepared. In present study, few completed projects have been taken and their positive impacts have been highlighted.

1.0 INTRODUCTION

Water is the precious gift of nature to humanity. The development of a nation is closely connected with the development of its water resources. However, in view of the wide variation in availability of water there is a need for conservation of water in order to exploit and manage the water resources potential. The planning and development of water resources projects play an important role in providing the storages required for ensuring supplies to a certain degree of reliability to meet the various water demands like domestic, industrial and irrigation etc

Basically there are two schools of thought in so far as the environment and development is concerned.

One school holds that ecological systems are fragile and highly unstable. Environmental modifications, beyond rather narrow limits could destroy natural stability which results from a diversity achieved through aeons of natural evolution. When stability in disturbed, dire consequences may result.

The second school of thought assumes that the environment is globally stable and that there is a large element of built in resilience in ecological systems. Accordingly to this view these systems can accommodate large scale disturbances and can recover to a new stable condition, once the disturbances are removed. This view of a Benign Nature sanctions large scale modifications of the natural environement.

The developing countries may go by the second school of thought. The poverty-stricken developing countries have no interest in constancy as the status quo will neither serve well to meet the hopes and aspirations of majority of their people nor will cater to their basic needs.

In view of the foregoing, any environmental programme will have to be based on the implicit "development is necessary" policy. It's goal should not be conservation or protection of the natural environment per-se, but for the conservation of productivity of primary natural resources to ensure that productivity of these resources is not deteriorated through development activities. The philosopy of development is to cement environmental dimensions into development projects to ensure possible socio-economic benefits optimum with the maintenance of environmental quality consistant with the development needs.

Because of the uneven distribution of rainfall in space and time, water resources development e.g. building of dams, reservoirs etc. are essential for economic growth of India.

The impact of water resources projects on the environment are quite diverse. The diversity may be due to varieties of resources and associated transformation of these resources. The impacts are experienced in the political, social, and economic environment. Economic impacts may include changes in economic structure and flows due to intervention of various developmental resources. Social impacts may be assessed by the changes in the levels of health, education, employment, community cohesion and the like. Political impacts also may be assessed by the changes in the levels of public access to the political decision makers and opportunities for citizen participation etc.

The river basin development leads to number of changes in the eco-system during the construction as well as in the operating stages. Sometimes impacts may be of a low magnitude and locally confined. In the case of large scale interventions like inter-basin transfers, the impact will have a large spread over time and space.

Water has many uses such as household, municipal, industrial, recreational, agricultural and navigational etc. As water has multiple uses and the activities related to such uses have influences in the socio economic structure, any intervention in the use pattern or uses configuration will spread ripples every where. Thus in the case of multipurpose water resources development projects (large or small), short term as well as long term changes take place in the environment, both during construction and operation stages. These changes include changes both in the physical as well as socio economic environment.

2.0 TYPES OF WATER RESOURCES DEVELOPMENT PROJECTS

Generally water resources projects are classified based on their intended functions and purpose (Table 2.1). However, for assessing the environmental impacts of the projects these may be classified as per the physical nature of the projects. Basically, there are five broad categories of water projects (Haber, 1979; UNESCO, 1984) as given below :

i) Impoundment of water
   a) reservoirs
   b) artificial control of lake outflows

ii) Channelization
   a) irrigation canals
   b) navigation canals
   c) drainage works
   d) dyking for flood protection
   e) erosion control measures

iii) Diversion of water
   a) between natural basins
   b) for consumptive use in house and industry

iv) Waste dilution and assimilation

v) Ground water extraction and recharge

The vegetation management for increased water yields is a category of water resources projects of recent origin and is still under experimental stage. The basic principle on which such a project is designed is that of manipulating the vegetation in upland watersheds. The yield of water for downstream users can be increased and this increase in yield is attributed to variation in evapotranspiration losses associated with manipulation of vegetation or change in landuse.

Table 2.1 : Purpose and Type of Water Resources Projects

Sl. No.	Purpose	Description	Type of works
1.	Flood control	Flood-damage prevention or reduction, Protection of economic development, conservation storage, river regulation, recharging of groundwater, water supply, development of power, protection of life	Dams, storage reservoirs, levees, floodwalls, channel improvements, floodways
2.	Irrigation	Agricultural production	Dams, reservoirs, wells, canals, weed-control and desilting works, drainage facilities
3.	Hydroelectric	Provision of power for economic development and improved living standards	Dams, reservoirs
4.	Navigation	Transportation of goods and passengers	Dams, reservoirs, canals, locks, open-channel improvements harbor improvements
5.	Domestic and industrial water supply	Provision of water for domestic, industrial commercial, municipal, and other uses	Dams reservoirs, wells, conduits, saline-water conversion
6.	Watershed management	Conservation and improvement of the soil, sediment abatement, runoff retardation, forests and grassland improvement, and protection of water supply	Soil-conservation practices, forest and range management practices, headwater-control structures, small reservoirs, and farm ponds
7.	Recreational use of water	Increased well-being and health of the people	Reservoirs, facilities for recreational use, works for pollution control

Contd....

Sl. No.	Purpose	Description	Type of works
8.	Fish and wildlife	Improvement of habitat for fish and wildlife, reduction or prevention of fish or wildlife losses associated with man's works, enhancement of sports opportunities, provision for expansion of commercial fishing.	Wildlife refuges, fish hatcheries, fish ladders and screens, reservoirs storage, regulation of stream-flows, stocking of streams and reservoirs with fish, pollution control.
9.	Pollution abatement	Protection or improvement of water supplies for municipal, domestic, industrial, and agricultural use and for aquatic life and recreation	Treatment facilities, reservoir storage for augmenting low flows, sewage-collection systems
10.	Insect control	Public health, protection of recreational values, protection of forests and crops	Drainage and extermination measures
11.	Drainage	Agricultural production, urban development and protection of public health	Ditches, tile drains levees
12.	Sediment control	Reduction or control of silt load in streams and protection of reservoirs	Soil conservation, sound forest practices, desilting works, channel and revetment works, bank stabilization, special dam construction and reservoir operations
13.	Salinity control	Abatement or prevention of salt-water contamination of agricultural, industrial and municipal water supplies	Reservoirs for augmenting low streamflow, barriers, groundwater recharge, coastal jetties.

As the evaporation/evapotranspiration process accounts for significant portion of the annual precipitation input on most watershed, the potential for increasing the water yield by vegetation manipulation becomes quite attractive.

The categories from (i) through (v) of water resources projects mentioned above can be implemented by various type of engineering works i.e. dams, channelization or river training, levees, canals, wells etc. The function of these works is described below:

2.1 Dams and reservoirs

Dams are major(on-channel) structures to create artificial lakes or reservoirs. The purpose served by these reservoirs may be divided into two broad categories(a) flood control, and (b) conservation.

The aim of flood control is to hold over some of the flood waters of a river when the discharge rate reaches a stage likely to cause damage in the downstream area and to release them gradually at a safe rate when the flood recedes.

Conservation storage is meant to conserve or save the surplus water brought down by a river during the periods when the supply exceeds the current demand, for utilization later on during periods when demand out strips the natural flow of the river. Conservation of water may be required for any one or more of the following purposes irrigation, navigation, water supply to towns or industries, recreation etc.

2.2 Channelization/river training

It is the modification by deepening and straightening of streams to help control the velocity of runoff, improve navigation and reduce flooding. The results of channelization are sometimes harmful to fish (due to increase in turbidity etc.) and wild life although the creation of

cutoff meanders, oxbow lakes may result in some improved fish and wild life habitat.

As far as flood is concerned, channelization increases the capacity of water ways to carry high stream flow before flood develops.

2.3 Levees /dykes

To keep streams within their banks during periods of high flow, the most accepted technique is to construct artificial levees or dykes. The main use of such structures is to control the over flow of water on both the banks of the river.

2.4 Canals

Canal is an artificial trench excavated in natural material along a designed alignment so that water can be conveyed through it.

A canal is frequently used to convey water for irrigation. In addition to transporting irrigation water, a canal may also be utilized to meet the demands for municipal, industrial and outdoor recreational navigational uses.

2.5 Wells

Wells are drilled to tap ground water resources lying in the subsurface reservoir i.e. the aquifer. These structures are used for lifting water through pumps or otherwise to irrigate the farmland or for water supply for domestic or industrial purposes.

There are some other water resources structures like barages, weirs, culverts etc., which are used to modify the flow characteristics of natural streams for better use.

Nowadays, to meet the diverse demands of water, most of the water resources projects are designed multipurpose i.e. for power generation, municipal water supply, irrigation, navigation, flood control etc.

The proper planning implementation and operation of these water resources projects will be the key to the development of the nation.

3.0 POSITIVE IMPACTS OF WATER RESOURCES PROJECTS

Water is the most essential and critical input for the survival and growth of mankind. Water resources development projects represent an integral part of the entire complex of development aimed at the remaking of nature useful for man. Water resources development projects are essential for industrial and economic growth of a nation.

Water projects are designed to be multipurpose i.e. allowing to meet the needs of all water uses and consumers. Various environmental impacts may result with the construction and operation of water resources projects. These impacts may be either large or small, beneficial or adverse. Benefits from water resources development projects may be direct as well as indirect. The main direct benefits of the water resources development projects are irrigation, power and partial flood protection. Irrigation greatly accelerates the agricultural development. These projects also provide water supply to towns and villages and industrial complexes through the reservoir, river, canals and by augmentation of ground water. While the direct benefits can easily be quantified and evaluated, it is rather difficult to do so in respect of indirect benefits. The indirect or secondary benefits like employment generation, growth of ancillary industries, improvement in socio economic conditions of farmers, improved communications, better marketing and health services etc. are difficult to quantify. The main benefits of the various components of multipurpose WRP are shown in the Table 3.1. some of the benefits from the water resources development projects are discussed here.

3.1 Irrigation and agriculture

Irrigation plays a crucial role in promoting agricultural development. Since the early 60's the total irrigated area in the Asian and Pacific region has increased by 36.7% from 94.1 million ha. to 128.6

Table 3.1. Positive Impacts of Multipurpose Water Resources Projects

Sr.No.	Component	Positive Impacts
1.	Catchment area	Introduction of socio economic infrastructure, special attention by Govt.(Firms) - awareness at all levels, improved water tables in the 5-6 kms upstream of reservoir, increased vegetation, availability of drinking water, better water resources for the population and animals, creation of aesthetic beauty-tourist and picnic places, social interaction with the local population-specially backward people (like Adivasis) in remote forest areas, cultural changes, microclimate changes.
2.	Dam or reservoir	Increase in water availability, ground water, flood control, drought control, employment generation, animal fisheries development, tourism, recreational value, pisciculture regulation of water supply in dry seasons, favourable flora and fauna changes, favourable microclimatic change, change in water quality, reservoir bed cultivation communication and transport linkage.
3.	Canal conveyance area	Recharging of ground water, improvement in water quality and provision of drinking water facility, minor pisciculture development, change in flora and fauna, communication linkage-canal roads, attraction of migratory birds, employment generation, change in soil characteristics and soil fauna, aesthetic beauty, recreational facilities, micro-climatic changes, drainage control.
4.	Command area	Improvement of levels and quality of ground water, more water recharge in the river, more productivity, positive change in cropping pattern, expansion of cultivated areas, intensity of cropping more effective use of fertilisers, additional economic benefits for cultivators, use of improved technology, employment generation, agrobased industries, service industries, increase in commercial activities, favourable micro-climatic conditions, reduction of erosion (soil) due to irrigation management of farms, better conditions for vegetation growth and its pattern, better sanitation, drinking water, infrastructure development, fishery, poulty, dairy, increase in number of wells, flood control and reduction in river and bed erosion, stabilisation and riverbed.
5.	Downstream area	Changes in flora and fauna, improvement of hydrology, flood control, reduction of flood ravages and water logging, stability of river bed and reduction in erosion, availability of better water resources in river and ground, drinking water facilities, health improvement.

million ha. in 1983. The F.A.O. of the U.N. predict that upto the year 2000, irrigated areas in developing countries could expand at the rate of 1.7 % a year, three quarters of the expansion taking place in Asia.

Only a small fraction of the rich water resources of India, is being utilized at present. The net irrigation at the time of Independence was only 17 percent. Since Independence a high priority has been accorded to irrigation development. The growth of sown and irrigated areas and food grain production are shown in Table 3.2.

Table - 3.2

Year	Net area sown (million ha)	Irrigation potential (million ha)	% irrigated	Total foodgrain production (million tonnes)
1950-51	118.75	20.85	17.6	15.20
1955-56	129.16	22.76	17.6	66.85
1960-61	133.20	24.66	18.5	82.00
1967-68	139.70	27.52	19.7	95.95
1973-74	142.70	32.60	22.9	104.67
1977-78	149.90	40.00	26.7	126.40
1983-84	155.20	60.00	38.7	142.00

The irrigation potential created in 1986-87 was about 65 million ha. and the food grain production was above 150 m tonnes. Major and medium projects accounts for the creation of about 47% of the above irrigation potential, while minor projects accounts for the rest. Among the minor projects the predominent contribution, slightly above 70% is that of ground water.

India faced the worst drought of the country in 1987. , even then, the food grain production was about 145 million tonnes. This was possible only due to the irrigation potential developed by the water resources development projects.

The introduction of irrigation projects (Dams/Reservoirs) leads to significant ecological changes. There is no doubt that an irrigation project has favourable effect on the microclimate e.g. relative humidity is increased, evaporation rates are lowered, and in certain cases temperatures are also modified favourably in the vicinity of the project area.

3.2 Hydro Power :

Energy is required for all round development of a nation, whether it is in the field of agriculture, or industrial sector. Power can be generated by many means e.g. atomic power, thermal power and hydro power.

India is not richly endowed with petroleum and natural gas resources and energy programme requires special caution. So, thermal and hydro powers are going to be the main stay of our energy requirements.

The hydro-electric power has several unique advantages. It is renewable and clean, causing least disturbances to environment. It is the most economical source of energy - the cost of generation of hydro, thermal and atomic power being approximately in the ratio of 1:2:3. The hydro plant is much more reliable then thermal plants - the maintenance and the out of commission time being less than 5% in comparison to thermal units which are not operating for 40 to 50% of the time in our country. As it uses no fuel, it is also free from cost escalation in future.

India produces about 17,000 M.W. hydro power out of a total of about 48,000 M.W. in 1987 India has utilizable hydro potential of about 75,000 M.W.

3.3 Flood/drought control :

Flood represents a serious problem in many river basins

throughout the world, particularly in the areas affected by typhoons. Flood plains occupy upto 20% of the territory in several countries of the Asian and Pacific region. In the countries of this region, the cost of damage caused by floods was estimated at more than Rs. 700 billion in 1981 and has been steadily increasing in most of the countries affected by floods. In India, the annual average loss has increased from less than Rs.2.8 billion during the first half of the 1960's to Rs.14 billion for the second half of the 1970's. In 1986, floods caused total loss of about Rs.42 billion.

This increase in the loss is due to increase in population and development activities in the flood prone areas. The losses would have been much higher, if their would have been no WR projects.

Droughts cause economic losses on the other extreme i.e. due to low rainfall. India experienced the worst drought of the country in 1987. . Despite of the drought, total food grain production in the country was about 145 million tonnes, slightly less than that of 1986-87. This became possible only due to the water resources development projects. In 1987-88, Country had a loss of about Rs. 15 billion in the agriculture sector only.

To mitigate or reduce the effect of floods and droughts water resources development projects play an important role Excessive runoff during the monsoon period is stored in large dams/reservoirs constructed upstream. This water can be used later on. This way the threat to economy due to floods and droughts can be partially reduced and huge amount of national property can be saved.

3.4 Water supply/Industrial development

With the construction of water resources development projects,

domestic and municipal water, supply to the nearby cities/towns is enhanced and hence providing good health, convenience and luxury of living to its people.

The commissioning of water resources development projects also give new opportunities for the development of new industries in the area. The textile and agrobased industries and dairy development gets a new thrust.

3.5 Tourism/recreation

The impoundment of water in dams and reservoirs create large lakes which attract large number of tourists giving substantial boost to the economy of the area. Recreational facilities like boating, rowing and other water sports are also created.

3.6 Ground water recharge

The water impounded in the reservoirs and water flowing in canals etc., significantly contribute to the ground water. The recharge of ground water takes place both in the reservoir area as well as in the command area. The rise in water table upto a certain limit is beneficial for the agriculture as well for domestic and municipal purposes.

3.7 Economic, social and cultural improvement

The beneficial effects of dams and reservoir construction are mainly economic which in turn leads to social and cultural improvements.

The beneficial economic effects include marked improvement in production by irrigation, hydro power, water supply and flood control (Elliot 1973). The vicious circle created by scarcity in food, under nourishment, ill health, unemployment, further reducing productivity and development of society is broken. Improvements in food production and power lead not only to direct benefits but also in linkages and multiplier effects which improve commerce and transport and accelerate demand for

consumer goods (Bottamley, 1973).

The pumping of large amount of money in the project area activates generation of large employment potential for skilled, semi-skilled and unskilled man power during construction period has a considerable socio-economic impact. The infrastructural facilities created by the projects in the construction area and the additional resources provided in the form of water and energy in the zone of benefit, apart from having a direct impact of the economy also results in setting off a chain reaction on other connected developmental activities.

An improvement in economic life leads to social and cultural improvements, such as improvement in health and hygene, incentive for children's education, adoption of more scientific techniques in farming, and reduction of migration from villages to towns. Dam building also inculcates self reliance and added confidence as the human effort nature can be persuaded to provide its bounties to satisfy the pressing needs of the community.

Besides these benefits, some other benefits like fishery development, navigation, and better communication are also achieved by the development of water resources projects.

4.0 SOME INDIAN EXAMPLES OF WATER RESOURCES PROJECTS AND THEIR BENEFITS

India has vast water resources. If all the available water allowed for evaporation, transpiration and seepage losses could be stored and a regulated flow established ,the rivers would carry a discharge of the order of 2 million cuseces round the year. The rainfall for the whole country is about 42", but it is ill distributed, being about 3" at Jodhpur in Rajasthan and about 460" at Cherapunji in Assam. Further during the hot weather from March to May, the rainfall throughout the country is practically nil. Due to this state of affairs prevailing in this country, artificial means of balanced distribution of water supply through WR projects during the period of cultivation was found necessary to achieve an assured production of crops. This is the reason why India posses the largest area under irrigation in the whole world.

The programmes and schemes in the states vary widely because of the physiographic and climatic conditions. The programmes executed so far have given benefits in terms of increased yields from agricultural land restoration of degraded lands, irrigation, ground water recharge, employment generation etc., which is evident from

i) Agricultural land treated in states of Gujarat, Tamil Nadu, Rajasthan, Haryana, Himachal Pradesh, Bihar and U.P. is 64.47 lakh ha. At the average rate of 0.2 tonne per ha., increased production is to the tune of 12.8 lakh tonnes.

ii) Forest land treated in Rajasthan, H.P., Bihar, Meghalaya, Tamil Nadu and Chandigarh is 4.35 lakh ha. Besides, an additional area of 5.32 lakh ha. was established by raising remunerative trees, utility plants such as cashew,sisal,mahuna,bhabhar grass etc.

iii) Degraded land, such as gullied areas, alkali soils, waste-

lands reclaimed/restored through soil conservation schemes comes to about 2.3 lakh ha. in the states of Bihar, Haryana, Karnataka, Punjab and Tamil Nadu.

iv) Life saving irrigation potential of 0.41 lakh ha. has been created through water harvesting in Karnataka, Bihar and Tamil Nadu.

v) Till 1982-83, 24.42 crore mandays worth of casual employment opportunities were generated in the states of Karnataka, Tamil Nadu, Rajasthan, Haryana, Himachal Pradesh and Bihar.

vi) Regular employment opportunities were created to the tune of 6446 man years in the states of Bihar, Gujarat, Haryana, H.P., Karnataka, Punjab and Rajasthan.

The important point that is of concern to hydrologists in India is non-uniform distribution of water resources through out the country. This can be indicated by the fact that in Pennar basin the available surface water is 800 cum/capita/year while in Brahmputra basin, it is as much as 10, 600 cum/capita/year. The temporal depth of water resources has also a gloomy picture which can be seen from the fact that out of the total precipitation of 400 m.ha.m. falling in India in a year, 75% is received during four monsoon months and the remaining 25% during the rest of eight months. In view of such spatial and temporal non-uniformity of water resources, it becomes essential to improve the temporal and spatial availability of water resources by development of river valley projects by construction of dams etc. The storage of water by building dams can be beneficial in raising agricultural production, providing water supply, generating hydro-power, control of floods, developing fisheries providing transport facilities and tourism facilities etc. some examples of such water resources projects and their benefits are given below.

4.1 Rajasthan Canal :

Rajasthan canal diverts the water of Satlej and Beas rivers to meet the demand of Irrigation in Rajasthan. The Rajasthan area was desert before the introduction of irrigation and the soil was sandy. There was practically no habitation. It was very thinly populated and there was no water for drinking purposes from ground or surface. Considerable environmental changes have taken place in the area with the introduction of irrigation crops of wheat, cotton, grams, jawar, bajara and maize and in some areas sugarcane are being grown to meet the demand of food in the country. Now this area is changing from desert to greenary and is producing food and fibre to meet the demand of the people.

There is considerable environmental change since the greenary has replaced the desert. Food habits of the people of the area are also chaning at a fast rate. This has great socio-economic impact on the area. The per-capita income of the farmers/beneficiaries have increased considerably. There is however, no doubt that the earlier profession of the people to keep herds of sheep and goats has been changed since they are occupied in cultivation.

Based on the survey data and following activity classification, income per household from different activities has been evaluated as given below .(Table 4.1).

Table 4.1 Income per household from different activities in Rajasthan Canal Command area

Activity	Income (Rupees)		
	With irrigation	Without irrigation	Difference
Agriculture	5050	1149	3901
Activities allied to agriculture	2285	2517	-292
Farm wages	1410	617	793
Non-farm wages	869	985	-116
Business/arts/crafts	940	626	314
Employment (Monday)	640	589	51

It would appear from the above table that with irrigation, there has been substantial rise in income from agriculture and business/arts/crafts. There is also a very significant rise in farm wages. As against the rise in income from these three, activities allied to agriculture (which mainly consists of animal husbandry , and non farm wages show fall in income. The rise in income from the two activities other than agriculture is obviously an indirect result of increased activity in agriculture. In one case availability of irrigation has resulted in more intensive cultivation, thereby creating greater demand for farm labour. In the case of business / arts crafts, higher agriculture income has caused a rise in demand for goods and services which are not produced within the households itself. While the rise in farm wage and business income will generally hold good as indirect benefits occuring from irrigation projects, fall in income observed in activities allied to agriculture and non farm wages may not hold good in all cases, they appear to be typical for the Rajasthan canal area. Before the Rajasthan canal water became available for several reasons, animal husbandry was the most profitable economic activity in what

is now the canal command area. With irrigation water becoming available, crop culture became a more profitable activity as compared to animal husbandry so that for area with irrigation, income activity allied to agriculture showed a noticeable fall.

4.2 Ukai Kakrapar Project

After the coming up of Ukai Kakrapar multi purpose project in Gujarat the irrigation potential has risen significantly influencing positively the agriculture production in the region.

Similarly significant favourable effects on power generation, flood protection, availability of water supply, fish culture, reclamation of saline lands, tourism, employment opportunity, industrial growth etc. have been realised.

A benchmark survey was carried out by Operational Research Group, Ahmedabad in 1985 for assessing the development, management and other aspects related to the irrigation systems. The data available was used for comparison of pre-project conditions (Table 4.2) The survey showed that for marginal farmers 75% of the income came from crop production and 25% from animal husbandry. For big farmers, the major income was only from crop production (Table 4.3).

Table 4.2: Effect on employment due to availability of irrigation in Ukai-Kakrapar Project area.

Effect on employment	Kharif	Ravi	Hot
Increased	105(34%)	136(48%)	140(46%)
No change	182(60%)	153(50%)	147(48%)
No answer	17(6%)	15(5%)	17(6%)

Figures in paranthesis are % with respect to 304 respondents

Source: Development, Management and use of Irrigation in Ukai-Kakrapar Project - a benchmark survey, IIM. Ahmedabad (August 1985).

Table 4.3: Per family and per capita income of farming household in Ukai-Kakrapar Project area (in Rs).

		Marginal	Small	Medium	Large	Total
Per family						
i)	Farm income	859	2857	8660	15749	5217
ii)	Hiring out family labour(Agri)	589	426	372	147	440
iii)	Hiring out family labour(non agri.)	127	76	59	57	91
iv)	Service or pension	3730	3602	2889	3796	3538
Total per family -		5305	6961	11980	19749	9286
Per capita						
i)	Farm income	151	455	1387	2284	852
ii)	Hiring out family labour (Agri.)	104	68	59	21	72
iii)	Hiring out family labour (non-Agri.)	22	12	9	8	15
iv)	Service or pension	655	574	463	551	578
Total per capita		932	1109	1918	2864	1517

Source : Development, Management and Use of Irrigation in Ukai-Kakrapar Project - a benchmark survey, IIM Ahmedabad (August, 1985).

The following data regarding Ukai Kakrapar project represents an impressive view of the purpose served by the project .

Climatic changes

The Ukai reservoir has caused a gradual but marked change in the meteorological regime of the region. The mean maximum temperature has decreased by 2% and mean minimum temperature has increased by 3%. The mean relative humidity has increased by 6%. There is also some change in rainfall pattern and evaporation.

Irrigation and Agriculture

Ther service areas under Ukai and Kakrapar canals are 139,600 ha and 204,000 ha. respectively. Under Kakrapar, the irrigation potential which was about 7% in 1957-58 rose to 100% in 1979-80. The corresponding utilization however increased from 6% in 1957-58 to only 65 in 1978-79, The total irrigated area on Kakrapar increased from about 13,000 ha. in 1957-55 to 129,200 ha. 129,200 in 1983-84. Sugarcane area has increased from 768 ha. in 1957-58 to 65,000 ha. in 1983-84.

With improvement of canals and their operation and provision of other related inputs, the agricultural production has been gradually increasing. There has been a yield increase of 25 to 50% in cereals, perenials, about 25% in orchards and 60 to 70% in pulses.

Power Generation

Ukai power house will be able to generate 670 GWH annually as per ultimate planning. However due to availability of surplus water, the station has generated 11,200 GWh between July 1974 and Dec.1986. This has greatly helped meeting the power shortage created by shutdown of thermal stations. With the availability of abundant cooling water, a large thermal power station of 840 MW has been commissioned at Ukai, and an atomic power station is under construction at Kakrapar.

Flood Protection

With planned flood control and reservoir operation the dam affords partial flood protection to the d/s areas including Surat city.

Before Ukai dam, floods had been very common in this area. During the past 94 years upto 1970, the flood at Surat had risen 19 times above the danger level of 28.96 m, the maximum level being of 31.55 m in August 1968. The catastrophic floods of 1944, 1959 and 1970 are still fresh in the people's memory.

Due to Ukai dam the situation has altogether changed, now Surat and other d/s areas are now free from heavy floods. As against the floods of 42,480 m^3/s in 1968, the maximum flood released since the completion of the dam has been 13,620 m^3/s, in 1973.

Water Supply

With ample water availability, domestic water demand and high water consuming industries have developed fast in the region.

Nearly 15 chemical and engineering industries, Hajira fertilizer complex and some private farms get their water needs from Kakrapar canals. A sugar factory lifts water from the Ukai reservoir. The Ukai thermal power station and the paper and pulp mill gets water from the Ukai Left Canal which will also feed another proposed paper mill. URBC system feed various industrial complexes like the Gujarat Narmada Valley Fertilizer Company, Industrial Estates at Ankleshwar and Panoli, the ONGC complex at Ankleshwar etc.

Lift Irrigation

To irrigate some out of command areas east of the canals, some higher patches in the command areas on the periphery of the reservoir, lift irrigation has been provided from the canals and the reservoir. Ninety eight such schemes from canals will irrigate about 19000 ha.

Fourteen schemes will lift water from the reservoir to irrigate about 7000 ha. of these 6 schemes are already in progress.

Fisheries

No commercial fishes existed in the river before impoundment. The reservoir was stocked with 76 million finger lings of major corps during 1979-81. Breeders from other rivers were transplanted during 1972-75. In 1975 monsoon, there was large scale breeding and commercial exploitation was started through the co-operative societies of affected people. Eleven such societies benefiting 10,000 displaced families are now fishing in the reservoir with annual catch of 4000 tonnes valued at about Rs.20 million at the origin.

Development of Saline Lands

With abundant canal waters, reclamation of 22,000 ha. of coastal salines in the command area has been taken up.

Tourism

Ukai is the largest man made lake in the Western India. It attracts thousands of tourists from Surat, Baroda, Ahmedabad and Bombay.

Secondary Benefits of the Project

Integrated development of disciplines related to irrigated agriculture has been taken up in this area under a separate Area Development Authority. Improved methods of farming, use of fertilizers, improved seeds and pesticides, land development, etc. have been undertaken along with practical demonstrations and extension facilities to train the farmers. This has led to the all round infrastructural and agricultural development of the region. The intensive and extensive agricultural development has enhanced employment possibilities. On full area development the project will provide estimated farm employment of 50.71 million

mandays as against the existing 21.60 million mandays. Agrobased rural industries, marketing and transport, construction of development works have provided additional employment.

Abundant water has attracted large industries relating to chemicals, pharmaceuticals, cotton, textiles, engineering, electrical goods, zari, timber, paper products, electronic goods etc. in huge industrial estates.

Firm availability of adequate cooling water (5.66m^3 /s) from Ukai was one of the main considerations in locating India's fifth atomic power station (940 MW) at Kakrapar. With water surplus to irrigation requirements, a 30 MW hydro station will also come up at Piparia.

4.3 Mahi Kadna Project

Climatic & rainfall

Micro climate changes have been indicated with the rise to average minimum temp. and in the relative humidity and fall in the average maximum temperature.

Irrigation and agriculture

The Irrigation potential increased from about 6000 ha. in 1958-59 to about 120,000 ha. in 1972-73 to 201,000 (100%) by 1979-80. The corresponding utilisation increased from about 900 ha. in 1958-59 to about 120,000 ha. in 1983-84.

Power generation

Kadana hydro power station is under construction (Dec.1985). It will have two reversible and 2 conventional turbines of 60 MW each. The pumped storage arrangement will utilise off peak surplus energy from the grid with power generation from the thermal, hydro nuclear and tidal power etc. The generation and demand curve will thus be evened out.

Due to the availability of assured water supply, a thermal power station of 630 MW with 3 units of 210 MW each has come up at

Wanakbori and other 3 units of 210 MW each will come up in future.

Flood protection

The Kadana dam affords partial flood protection to the d/s areas in Panchmahals and Kheda districts as a result of planned and controlled reservoir operation. Before construction of Kadana dam floods of varying intensity and magnitude had been very common in the areas down stream of Kadana, with the construction of the reservoir however considerable flood protection has now been provided to the area.

Work supply

Apart from providing direct drinking W.S. to Kadana and Diwada villages and Govt. colonies the project indirectly meets with the water supply needs of several urban and rural area d/s and various large industries. The releases from Kadana and Wanakbori help maintaining adequate surface and sub-surface discharges as usual from where vadodara municipal corporation, Gujarat Refineries and Gujarat State Fertilisers Company draw their water requirements. The thermal power stations at Wanakbori and Dhuwaran also get water from the Mahi-river.

Industrial development

There are a large number of small scale industries in almost all the talukas of the district. Large scale industries comprising dairy, ginning, oil milling, cement products, glass works, engineering, chemical and textile complexes in MRBC command area are located in and around Anand, Nadiad, Thasra and Cambay. Nearly 100 rice mills, 20 cotton ginning units, 100 tobacco processing plants and one cooperative sugar factory have been set up in the command as a remark of development of irrigated agriculture.

Fisheries development

The fish catch during 1983-84 was 145 metric tonnes and during 1984-85, it has reached 250 metric tonnes. The affected adivasis on an average earn Rs.900/- to Rs.1000/- per month for 10 months. The reservoir fishing has helped nearly 700 families to earn a livelihood over and above what they can earn from agriculture.

Tourism: With its expanse of 172 Km. the reservoir attracts tourists from all over Gujarat as well as from Rajasthan.

4.4 Idukki Reservoir

About 124 Km. of new road have been built up to and in the project area. The Idukki township of about 32 sq.km. has sprung up below the main dam. The displaced villages have been rehabilitated.

A firm power generation of 2015 million units per annum is available with an additional 376 million units per annum with the completion of the third stage of the project. This has practically eliminated the drastic power shortage in the state existing for a pretty long time.

The regulated release of water from the power house is to the Muvattupuza river will be impounded in a tail race scheme with a 60 feet high dam. A small power house of 6 MW will also be added to this scheme. The waters of this tail race will irrigate 18,616 ha. of paddy, coconut and rubber plantation against the submergence of 420 ha. under the reservoir

The Idukki reservoir has resulted in a vast new forest area becoming accessible. The reservoir is also suitable for pisciculture.

A newsprint factory has come up 40 km. d/s of the tail race mainly because of the availability of this water. Effects of regulated releases on regional industry and commerce will also be significant.

4.5 Bundelkhand Region

Construction of lakes and reservoirs has always been a welcome feature in the arid Bundel Khand region of U.P. After Independence many reservoir systems were constructed for the immense benefit of the public to ameliorate the poverty stricken conditions of the area.

Overall benefits of the WRD projects in this area are summarized in the Table 4.1.

4.6 Bhima Project

A recent survey carried out by IFAD of the Bhima project area in Maharashtra revealed several interesting and hidden secondary benefits, like high literacy rate in command area, improvement in health due to better nutrition and overall change in the attitude and life style.

Table 4.4: Beneficial Effects of Water Resources Projects in Bundelkhand Region

Beneficial Effects / Dams	Improvement in Land Use Pattern	Improvement in Crop Pattern	Improvement in Agricultural Production	Power Generation	Domestic & Industrial Water Supply	Development of Pisciculture	Flood Control	Development of Tourism & Scenic Beauty	Development of Communication	Employment Opportunities	Development of Industries	Overall Socio-Economic Impact
Govind Sagar	+3	+2	+3		+2	+2	+2	+2	+2	+1	+1	+3
Jamnl	+3	+3	+3		+1	+3	+2	+3	+3	+2		+3
Matatila	+4	+4	+4	+3	+4	+4	+2	+3	+2	+3	+4	+4
Dhukwan	+2	+2	+2				+1	+3	+2	+1		+2
Parichha	+3	+3	+3		+2	+2	+2	+3	+2	+2		+2
Pahuj	+2	+2	+2		+3	+2	+2	+2	+2	+2		+4
Saprar	+2	+2	+2		+3	+3	+1	+1	+2	+1		+3
Paharl	+2	+2	+2			+3	+1	+2	+1	+1		+3
Lahchura	+3	+3	+3			+2	+1	+3	+2	+2		+3
Arjun	+2	+2	+3			+3	+1	+2	+2	+2		+3
Kabri	+2	+1	+2			+2	+1	+1	+1	+1		+2
Chandrawal	+2	+1	+2			+2	+1	+1	+1	+1		+2
Ohen	+2	+1	+2			+2	+1	+1	+1	+1		+2
Barwa	+2	+1	+2			+2	+1	+1	+1	+1		+2
Gangao	+2	+3	+3			+3	+1	+1	+2	+2	+1	+3
Rangawan	+2	+3	+3			+3	+1	+2	+2	+2	+1	+3
Bariarpur	+3	+3	+3			+2	+1	+2	+2	+2	+1	+4

Entry in a Box indicates the Existence or Non-Existence of the Beneficial Effect & its Magnitude.

		Mild	Considerable	High	V.High
Existence	:	+1	+2	+3	+4
Non-Existence	:	Indicated by Blank space			

5.0 CONCLUSIONS

It has been recognised that water resources projects are necessary for the development of a nation. Although, it is true that the environment is degraded by both inappropriate development and lack of development, yet the importance of sustainable development should be realised.

One of the objectives of water resources development should be, to the extent possible and desirable, to enhance the quality of environment by the management, conservation, preservation, creation, moderation or improvement of quality of certain natural and cultural resources and ecological systems.

During the last 100 years a large number of water resources projects have been constructed in India either for storage of surplus water during monsoon season and utilizing the same in the following dry months or to divert water to the areas of low rainfall for the beneficial purposes. In India before Independence about 190 dams and reservoirs were existing. Since then number of large and medium dams have been planned and constructed contributing significantly for the attainment of self sufficiency in food grains. Now, India has about 1200 dams.

The installed hydropower has increased from about 600 MW in 1947 to about 15000 MW in 1985 which has helped large industries, rural electrification and cottage industries and above all conjunctive use of water with tube wells for irrigation. The irrigation potential has increased from 22.6 M.ha in 1951 to 57 Mha. in 1980 (Pandhey, 1981) to 60 Mha. in 1984 of which only 15% is being utilised. The food production has increased almost three from 50 million tonnes in 1947 to almost 150 million tonnes in 1985. Inputs like improved seeds, fertilizers ,pesticides were also required but irrigation made an important contribution.

Productivity increased much more in irrigated lands than on unirrigated ones. With increase in the area of irrigated land the production has become less susceptible to the vegaries of rainfall. Inspite of a large increase in population, the per capita food production has increased by 2%. Although there have been many short comings in planning and distributing of water resources and in agricultural practices, particularly lack of attention to drainage, yet dams and reservoirs have created the irrigation potential which can easily sustain a much higher intensity of crops, with scientific farming . The command area development authorities are now initiating this proces. The development of water resources projects deserves a very high priority in country like India where about 40% of the population lives below required nutrition level. Increased agricultural productivity and more equitable distribution of national income, are essential to abolish this kind of poverty. Irrigation is the most powerful means of acceleration for agricultural growth.

Due to floods and droughts, agricultural and animal wealth worth billions of rupees is destroyed every year. Proper utilisation of water resources can reduce partial, if not completely, the losses due to these natural calamities. The drought of 1987-88 has also highlighted the seriousness of the domestic and industrial water situation of the country. This need, which has the highest priority, has also to be met from the available water resources with proper planning.

After a detailed discussion on the benefits of the water resources development, i.e. direct as well as indirect benefits, it becomes evident that this type of projects have contributed a lot to the development and progress of the nation.

The discussion also indicate that the impact of the water resources projects on environment are not only negative as being propagated

by many people, but are also positive in many aspects.

The next step in this direction should be the quantification of positive impacts of completed water resources projects, and its comparision with negative impacts. Though it is difficult to obtain data pertaining to social and cultural benefits, an attempt to develop the procedure for quantification should be made.

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