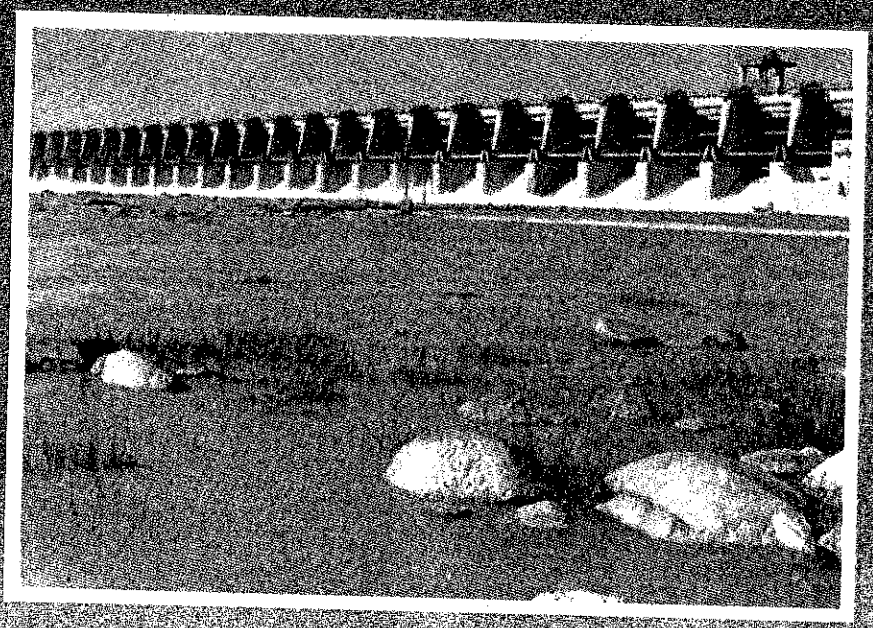
DEVELOPMENT OF IRRIGATION, DRAINAGE & FLOOD CONTROL IN INDIA



PRESENTED BY

INDIAN NATIONAL COMMITTEE ON IRRIGATION & DRAINAGE
FOR 42ND INTERNATIONAL EXECUTIVE COUNCIL MEETING OF
INTERNATIONAL COMMISSION ON IRRIGATION & DRAINAGE
BEIJING, CHINA, APRIL, 1991.

GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION
NEW DELHI

GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION

DEVELOPMENT OF IRRIGATION, DRAINAGE & FLOOD CONTROL IN INDIA

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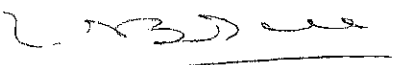
INDIAN NATIONAL COMMITTEE ON IRRIGATION AND DRAINAGE FOR 42ND INTERNATIONAL EXECUTIVE COUNCIL MEETING OF INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE HELD AT BEIJING, CHINA, IN APRIL, 1991.

CENTRAL WATER COMMISSION

The year 1991 has been designated as the "Asia Year" by the International Commission on Irrigation & Drainage. It is appropriate that ICID has requested Member Countries to bring out a country paper highlighting development activities undertaken in irrigation, drainage and flood control during the past decades as well as those planned to be undertaken in 1990s for presentation at the 42nd International Executive Council meeting at Beijing in April 1991. Accordingly, a report on the developmental activities in the above fields undertaken in India during various five year plans and those planned in the future decades has been prepared. It sets out the long heritage of India in irrigation development, its present policies and future perspective. It also refers to the expertise built up in the country which is being shared with other developing countries. Participation in ICID Conferences, interaction with ICID Committees and Working Groups and use of their publications have been of great help in developmental activities.

I earnestly hope that this country paper will give a good insight into the achievements made by India in the fields of irrigation, drainage and flood control.

Assistance rendered by WAPCOS and their Consultant Shri N.K.Dikshit, in preparation of this document is gratefully acknowledged.



(V.B.PATEL)
CHAIRMAN,
CENTRAL WATER COMMISSION, &
CHAIRMAN,
INDIAN NATIONAL COMMITTEE ON IRRIGATION & DRAINAGE (INCID)

INTERNATIONAL COMMISSION ON IRRIGATION & DRAINAGE

ASIA YEAR 1991

COUNTRY REPORT

DEVELOPMENT OF IRRIGATION, DRAINAGE AND FLOOD CONTROL IN INDIA

INDIAN NATIONAL COMMITTEE ON IRRIGATION AND DRAINAGE

SUMMARY

1. India is the seventh largest country in the world and covers a geo-graphical area of 329 million hectares(m ha), of which the cultivable area is 186 m ha. The present cultivated area is 143 m ha and the corresponding gross cropped area is 175 m ha, of which 71 m ha (40%) is irrigated. The term "Gross" accounts for cropping intensity over the same area.

IRRIGATION

2. The average annual rainfall is 1170 mm. The average annual flow in the rivers is assessed as 178 million hectare metres (m ha m) and the annual utilisable flow is estimated as 70 m ha m. In addition, the utilisable ground water potential is estimated as 41.8 m ha m. The ultimate irrigation potential is estimated as 113.5 m ha. The potential created at the end of Seventh Plan (1989-90) was 79.5 m ha, of which the actual area irrigated is 71 m ha. India accounted for 25% (62 m ha) in 1986 of the world irrigation (250 m ha).

3. Irrigation in India dates back to pre-historic times. Irrigation received due

attention even before Independence in 1947, by the Hindu, Muslim and British rulers as it was an important input for successful crop growth in most parts of the country. With the launching of Five Year Plans in early fifties, the irrigation development received a great impetus in view of the need for stepping up of agriculture production to meet the demand of the growing population. This document traces the growth of irrigation in different Five Year Plan periods covering the past four decades and also the future perspective for growth in the irrigation sector.

4. With the rapid growth in the irrigation potential, certain gap developed between the potential created and actual irrigation due to lack of development activities on the farmers' fields. There has been also wastage of water, waterlogging and other deficiencies leading to a low irrigation efficiency. Corrective measures have been initiated like Command Area Development Programme, National Water Management Project, Conjunctive use of surface and ground water, setting up of training institutes for Irrigation Management, etc. A National Water Policy has also been enunciated in 1987 for optimal use of water resources.

5. FLOOD CONTROL AND DRAINAGE

5.1. The total flood prone area has been assessed as 32 m ha. The ancient flood control measures consisted of embankments along rivers and channel improvements. In 1954, a comprehensive national policy was declared which envisaged both short and long-term measures for flood control with appropriate priorities. In addition to structural measures such as detention reservoirs, embankments, channel improvements etc., certain non-structural measures such as flood forecasting and flood

plain zoning were also adopted. The total area protected by the end of Seventh Plan (1989-90) was about 13.8 m ha.

5.2. It is estimated that an area of 6 m ha is affected by drainage congestion, of which 3.4 m ha is due to inundation by floods and 2.6 m ha due to water logging in irrigation Commands. Remedial measures adopted in the flood affected areas include channel improvement, structures to prevent entry of floodwaters to cultivated areas etc. In the case of drainage congestion in irrigated areas, measures adopted include surface drainage, lining of canals to prevent seepage and sinking of tubewells to depress the ground water table.

6. WATER LAWS AND IRRIGATION ACTS

Under the Constitution, water is a State subject except that the Central Government has been charged with the responsibility for regulation and development of inter-state rivers and river valleys. The Parliament has passed Inter-State Water Disputes Act 1956. Similarly, the States have passed Irrigation Acts to cover the various facets of irrigation development including regulation for operation and maintenance, which are amended from time to time. A model bill for ground water legislation is also under consideration by States.

7. ORGANISATION FOR DEVELOPMENT OF IRRIGATION, DRAINAGE AND FLOOD CONTROL

Irrigation being a State subject, projects are planned, constructed and operated by State Irrigation Departments. The Central Government acts as a co-ordinator and promoter of development. The Central Ministry of Water

Resources with the assistance of Central Water Commission and Central Ground Water Board plays an important role in formulating the national policy in co-ordinating the activities of the States. Water and Power Consultancy Services (I) Ltd. (WAPCOS), a public sector undertaking under Ministry of Water Resources offers consultancy services in the water and power sectors. The company has registered with International organisations such as World Bank, Asian Development Bank, FAO etc., and has offered consultancy services to a number of countries in Asia and Africa, besides assisting the States in India for preparing feasibility reports of projects aided by International Financial agencies and external donor countries.

COMMISSION INTERNATIONALE DES IRRIGATIONS ET DU DRAINAGE

ANNEE DE L'ASIE 1991
RAPPORT

DEVELOPPEMENT DE L'IRRIGATION, DRAINAGE ET MAITRISE DES CRUES EN INDE

COMITE NATIONAL DE L'INDE SUR L'IRRIGATION ET LE DRAINAGE

RESUME

1. L'Inde se classe septième parmi les grands pays du monde et couvre une superficie géographique de 329 millions d'hectares dont la superficie cultivable est de 186 millions d'hectares. La superficie cultivée actuelle est de 143 millions d'hectares et la superficie récoltée brute corres-pondante est de 175 millions d'hectares dont 71 millions d'hectares (40%) sont irrigués. Le terme 'brut' représente l'intensité de culture sur la même superficie.

IRRIGATION

2. La précipitation annuelle moyenne est de 1170 mm. L'ecoulement annuel moyen dans les rivières tel qu'il a été évalué est de 178 millions d'hectares mètres et l'écoulement annuel utilisable est estimé à 70 millions d'hectares mètres. En outre, le potentiel d'eau souterraine utilisable est estimé être de 113,5 millions d'hectares. Le potentiel créé à la fin du septième plan quinquennal (1989-1990) était de 79,5 millions d'hectares dont la superficie irriguée réelle est de 71 millions d'hectares. L'Inde représentait 25% (62 millions d'hectares) en 1986 de l'irrigation mondiale (250 millions d'hectares).

3. L'irrigation en Inde remonte aux temps pré-historiques. Elle a été accordée une attention particulière même avant l'indépendance en 1947 par les dirigeants hindous, musulmans et anglais étant donné

qu'elle constituait l'élément important pour une bonne croissance de cultures dans la plupart des régions du pays. Avec le lancement des plans quinquennaux au début des années cinquante, le développement de l'irrigation a reçu une grande impulsion par suite de la nécessité d'accroitre la production agricole en vue de répondre aux besoins de la population croissante. Le présent document trace la croissance de l'irrigation à différentes périodes des plans quinquennaux couvrant les quatre dernières décennies et aussi la préspective de croissance dans le secteur de l'irrigation.

4. Avec la croissance rapide du potentiel d'irrigation, certaines lacunes se sont développées entre le potentiel créé et l'irrigation réelle par suite de l'absence des activités de développement sur les champs des agriculteurs. Il y a eu aussi gaspillage d'eau, imbibition d'eau et autres insuffisances entrainant un rendement faible de l'irrigation. Des mesures correctives ont été initiées telles que le programme de mise en valeur de la superficie dominée, l'utilisation conjonctive de l'eau de surface et de l'eau souterraine, l'établissement d'instituts de formation pour la gestion de l'irrigation etc. Une politique nationale sur l'eau a été aussi énoncée en 1987 en vue d'une utilisation optimale des ressources hydrauliques.

5. MAITRISE DES CRUES ET DRAINAGE

5.1 La superficie totale prédisposée aux crues a été évaluée à 32 millions d'hectares. Les anciennes mesures de maitrise des crues comprenaient des digues le long des rivières et les aménagements des lits des cours d'eau. En 1954, une politique nationale détaillée a été déclarée qui envisageait des mesures à court terme et à long terme pour la maitrise des crues avec des priorités appropriées. En plus des mesures structurales telles que les

réservoirs de retenue, les digues, les aménagements des lits des cours d'eau etc., certaines mesures non-structurales telles que la prévision des crues et le zonage des champs d'inondation ont été aussi adoptées. La suprficie totale protégée à la fin du septième plan quinquennal (1989-1990) était d'environ 13,8 millicns d'hectares.

5.2 On estime qu'une superficie de 6 millions d'hectares est affectée par la congestion du drainage dont 3,4 millions d'hectares est dû à l'inondation par les crues et 2,6 millions d'hectares dû à l'état des terres rendues incultivables par leur teneur excessive en eau dans les superficies irrigables dominées. Les mesures correctives adoptées dans les régions affectées par les crues comprennent l'aménagement des lits des cours d'eau, les ouvrages pour empêcher l'entrée des eaux d'inondation dans les régions cultivées etc. dans le cas de la congestion du drainage dans les régions irriguées, les mesures adoptées comprennent le drainage de surface, le revêtement des canaux pour empêcher l'infiltration et le forage de puits tubulaires en vue de réduire la nappe souterraine.

6 LOIS SUR L'EAU ET L'IRRIGATION

Aux termes de la constitution, l'eau est un sujet d'Etat sauf que le Gouvernement Central est chargé de la responsabilité de la régulation et de la mise en valeur des rivières passant par plusieurs Etats et des vallées fluviales. Le parlement a adopté en 1956 la loi sur les litiges entre Etats concernant l'eau. De même, les Etats ont adopté des lois sur l'irrigation pour couvrir les divers aspects du développement de l'irrigation y compris la régulation pour l'exploitation et l'entretien, lesquelles sont modifiées de temps en temps. Un projet de loi type sur la législation concernant l'eau souterraine est aussi à l'étude des Etats.

7. ORGANISATION POUR LE DEVELOPPEMENT DE L'IRRIGATION, DU DRAINAGE ET DE LA MAITRISE DES CRUES

L'irrigation étant un sujet d'Etat, les aménagements sont conçus, réalisés et exploités par les services d'irrigation des Etats. Le Gouvernement central agit en tant que coordinateur et promoteur de développement. Le Ministère central des Ressources Hydrauliques avec l'assistance de la Commission Centrale pour l'Eau et de là commission Centrale pour l'Eaou Souterraine joue un rôle important dans la formulation de la politique nationale visant à la coordination des activités des Etats. La Water and Power Consultancy Services (India) Limited (WAPCOS), une entreprise du secteur public sous le Ministère des Ressources Hydrauliques offre des prestations d'ingénieurs conseils dans les domaines de l'eau et de l'énergie. La Société est inscrite auprès des organisations internationales telles que la Banque Mondiale, la Banque Asiatique de Développement, la FAO etc. et a offert ses prestations d'ingénieurs-conseils à plusieurs pays de l'asie et de l'Afrique, en plus d'assister les Etats de l'Inde dans l'élaboration des rapports de faisabilité des projets bénéficiant de l'aide des agences financières internationales et des pays donateurs externes.

C O N T E N T S

DEVELOPMENT OF IRRIGATION, DRAINAGE AND FLOOD CONTROL IN INDIA

PREAMBLE

The year 1991 has been designated as "Asia Year" by the International Commission on Irrigation and Drainage (ICID). In this connection, ICID has proposed that Member countries may bring out a country paper highlighting development activities undertaken in irrigation, drainage and flood control during the recent past decades as well as those planned to be undertaken in 1990's, the last decade of the present Century. It is also proposed to present the country papers of different member countries at the 42nd International Executive Council meeting to be held in Beijing in April 1991, as a part of celebrations for "Asia Year 1991".

I. IRRIGATION DEVELOPMENT

INTRODUCTION

1.1 Irrigation in India has been practised from pre-historic times and it has the largest irrigated area in the world today. India is the seventh largest country in the world and covers a geographical area of 329 m ha (Million hectares) of which, the cultivable area is 186 m ha. The present cultivated area is 143 m ha which is also called the net sown area. Taking into account the multiple cropping adopted in different crop seasons, the total gross cropped area is estimated as 175 m ha. The present gross irrigated area is 71 m ha which represents 40% of the gross cropped area. Similarly the net irrigated area (or net cultivated area irrigated) is 33% of the net sown area on which

crops are grown. In 1986, the percentage of gross irrigated area in India was about 25% of the world irrigated area.

1.2 Although the average annual rainfall is about 1170 mm, its distribution in time and space is not uniform. As a result, some parts of the country may experience drought, while in some parts floods might occur due to excessive precipitation. One third of the country constitutes the drought affected areas. In such areas, irrigation is essential to ensure even a single crop. In view of this position, irrigation has been accorded high priority in the National Development Plans.

2. LAND AND WATER RESOURCES

2.1 Agriculture occupies a key position in the Indian economy because of its contribution to the overall economic growth, through supplies of food, raw materials and exports. It is also a source of livelihood for a majority of the population. So the available land and water resources have to be put to optimum use to support agricultural production.

2.2. The annual average rainfall received on the total geographical area of 329 m ha is about 1170 mm which corresponds to an annual precipitation of 400 million hectare metres (m ha m). The average annual flow of all the river systems in the country was assessed by Dr. A.N.Khosla in 1949 as 167.4 m ha m (1674 billion cubic metres). His study was based on the annual normal rainfall and annual mean temperature. Since then, scientific discharge observations have been initiated throughout the country and the Central Government has organised such observations at key points in different river basins. As a result of collection of more refined statistics, the average annual flow has

been reassessed as 178 m ha m. This is exclusive of evapo-transpiration and soil moisture storage. However, on account of limitations of topography, physiology, geology, dependability, quality and the present stage of technology, only a part of the annual flow is utilisable. The National Commission on Agriculture (1976) estimated this utilisable flow as 70 m ha m.

2.3 GROUND WATER

Scientific ground water investigation in the Country was started in the middle of nineteenth century. In 1931, quantitative assessment of aquifer of Gangetic Plain was initiated. Systematic regional surveys were undertaken by the Ground Water and Engineering Division of the Geological Survey of India in 1945 and in 1954 such work was carried out by the Exploratory Tubewells Organisation of the then Ministry of Food and Agriculture. In 1972 the above two organisations were merged to form a single National Authority viz Central Ground Water Board which was the focal point for all matters relating to exploration, assessment, development, scientific management and regulation of ground water resources. At the State level, the State Ground Water Directorates have been set up to shoulder similar responsibilties. The ground water potential has been estimated as 41.8 m ha m.

2.4 OTHER SOURCES OF WATER

There are relatively insignificant quantities of lake waters in the country which can be beneficially harnessed and used mostly to meet local water requirements. Snow and ice in the Himalayan mountains constitute an important source for contribution to annual surface flows

particularly in the form of snow melt in the hot weather season to enable round the year flows in the Indo-Gangetic rivers. Systematic investigations will be necessary to quantify the contribution from this source of water.

2.5 To sum up, the utilisable water resources are estimated as 111.8 m ha m, 70 m ha m from surface sources and 41.8 m ha m from ground water.

3. DEVELOPMENT BEFORE INDEPENDENCE (1947).

3.1 The history of irrigation development in the country can be traced back to pre-historic times. Vedas and ancient Indian scriptures made reference to wells, canals, tanks and dams which were beneficial to the community and their efficient operation and maintenance was the responsibility of the State. Civilizations flourished on the banks of the rivers and harnessed the waters for sustenance of life. According to the ancient Indian writers, the digging of a tank or a well was amongst the greatest of the meritorious acts of a man. Brihaspathi, an ancient writer on Law and politics states that the construction and repair of dams is pious work and its burden should fall on the shoulders of rich men of the land. Vishnu Purana enjoins merit to a person who effects repairs to wells, gardens and dams. Vishnu Gupta Kautilya (300 B.C.) states, "During times of famine, the King and his subjects took shelter near dams; aquatic life in rivers, canals and dams was protected and fishing was allowed under a licence.....If privately managed dams were neglected for five years their charge was taken over by the State. If they were constructed by public contribution, revenue for five years was remitted."

3.2. The entire land-scape in the central and southern India is studded with numerous irrigation tanks which have been traced back to many centuries before the beginning of the Christian era. In Northern India also there are a number of small canals in the upper valleys of rivers which are also very old. Mention may be made of Grand Anicut in the Cauvery river which was believed to have been built in second century AD.

3.3. This tradition was also continued by Muslim rulers who took keen interest in constructing new irrigation works. In 1568 Akbar wrote :

"In acknowledging God's mercy in establishing this great Empire, my desire, purer than water, is to supply the wants of poor, and to leave permanent marks of the greatness of my Empire by digging canals and founding cities, by which too, the revenues of my Empire will be increased. For God has said, from water all things are made. I consequently ordain that this Jungle in which subsistance is obtained with thirst, be converted to a place of comfort, free from that evil."

3.4 When British conquered this country, the total area irrigated in the country was relatively small compared to the present standard and may be only a few million acres. In the nineteenth century, the British also took interest in irrigation development soon after they established their hold on different parts of the country. During the period 1800-1836, the old Yamuna canals in the North and Cauvery Delta system (originally built in 200 A.D.) in the South were remodelled. Between 1836 to 1866, large projects viz the Upper Ganga Canal in Uttar Pradesh, the Krishna and Godavari Delta

Canal in Andhra Pradesh, the upper Bari Doab Canals in Punjab were constructed and in this connection the names of Sir Arther Cotton and Sir Proby T. Cantley, the Royal Military Engineers, who made their significant contribution to irrigation development, may be mentioned.

3.5 In 1866 important and radical changes were made in the policy governing execution and financing of irrigation projects with the following decisions taken.

i) Irrigation projects would, in future, be constructed by the State only through its own agencies.

ii) The projects would be financed from Public loans raised for the purpose and,

iii) Political boundaries would not come in the way when the best possible utilisation of river water for irrigation purposes was considered.

This decision gave philip to construction of a number of projects viz Sirhind canal in Punjab, Lower Ganga Canal, Agra Canal, Betwa Canal in Uttar Pradesh, Periyar system in Tamil Nadu, Mutha canals in Maharashtra and a few others now in Pakistan. The total irrigated area which was about 1 m ha in 1850 rose to 11.66 m ha in 1900.

3.6. In 1901 the Govt. of India appointed a special Commission known as 'Indian Irrigation Commission to report on irrigation as a protection against famine in India. In 1904 the Commission presented its report in which it recommended definite lines of policy in selection, financing and maintenance of Irrigation works. As a result of these

recommendations, a large number of new projects were undertaken. The more important projects were :

Triple Canal Project (now in Pakistan),
Tribeni Canal Project (Bihar),
Godavari Canals (Maharashtra),
Pravara Canal (Maharashtra),
Nira Right Bank Canal (Maharashtra),
Sarda Canal and Wanganga Canal (Uttar Pradesh) and Mahanadi Canals (Madhya Pradesh).

3.7 With the introduction of Montagu-Chelmsford Reforms in 1921, after the First World War, a change in the policy governing financing of irrigation projects was brought out. The provincial Governments were authorised to raise loans for financing irrigation projects instead of Govt. of India doing it for them. This led to an increase in the tempo of construction of new irrigation projects. The important projects built during 1921-1935 were :

Krishnaraja Sagar Project (Karnataka),
Nizamsagar Project (Andhra Pradesh),
Cauvery Delta Project (Tamil Nadu),
Bikaner Canal (Rajasthan),
Sutlez Valley Canals and
Sukkar Barrage Project (now in Pakistan).

The total irrigated area in 1935 was 18.2 m ha. With the passing of Govt.of India Act 1935,the subject of 'Irrigation' was transferred from the Centre to the provincial or State Governments. The Government of India was no longer concerned with irrigation development except where disputes arose between neighbouring provinces. But in 1945, a Central Organisation known as Central Waterways, Irrigation and Navigation Commission (CWINC), subsequently renamed as "Central Water & Power Commission" (CW&PC) in 1950 and now as the "Central Water Commission" (1974) was set up for assisting the provincial

Governments and for co-ordinating the relevant activities in irrigation development.

3.8. The Partition of United India at the time of Independence in 1947 resulted in substantial reduction of the irrigated area. On the eve of Independence, the total net irrigated area was about 28.2 million hectares(m ha) which was bifurcated to 19.4 m ha in India and 8.8 m ha in Pakistan. The corresponding net sown area was 98.5 m ha in India and 18.3 m ha in Pakistan. The percentage irrigated area to net sown area was 19.7% for India and 48.1% for Pakistan. This showed that the percentage of irrigated area dropped to 19.7% after partition from 24.1% in the undivided India. The major canal system which went to Pakistan was the Indus System. East Bengal, now Bangladesh, which comprises the fertile Ganga-Brahmaputra Delta region of Bengal also fell in Pakistan in 1947. This area is situated in assured rainfall areas, producing bumper rice and jute crops.

3.9. The irrigated areas which remained with India,barring some of the old works in Uttar Pradesh and in the deltas of the South, were mostly of protective nature to provide sustenance during famine and not meant for producing high yields. After Independence, this situation had to be improved by providing high priority for irrigation development to meet the needs of growing population.

3.10. **CONTRIBUTION OF IRRIGATION TO INCREASE IN AGRICULTURE PRODUCTION**

Irrigation has played a key role in raising agriculture production in the country in the last four decades by providing insurance against drought which has also lead to achievement of self-sufficiency in food grains production. The

food grains production in the country increased from 51 million tonnes in 1950-51 to about 175 million tonnes in 1989-90. The percentage contribution of irrigated areas to the total production went up from about 30% to 60% in the last four decades.

IRRIGATION IN INDIA IN COMPARISON OF WORLD IRRIGATION

3.11. Irrigation has been practised in the world for several thousand years. Western civilisation spread from the dry soils of Mesopotamia where survival depended upon water of the Tigris and Euphrates rivers to give life to the land. In present day Iran, an extensive system of tunnels called 'Kanats', channelled water by gravity from mountains to crop lands as far back as 2,500 years ago. Early books of the Bible refer several times to irrigation and it is no coincidence that perennial flows of the biblical region's two great rivers, the Nile and Euphrates broadly formulated the boundaries of promised land. Irrigation also developed in the Aral Sea basin and California Central Valley, which were the fruit and vegetable baskets of Soviet Union and United States respectively. Without irrigation, yields in the critical grain-growing areas of Northern China, North west India and Western United States would drop by one-third to one half. The table below shows the irrigation development in India in comparison with the whole world.

(Million Hectare)

Year	Gross Irrigated Area in India	Gross Irrigation in the World
1800	1.0	8.0
1900	11.66	40.0
1950	22.6	94.0
1960	28.5	140.0
1970	38.5	198.0
1986	62.0	250.0

It will be seen from the above table that Irrigated area in India in 1986 was about 25% of the total irrigated area of the world.

4. DEVELOPMENT DURING FIVE YEARS PLANS.

4.1 At the time of launching of the First Five year Plan in 1951, the net irrigated area was 20.85 m ha. With 1.71 m ha irrigated during more than one crop season, the gross irrigated area (sum of irrigated areas in different crop seasons in the year) was 22.6 m ha. The Country assigned a very high priority to irrigation in the Five year Plans. As a result, giant multiprupose and irrigation projects like the Bhakra Nangal in Punjab; Damodar Valley in Bihar and West Bengal and Hirakund in Orissa, were taken up. With the rapid strides made in Irrigation development, the gross irrigated area which was 22.6 m ha in 1950-51 rose to 60.4 m ha in 1984-85 (at the end of Sixth Five Year Plan Period). A further addition of about 11 m ha was made during the Seventh Five Year Plan (1985-90) bringing the total irrigated area to about 71 m ha at the end of Eighties. The corresponding irrigation potential created is around 79.5 m ha.

4.2. The table below shows the investment made on irrigation development from all sources (major, medium and minor - See Para 4.3) and the potential created in the various Five Year plan periods.

INVESTMENT AND DEVELOPMENT OF IRRIGATION POTENTIAL

Plan Period	Rate of Exchange of Indian Rupees to one US$ at beginning of the plan period	Invest. in Rs. million	*Pot. cummu. gross in m ha	*Pot. created during the period m ha
Pre-Plan	-	-	22.6	-
First Plan	4.76	4460	26.26	3.66
Second Plan	-	5220	29.09	2.83
Third Plan	9.09	9090	33.61	4.52
Annual Plans	-	7600	37.10	3.49
Fourth Plan	7.50	17500	44.20	7.10
Fifth Plan	-	30730	52.12	7.92
Annual Plans	7.8	25530	56.60	4.48
Sixth Plan	7.8	93180	67.90	11.30
Seventh Plan	13.0	140780	79.50	11.60

* 'Irrigation Potential' created is defined as the aggregate gross area that can be irrigated annually by the quantity of water available from works completed up to the last point of water delivery system up to which the Government is responsible for construction i.e. generally up to irrigation outlets serving 40 ha blocks of lands normally having capacity of about 0.03 cumec to 0.06 cumec.

* 'Irrigation Potential Utilised' (Actual gross irrigated area) is defined as the aggregate of the area actually irrigated in the different crop seasons in a year (July to June).

It will be seen from the above table that the yearly rate of growth of creation of irrigation

potential has more than trippled in the Seventh Plan (1985-90) in a period of four decades. The significant growth has been possible due to launching of a large number of irrigation projects from time to time.

4.3. In India, irrigation projects are classified into three categories viz major, medium and minor. Projects which have a Culturable Commanded Area (CCA) of more than 10,000 ha are termed as Major projects; those which have a CCA of less than 10,000 ha but more than 2000 ha are termed as medium projects; and those which have a CCA of 2000 ha or less each are known as minor projects. Minor irrigation projects have both surface and ground water as their sources, while major and medium projects exploit surface water resources.

4.4. **RUN-OF-THE RIVER AND STORAGE SCHEMES**

In the early stage of irrigation development, emphasis was on diverting the flow in the rivers through weirs, anicuts i.e. run-of-the river schemes to utilise the river flow during the monsoon and to some extent in the non-monsoon rabi period (Winter Crop Season). Such schemes were largely developed in the Indo-Gangetic plain (and to some extent in other river basins) as the river flows are also substantial during the non-monsoon period due to snow melt from the Himalayas. After Independence, it was soon realised that major storage works had to be undertaken to firm up irrigation supplies from the run-of-the river schemes and also to generate hydropower. Multipurpose reservoir projects were also planned to include flood control benefits by providing flood storages like Damodar Valley project (D.V.C.). In the successive Five Year Plans, greater emphasis has been laid on construction of storage works. So far, 2179 large and medium size dams of height

15m and above have been constructed. The total live storage capacity of reservoirs completed upto 1989 is 166000 m cu m (16.6 m ha m). Besides dams under construction will add another 77000 m cu m (7.7 m ha m) and those under formulation are expected to add another 130000 m cum(13 m ha m).

The table below shows the state-wise details of live storage capacities of irrigation and multipurpose projects.

LIVE STORAGE CAPACITIES OF IRRIGATION AND MULTIPURPOSE PROJECTS

Sl. No.	State	LIVE STORAGE CAPACITIES Completed Projects	Proj.under Construct.	Total	Proj.Under Consid.tn.
1	Andhra Pradesh	24272.89	2433.83	26706.72	1984.47
2	Arunachal Pradesh	-	-	-	45500.00
3	Assam	-	1054.32	1054.32	1023.90
4	Bihar	5441.16	4281.16	9722.32	3638.65
5	Goa	44.20	239.13	283.33	-
6	Gujarat	13850.35	7272.55	21122.90	2007.82
7	Himachal Pradesh	14513.44	109.55	14622.99	356.40
8	Jammu & Kashmir	-	-	-	14.95
9	Karnataka	17493.97	7001.12	24495.09	96.69
10	Kerala	4617.35	1550.69	6168.04	1948.57
11	Madhya Pradesh	15373.90	24088.89	39462.79	8856.28
12	Maharashtra	20028.03	13067.56	33095.59	4602.49
13	Manipur	396.50	124.58	521.08	16315.00
14	Meghalaya	697.96	-	697.96	508.94
15	Nagaland	-	1220.00	1220.00	-
16	Orissa	13474.46	3288.18	16762.64	21947.67
17	Punjab	10.36	2344.00	2354.36	-
18	Rajasthan	7672.97	659.16	8332.13	1800.63
19	Tamil Nadu	6712.74	54.00	6766.74	-
20	Tripura	-	312.90	312.90	-
21	Uttar Pradesh	16385.76	7608.66	23994.42	20160.16
22	West Bengal	1463.68	-	1463.68	171.44
23	Pondicherry (U.T.)	13.79	-	13.79	-
	Total in M.Cum.	162463.51	76710.28	239173.79	130934.06
	in Cubic Km.	162.5	76.7	239.2	130.9

Note : Projects having a live storage capacity of 10 M.Cum.and above only are included.
An additional live storage capacity of 3 cubic Km. is estimated to be created through medium projects each having a capacity of less than 10 M.Cum. thus making a total live storage capacity of 166 Cubic Km.in completed projects.

4.5. MAJOR AND MEDIUM IRRIGATION PROJECTS.

4.5.1. First Plan (1951-56)

In the First Five year plan,there were about 267 major and medium schemes under implementation inclusive of those taken up in the pre-plan period. Important major projects were:

NagarjunaSagar in Andhra Pradesh,
Kosi in Bihar,
Chambal complex in Rajasthan and Madhya Pradesh,
Harike in Punjab,
Tungbhadra in Karnataka and Andhra Pradesh,
Bhadra and Ghatprabha in Mysore (now Karnataka),
lower Bhawani in Tamil Nadu,
Matatila in Uttar Pradesh and
Mayurakshi in West Bengal.

The total cost of the projects included in the First Plan was Rs.7 900 million and the corresponding ultimate irrigation potential of projects was 8.9 m ha An investment of Rs.3 800 million was made on these projects in the plan period (including Rs.800 m spent before plan period on the schemes continued from preplan period) to create an irrigation potential of 2.48 m ha.

4.5.2. Second Plan (1956-61)

In the Second Plan 195 major and medium projects were taken up, of which 25 were major schemes. Some of the major schemes were :

Rajasthan Canal,
Gandak in Bihar and Uttar Pradesh,
Parambikulam Aliyar in TamilNadu,
Kabini in Karnataka,
Kangsabati in West Bengal,

Kadana, Ukai and Broach (Narmada) in Gujarat and Purna, Girna and Khadakwasla in Maharashtra.

The cost of schemes included in the Second Plan was Rs.10 200 million and the expenditure incurred during the plan period was Rs.3 800 million to create an irrigation potential of 2.14 m ha.

4.5.3. **Third Plan (1961-66)**

In the Third Plan, only 9 major and 86 medium schemes were taken up as new schemes, in view of the large number of carryover schemes of the first two plans. The cost of the new schemes was about Rs.3 640 million. The important major projects added were Malaprabha and Upper Krishna in Karnataka. The total expenditure incurred in the plan period on both carryover and new schemes was Rs.5 830 million to create an additional irrigation potential of 2.3 m ha.

4.5.4. **Annual Plans (1966-69)**

During the triennium 1966-69, most of the States concentrated on large number of carry over schemes Maharashtra, however, launched six new schemes viz

Bhima,
Krishna,
Upper Godavari and
Jayakwadi,
Warna,
Kukadi.

The expenditure incurred on all the schemes in the three year period was Rs.4 340 million to create an additional irrigation potential of 1.53 m ha.

4.5.5 **Fourth Plan (1969- 74)**

In view of the large number of on-going schemes, the Fourth Plan concentrated its effort in completing the long lingering schemes. During the plan period 9 major and 73 medium schemes were completed. Of the 9 major schemes completed, three were taken up in the First Plan, three in the Second Plan and one each in the Third and the Fourth Plans. The expenditure incurred on all the schemes included in the Plan was Rs.12 370 million to create an additional irrigation potential of 2.6 m.ha.

4.5.6. **Fifth Plan (1974-78)**

The original Fifth Five Year Plan which was formulated for five years (1974-79) was terminated at the end of four years (1974-78) due to change in Governmental policies. The Fifth Plan also concentrated on completion of carry-over schemes and very few new schemes were taken up in the Plan Period. The expenditure incurred on all the schemes implemented during the plan period was Rs.24 420 million to create an additional irrigation potential of 4 m.ha.

4.5.7 **Annual Plans (1978-80)**

With a new Government at the Centre, the concept of Five Year Plan underwent modifications to the one of rolling plans. This period also saw increased emphasis in completion of on-going schemes. One major and 20 medium schemes were completed, with an investment of Rs.20 560 million on the entire programme to create an additional irrigation potential of 1.90 million ha.

4.5.8 **Sixth Plan (1980-85)**

The Sixth Plan envisaged an investment of Rs. 83 910 million to create an irrigation potential of 5.74 m ha. At the plan formulation stage it was envisaged that 65 major projects started before April 1976 would be completed on priority. However, due to priority of investment on externally aided schemes, adequate finances could not be provided to such projects and only 32 major projects could be completed. Factors which affected early completion of the carryover schemes were problems of land acquisition, rehabilitation, changes in scope of projects originally sanctioned. Notwithstanding the problems faced as mentioned above, the Sixth Plan saw completion of 32 major and 158 medium schemes to create an additional irrigation potential of 3.4 m ha with an investment of Rs.73 690 million on the entire programme.

4.5.9 **Seventh Plan (1985-90)**

The Seventh Plan envisaged an investment of Rs.115.56 billion to create an additional irrigation potential of 4.3 m ha. There were 181 major and 433 medium schemes in the Seventh Plan which were continuing from the earlier plan periods. During the plan, another 18 major and 29 medium schemes were added. There was shortfall of about 1 m ha in the creation of additional irrigation potential. The main reasons for non-completion of projects as planned and shortfall in the creation of potential targetted in the plan period were :-

i) Considerable proliferation in taking up of schemes during Fifth plan and consequent thin spreading of resources.

ii) Externally-aided Schemes being costlier than other plan projects, were provided larger outlays thereby starving other plan projects in providing planned finance.

iii) Changes in the scope of projects and consequent time and cost overruns with financial resources constraints to complete them early.

iv) Improper planning of works and delay in planning distribution system.

v) Increased provisions required for meeting the environmental costs due to greater awareness of their importance.

Some of the above deficiencies have to be made good in the Eighth and subsequent Five Year Plans. The investment in the plan period is Rs.113 billion and the corresponding additional irrigation potential is 3.13 m ha.

4.5.10. A list of major irrigation projects completed during the first four decades of Planning in the Country (1950-90) is given in Annexure - I.

4.6.MINOR IRRIGATION PROJECTS

4.6.1. The minor irrigation projects generally comprise all ground water schemes like dugwells, tubewells and surface water flow and lift schemes. Micro storage schemes and percolation tanks to replenish ground water are also taken up under this programme. The investment for this programme largely comes from institutional and private sources. Public sector outlays are spent for construction of surface flow and lift schemes and deep tubewells. Ground water development forms the bulk of the programme which is essentially a farmers' endeavour through individual and co-operative efforts backed

by institutional financing. Minor surface water flow and lift schemes are particularly suited for irrigated agriculture in undulating hilly regions with high plateau lands. They are good sources of irrigation in chronically drought affected areas. Since the schemes are labour intensive, they provide excellent rural employment.

4.6.2. Since the commencement of planning era in the early fifties, minor irrigation development has registered a significant growth in view of the need to provide water for sustaining agricultural production particularly in drought years with the support of ground water exploitation. Public sector investment also increased over the Five year plans alongwith the growth of private and institutional investment. The Central Ground Water Board (CGWB) which is an apex body at the national level carries out hydrogeological surveys at the macro level. At the micro level, surveys are undertaken by State Ground Water organisations who are also responsible for exploitation of ground water. Ground water development made a significant contribution in the growth of minor irrigation sector as would be revealed from the following table :

Plan Period	Investment in Rs. million		Cumulative Irrigation Potential in m ha			Potential created during the Plan Period in m ha
	Pub Sect	Credit by Banks	Ground Water	Surf. Water	Tot.	
Pre-Plan	-	-	6.50	6.40	12.90	-
First Plan	660	Negli	7.63	6.43	14.06	1.16
Second Plan	1420	190	8.30	6.45	14.75	0.69
Third Plan	3280	1150	10.52	6.48	17.00	2.25
Annual Plans	3260	2350	12.50	6.50	19.00	2.00
Fourth Plan	5130	6610	16.50	7.00	23.50	4.50
Fifth Plan	6310	7800	19.80	7.50	27.30	3.80
Annual Plans	4970	4900	22.00	8.00	30.00	2.70
Sixth Plan	18020	14380	27.80	9.70	37.50	7.50
Seventh Plan	32278	33120	34.98	11.15	45.93	8.43

4.6.3. Surface Water Schemes consist of tanks and reservoirs, diversion schemes in hilly areas, water conservation and ground water recharging schemes. As in the case of major and medium irrigation programme, there is a large backlog of carryover schemes inspite of the fact that priority was given for early completion of such schemes in the Seventh Plan. It is estimated that in 1989 there were 7 800 such schemes requiring Rs.8 150 million for completion. Some of these are funded with financial assistance from World Bank, USAID, EEC, Netherlands, Germany, etc.. Modernisation of tank irrigation systems have been taken up under external assistance in Karnataka, Kerala, Andhra Pradesh, Madhya Pradesh, Maharashtra and Orissa.

4.6.4. The table below shows the growth of number of different categories of minor irrigation projects from 1951 to 1990 :

	1951	1990
Dugwells	3.86 million	9.5 million
Shallow tubewells	3 860	4.75 million
Deep tubewells	2 400	63 580
Electrical pump set installed	21 000	8.23 million
Diesel pump set installed	66 000	4.35 million

A census of minor irrigation units is currently in progress in various States and the above statistics will be firmed up after completion of the census.

Minor Irrigation Corporations

4.6.5. Ground water development under minor irrigation programme is financed from public sector, institutional and private sources. In order to channelise flow of institutional finances for development of both surface and ground water, Minor Irrigation Corporations have been set up in nine States. The main functions of these corporations are creation of minor irrigation potential and its utilisation through installation of tubewells, borewells and their operation and maintenance, lift irrigation schemes from rivers, streams, canals and drains. Some Corporations also undertake manufacture and installation of pumps and gates, carrying out of hydrographical surveys. Since these Corporations serve to a large extent the weaker sections of the farmer community, they are not profit oriented. Economic water rates are not charged for the water supplied. The difference between economic water rate and the actual water rate charged is subsidised by the Government and the subsidy is paid to these Corporations.

4.6.6 **Seventh Plan (1985-90)**

The Seventh Plan envisaged a target for irrigation potential of 8.6 m ha comprising 7.1 m ha from ground water and 1.5 m ha from surface water schemes. The achievements under selected items of the programme were as under :

i)	Dugwells (Numbers)	0.75	million
ii)	Shallow tubewells (Numbers)	1.40	"
iii)	Deep tubewells (Numbers)	17500	
iv)	Electrical Pumpset (Numbers) to be installed	2.5	million

A review of the performance showed that by and large physical targets for creation of irrigation potential were achieved although there was some shortfall in the dug well and deep tubewell programmes. While the investment under public sector outlay exceeded the target, institutional financing resulted in some shortfall. The achievement in the potential was assessed as 8.43 m ha comprising 6.98 m ha from ground water and 1.45 m ha from surface water.

5. **SOME PROBLEMS RELATING TO IRRIGATION AND DRAINAGE**

5.1 Major projects meant to store and convey water for irrigation are very costly. Of late,there has been severe criticism from Environmentalist groups about the adverse effects of such projects on the ecology of the area. Recent capacity surveys of some of the major reservoirs in the country have revealed that the rate of silting was more than what was assumed originally and provided for as dead storage to accomodate the silt inflow into the reservoirs. The problem of soil conservation in the catchment areas of river valley projects is engaging the earnest

attention of the Government. In recent years, a rigorous procedure for environmental impact assessment has been introduced and the Ministry of Environment and Forest of the Government of India has to clear all projects from environmental and forest angle. In addition, better rehabilitation of displaced persons from the reservoirs is also a charge on the project costs. Suitable environmental safe-gaurd measures have to be provided alongwith the implementation of engineering part of the projects.

5.2 The projects after completion are operated by the project authorities and proper maintenance is ensured for permanent irrigated agriculture and effective use of other facilities. Lack of proper maintenance has lead to deterioration of systems, endangering the very irrigated area and to costly rehabilitation later. The rehabilitation of the old system has received priority in the Plans in order to stabilise irrigation in those systems.

5.3 Like many other countries, India has the sad experience of the occurrence of water logging and salinity of soil with the introduction of irrigation in flat areas where natural drainage conditions were not favourable and adequate drainage facilities were not provided. Such problem has developed in a number of projects like Chambal, Tawa, Tungbhadra, etc.. In some cases,the cause has been traced to the existence of perched water table very close to the ground surface. The need to carry out subsoil water surveys before and at the time of preparation of project has been recognised and is being attended to. Also provision for drainage on the basis of field investigation is generally made in the project cost and implemented as a part of the project.

5.4 Water management on the field has not received due attention so far. As discussed in the section on water management later in this paper, Command Area development authorities have been set up in major projects to assist the farmer in the efficient and economic use of water in the field and adoption of all suitable measures to maximise production. The yields from irrigated area are at present low compared to those in advanced countries and also those in some progressive States in India. Improved water management, with timely availability of all inputs in addition to water, is likely to increase the productivity.

5.5 Experience has taught that there must be pre-planning for agricultural development. Crop patterns are planned for the project. Regional pecularities and traditional habits generally tend to thwart scientific approach. However, they are steadily giving way to progressive techniques. In order to educate the farmers to take to improved techniques, intensive extension service and demonstrations on the farmers' fields are being organised.

5.6 Over-use of water on the fields by farmers is due to field to field irrigation in some projects. This leads to water-logging, besides loss of precious water. Water and Land Management Institutes (WALMIs) (See para 6.11) in various States are engaged in training of operation and maintenance personnel in irrigation management, carrying out operation research and adaptive trials. Farmers are also being trained besides their being encouraged to participate in irrigation Management.

5.7 'Lease' system in vogue in some States in India inhibits rapid development and attempts are being made to replace it by 'free will' irrigation as in vogue in the States of Uttar

Pradesh and Punjab. This will ensure speedier utilisation of the irrigation potential created.

5.8 Shifting cultivation ('Podu' or 'Jhum') practiced in the hill slopes of many States particularly in the North-East leads not only to denundation of forests but also wasting away of rich top soil and adding to the sediment load in rivers and streams. This practice is discouraged by settlement of the tribes in specific areas and alloting cultivable land to them with some irrigation facilities. Soil conservation measures have been taken up in such areas.

5.9 Functioning of drains is badly affected due to obstruction caused by roads, Railways, Canals, etc. The structures built at the crossing are often having inadequate waterway due to under provision made for reasons of economy. The flow in the drains is obstructed due to afflux caused by these under capacity structures. Also cross bunds put across drains for irrigation, navigation or fishing affect the functioning of the drains. Attempts are being made to give proper attention to this problem.

6. WATER MANAGEMENT TO ACHIEVE SPEEDY UTILISATION OF IRRIGATION POTENTIAL.

6.1. Gap Between Potential Created and its Utilisation.

With the rapid expansion of irrigation programme since the beginning of the planning era in early fifties, there was significant growth in irrigation potential in the Five Year Plans. It was soon realised that the potential created was not being utilised fully due to lack of development activites on the farmer's field to distribute the water equitably and effeciently. Thus certain gap developed between the potential created and its utilization as can be seen from the table below :

	Cumulative potential m.ha.	Cumulative utilisation m. ha.	Gap in utilisation of potential m ha
1950-51	22.6	22.6	-
1979-80	56.6	52.6	4.0
1984-85	67.9	60.4	7.5
1989-90	79.5	71.0	8.5

Efforts to minimise the gap were initiated early in Fifth Plan by taking up of a command area development programme as discussed in succeding paragraphs.

6.2 In the past, design and construction of channels have been based on traditional crop pattern and irrigation practices. Also the obligation for construction and maintanence of field channels taking off from the outlets provided by the project, vested with the farmers which did not work. With the rapid development of science and technology, introduction of high yeilding variety of crops, fertilisers, pesticides etc, land utilisation and water management technology have assumed great importance. While greater emphasis was laid in the Five year plans started after Independence for taking up of a large number of projects to create more irrigation potential, its utilisation did not keep pace and certain lags developed resulting in idle potential. As a result, water could not be used effectively for increasing productivity.

Command Area Development Authorities

6.3 In 1974, the Government of India approved a Scheme for command area development whose basic objective was to optimise utilisation of irrigation potential. The integrated development

of command areas covers the following aspects:

(i) Modernisation and efficient operation of the irrigation system as well as development of the drainage system beyond the outlet serving 40 hectare blocks;

(ii) Construction and lining of field channels/water courses.

(iii) Land levelling and shaping.

(iv) Construction of field drains.

(v) Conjunctive use of surface and ground water.

(vi) Adoption and enforcement of suitable cropping pattern.

(vii) Introduction and enforcement of Warabandi (Rostering system for water distribution).

(viii) Preparation of a plan for supply of inputs; credit, seeds, fertilisers, pesticides etc. and

(ix) Stregthening of the existing extension, training and demonstration organisation.

6.4. Warabandi is a rostering system under which the farmers get a right to take water on a fixed day of the week and at a fixed time for a fixed period. The distribution system is so designed that the outlets are all open and the flow in the canal is for a fixed period during which the flow in field channel through open outlets is able to meet the requirement of farmers below the outlet provided the water is taken by turns. This system is operative in North India.

In other parts of the country like in Maharashtra, Water Distribution is under three

different systems. These are :

Rotation System.
Shejpali System.
Block System.

Under rotation system, water is supplied to sanctioned crop at the fixed interval, while the canal is running continuously for a period of 10 days.

Under the Shejpali System, water is distributed according to a pre-determined date and time in each rotation according to the turn of the individual farmer. The farmers at the tail end of the Command are served first and those at the head of the channel being served last.

Under the block system, one third of the area in each block is to have sugarcane or perennial crop and the remaining two third is to be used for seasonal crops. The blocks are sanctioned for six years. There is assured supply of water under this system and the farmers can take up works of land improvements and plan their cultivation well.

6.5 The Command Area Development programme which was launched in the Fifth Plan (1974-78) covered 60 major and medium irrigation projects. The emphasis was on the development of infrastructure required to deliver the water to the farmers' fields. The experience in the operation of the programme in the Fifth Plan showed that once the farmer was assured of timely and adequate supply of water, he himself took up some of the on-farm development works such as land levelling in those areas where the slopes were not very steep and undulations in the ground were small. At the time of formulation of the Sixth Plan (1980-85), it was noticed that very little progress had been achieved in the implementation of

on-farm development works. (main emphasis in the Fifth Plan) due to a variety of reasons such as absence of updated land records, difficulties in the flow of institutional credit, resistance of farmers to the implementation of land reforms and inadequate organisation and machinery for carrying out on-farm development works.

6.6 When the Sixth Plan commenced, there were 76 projects with an ultimate potential of 15.3 m ha in 16 States and one Union Territory. The area covered under the field channel construction was 3 m ha and under land levelling about one m ha. The achievement in the Sixth Plan was 5.24 m ha in respect of construction of field channels and half a million hectares in respect of land levelling. A review of the performance in the Sixth Plan showed that organisational weaknesses had come in the way of fully achieving the objectives of the programme. The investment made on the progrmme during the Fifth and Sixth plans were as under :

Plan Period	Public Sector Outlay (Rs. million)
Fifth Plan (1974-78)	1 476
Annual Plan (1978-80)	1 883
Sixth Plan (1980-85)	7 770

6.7. At the begining of the Seventh Plan, there were 102 command area development projects covering a total culturable command area (CCA) of 17.4 m ha. During the Plan period 29 more projects were taken up and the total number of projetcs went up to 131 covering a CCA of 18.5 m ha. The Plan emphasized that with improved water management, agricultural production will have to be stepped up. In order to achieve this objective, efforts were made to develop proper linkages in such a way that a multi-disciplinary team of irrigation engineer, agriculture

scientist and administrators engaged in the task would co-ordinate the activities and the research experience gained in the laboratory and demonstration farms would be transfered to the field so that the farmers take to improved practices to achieve higher yields from crops. The plan also emphasized farmers' participation in the success of the programme.

6.8. The achievements in Seventh Plan in the construction of field channels and land levelling were 6.8 m ha and 1.8 m ha respectively. There was some shortfall in achievement of targets. Some of the reasons identified for this shortfall were problems of land consolidation, inadequate staffing, lack of unified control in the field channel construction,lack of timely availability of water for warabandi coupled with absence of suitable farmers organisations etc. These deficiencies will be overcome in the Eighth and subsequent five year plans alongwith extending the command area package to other major, medium and minor irrigation projects so as to ensure synchronisation of command area projects with the completion of the main irrigation projects.

6.9 PRODUCTIVITY IN IRRIGATED COMMANDS

The production potential of agriculture as revealed from national demonstrations is much higher than the actual productivity in the command areas. One of the major objectives of the command area development programme is to increase productivity in the irrigation commands through an integrated approach to water and crop management. Productivity can be improved not only by improvement in the level of utilisation of irrigation potential created but also by the timely supply of inputs viz water, seed, fertiliser, pesticide, etc and providing suitable extension services. A review of the

performance of the programme has revealed that in the command areas, increase in productivity has been achieved to a varying degree in certain crops such as paddy, jowar, wheat, groundnut, gram, etc. It is seen that productivity of paddy in Maharashtra has gone up by 53% in Ghod project and as much as 176% in Bagh project. Similarly in wheat, highest and lowest increases in productivity were 123% in the Krishna Project and 12% in Ghod project of Maharashtra. Similar increases have also been reported for other crops like groundnut, gram, jowar, etc. by other States. However, these estimates were not based on crop cutting experiments on a rational sampling procedure. A suitable methodology has to be evolved in this respect. The Central Ministry of Water Resources has initiated a pilot project in Tamil Nadu State in the command of Lower Bhavani Project to evolve an appropriate methodology.

6.10 FARMERS' PARTICIPATION

Under the command area development programme, one of the objectives is to encourage farmers' participation in construction activities such as land levelling and shaping, construction of field channels and equitible distribution of water among the farmers'land holdings which are generally small. For this purpose, farmers are induced to form co-operatives/outlet committees who will be fully associated not only with the implementation of the programme but also undertake responsibility for providing inputs for irrigated agriculture and for marketing of the produce. The farmers' associations and co-operatives established in some parts of the country have been successful in the equitable distribution of water among their members, the bulk of the water supply being given by the Irrigation Department to such co-operatives. Ten States in the country have so far established Seventy irrigation water users co-operatives /

Societies in 29 projects. The total membership of the societies is 15 000 serving an irrigated area of 43 000 ha in different projects.

6.11. TRAINING IN WATER MANAGEMENT

With the expansion of the irrigation programme, the need for training personnel both in the methods of construction and in efficient management of the irrigation system has assumed greater importance. Apart from the training of personnel engaged in the command area programme particularly operation and maintenance for improved water management, the farmers have also to be educated if improved water management has to be achieved. Water and Land Management Institutes (WALMI) and Irrigation Management and Training Institutes (IMTI) have been established for the purpose in the States of Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and Uttar Pradesh. There is also a proposal to set up a National Irrigation Management Institute as an apex body at the Central level to co-ordinate the activities of the State level institutes in order to meet the growing needs of trained personnel in water resources sector.

A study carried out in 1985 estimated the following requirement of engineers for operation, maintenance and management for the existing and projected irrigated areas mainly under major and medium irrigation projects upto the year 2000 AD :-

- Senior Level Engineer (Chief & Superintending Engineers)	500
- Middle Level Engineers (Executive & Asstt. Engineers)	6 200

- Junior Engineer, New entrants and Non-Engineering Technical Assistants 20 000

In order to meet the growing demand of training of the above personnel, WALMIS and State Engineering Training Institutes would be stregthened, besides setting up of new institutes in the States where they have not so far been set up. The strengthening would also take into account increased requirement of training of field level functionaries in water management.

7. Research

7.1 Research activities in the field of irrigation and flood control have to keep pace with the development of technology and have to be accelerated with the expansion of the development programme in Five Year Plans. Research Institute at both Central and State levels have to be similarly expanded to meet the needs of (i) basic and fundamental research, and (ii) applied research in the water resources sector. At the Central Level, research activities are undertaken by the Central Water and Power Research Station (CWPRS) at Pune, Central Soils and Material Research Station (CSMRS) at New Delhi, National Institute of Hydrology (NIH) at Roorkee (U.P.), Central Board of Irrigation and Power (CBI&P) New Delhi and State level Irrigation Research Institutes. Besides, infrastructure facilities are also available at the National Institutes such as Roorkee University, Indian Institutes of Technology (IITs), Water Technology Centre, New Delhi and some of the leading Agricultural Universities.

7.2 Research projects are also funded by external agencies like UNDP, FAO, etc. to

support the national effort in this regard. Keeping in view the large investment made in the water resources Sector during Five Year Plans the National Conference of Irrigation and Water Resources Ministers of States and Union Territories held in July 1986 recommended that an allocation of 1% (one percent) of the capital investment be reserved for Research so that research facilities both at the Centre and State level could be expanded to meet the needs of research in formulating technically sound and economic designs for water resources structures. This would be considered in formulating Eighth and subsequent Plans.

7.3 The major research activities of the CWPRS cover model testing, basic research and evaluation of economic designs for ensuring safety and operational efficiency of the river valley projects at their formulation stage. The CSMRS has been conducting basic and applied research and providing advice in the field of geo-mechanics and construction services to the various departments of Central and State Govts. The NIH has carried out review of literature and testing of computer programmes, collection of data, training of scientists, implementation of consultancy research project for ground water modelling studies. The Institute has also identified priority areas for research in hydrology which will assist in proper formulation of river valley projects. WALMIs in the various States and Water Resources Centre in some Universities undertake action research on the live systems and adoptive trials on the farmers' fields for improved water management.

8. Perspective for Eighth Five Year Plan (1990-95) and beyond.

8.1 The utilisable water resources are estimated as 111.8 m ha m (see para 2.5). The National Commission on Agriculture (1976)

estimated that with the growing demand of municipal and industrial needs, which may touch a figure of 28 m ha m by the year 2025, the available water resources for irrigation would be about 77 m ha m by 2025. A rough estimate of utilisation based on the irrigated area in 1989-90 of 71 m ha may be put at 50 m ha m.

8.2 National Water Policy

8.2.1. The National Water Policy adopted in 1987 gave direction about future development as follows :-

"Resources planning in the case of water has to be done for a hydrologic unit such as drainage basin as a whole or a sub-basin. All individual development projects and proposals should be formulated by the States and considered within the frame work of such an overall plan for a basin or sub-basin, so that the best possible combination of options can be made. Appropriate organizations should be established for the planned development of a river basin as a whole. Special multi-disciplinary units should be set up in each State to prepare comprehensive plans, taking into account not only the needs of irrigation but also harmonising other water uses, so that the available water resources are determined and put up to optimum use, having regards to the existing Argeements and Awards of Tribunals under the relevant laws. Water should be made available to water short areas by transfer from one river basin to another based on a national perspective after taking into account the requirements of the areas/basins."

8.2.2. The successive Five Year Plans have emphasised preparation of Master plans by the State Govts. Some States have made attempts to prepare Mater Plans. Kerala State prepared the plan in 1958 and updated it in 1974. Outline master plans have been prepared by the States of

Uttar Pradesh, Manipur, Madhya Pradesh, (for Betwa River Basin) and similar plans are in progress in the States of Bihar, Haryana and Karnataka. The river basin organisation should have a multi-disciplinary team of Engineers, (Water resources and power) Hydrologists, Agronomists, Economists, Geo-hydrologists, Public Health Specialists, Environmentalists, Social Scientists, etc. Besides preparation of basin plan, the organisation should formulate the strategy for land and water use for the basin and integrate all development programmes implemented by various agencies concerning catchment treatment/watershed management, rehabilitation of oustees from the projects, anti-waterlogging and salinity control measures, conjunctive use of surface and ground water etc. It should also monitor implementation of environmental safegaurd measures along with the development project.

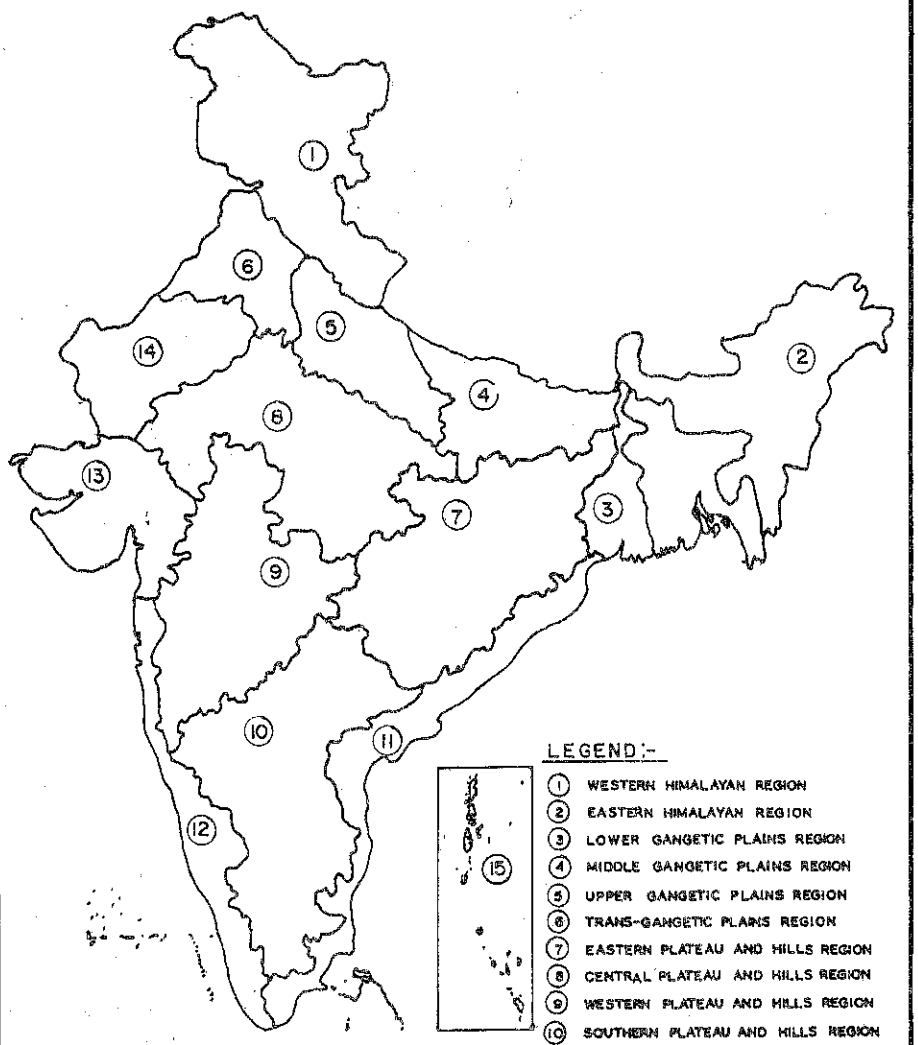
8.3. The ultimate irrigation potential is estimated as 113.5 m ha comprising 73.5 m ha from surface irrigation schemes and 40 m ha from ground water schemes. The irrigation potential from ground water schemes is likely to increase in near future. Besides a National Perspective for water resources development has been prepared with a view of optimally utilising the available water resources of the country by storage and inter-basin transfer from surplus to deficit and drought prone areas. This national perspective envisages an additional irrigation benefit of 25 m ha from surface water and 10 m ha from ground water. Even when the available water resources are harnessed fully, it may be that the entire cultivable area of 186 m ha may not be adequately served with irrigation facilities. Greater emphasis has, therefore, been laid on optimum use of irrigation facilities. The National Commission on Agriculture (1976) has estimated that gross cropped area in the country is expected to increase to 165 m ha in the year 2000 A.D. and

to 210 m ha in 2025 A.D. It is expected that the irrigation potential of 113.5 m ha may be created by the year 2010 A.D.

8.4. **Planning based on Agro-climatic zones**

The country has been divided into 15 broad agro-climatic zones based on soil types, climate and water resources in these zones. Map below shows the details of these zones. Land and water strategies and cropping patterns suitable for each zone have been worked out. 15 zonal planning teams headed by senior Vice-chancellors of Agriculture Universities have been constituted with multi-disciplinary personnel to prepare concrete operational plans for each zone identifying the thrust areas.

INDIA
AGRO-CLIMATIC ZONES



8.5. Conjunctive use of Surface and Ground Water.

Conjunctive use of surface and ground water in the Command areas will enable maximisation of agricultural production and optimise use of available water. This will also help in reducing the ill effects of waterlogging. Crop planning is based on greater emphasis being given for ground water development through public and private investment in the command areas. Operational research on the live systems has been planned in some States by WALMIs and Universities on this aspect. In planning new projects the concept of conjunctive use is fully taken into account so as to optimise use of surface and ground water in the area benefitted from such projects.

8.6. The strategy which needs to be followed in the decade 1990s will not be very different from the one adopted for the Seventh Plan in view of the large number of on-going schemes which are spilling over from plan to plan. Besides, high priority has to be given for speedy utilisation of irrigation potential created and modernisation of projects to protect the existing irrigated areas threatened by deterioration of old irrigation systems. Some of the elements of the desirable strategy are

(a) In a large country like India with significant spatial variations in Agro-climatic condition, region-wise approach for irrigation development has to be followed as the basis of Agro-climatic zones identified by the country for agricultural development.

(b) Implementation of new projects in a fixed time frame.

(c) Carrying out pre-planing studies in order to correctly estimate the cost and benefits in order to avoid frequent change in scope during implementation stage.

(d) Advanced planning of scarce material like cement, steel, coal, oil, etc.

(e) Improved implementation of the programmes by aiding and stregthening monitoring organisations.

(f) Modernisation of existing irrigation projects.

(g) Optimisation of benefits through better management and operation of existing systems through efficient conjunctive use of surface and ground water along with adoption of Warabandi (rostering system).

(h) Efficient water management and formulation and monitoring of irrigation programmes for different seasons in a water year.

(i) Stregthening of Command Area Development Organisations.

(j) Ensuring adequate maintenance of the canals by making adequate financial allocation.

(k) Setting up of a system of regular evaluation of project performance vis-a-vis the project designed aspects.

(l) Detailed investigation for new projects benefiting Tribal areas, drought prone areas and areas having large percentage of Schedule Castes, Scheduled Tribes and other economically weaker sections of the society.

(m) Preparation of environmental impact assessment after carrying out proper investigation for formulation of environmentally sound projects.

(n) Investigations for the national plan for inter-basin transfer of water from the surplus water regions to the water short regions.

II FLOOD CONTROL AND DRAINAGE DEVELOPMENT

1. DIMENSION OF THE PROBLEM

1.1 FLOOD CONTROL

1.1. The total of the unprotected and protected areas flooded in any year, constitutes the area liable to floods. The maximum area damaged in one year is assumed as the summation of maximum areas damaged in each State in any year. Based on this criteria, it is estimated that an area of 25 millions hectares (m ha) is liable to flooding. It was, however, observed during the last decade a number of areas not hitherto considered as liable to floods have been affected. Besides in the areas already protected from floods some area may be flooded due to failure of flood protection works already completed. It was estimated in 1980 that the total area liable to floods as 40 m ha taking into consideration the factors mentioned above. This figure would be updated from time to time based on longer series of hydrological data collected.

1.2. Due to topographical and economic factors, protection cannot be provided to all areas subject to flooding. It is also clear that the same degree of protection need not be provided to all areas liable to flooding. Protection is provided on the basis of frequency of flooding and based on this, areas would be categorised as protectable under frequencies of 25, 50, 100 years or of a higher order. Considering these factors, it has been assessed that the protectable area is 32 m ha. A reasonable protection has already been provided to about 13.8 m ha by the end of the Seventh Five Year Plan (1985-90).

2 DRAINAGE

2.1. The Ministry of Water Resources is currently attempting to get precise data about the extent of waterlogging in different parts of the country. However, the National Commission on Agriculture (1976) estimated that an area of about 6 m ha is water logged in the Country, the State wise distribution being as under :

State	Water logged area in m ha
Andhra Pradesh	0.339
Bihar	0.117
Gujarat	0.484
Haryana	0.620
Jammu & Kashmir	0.010
Karnataka	0.010
Kerala	0.061
Madhya Pradesh	0.057
Maharashtra	0.111
Orissa	0.060
Punjab	1.090
Rajasthan	0.348
Tamil Nadu	0.018
Uttar Pradesh	0.810
West Bengal	1.850
Delhi	0.010
	5.986

Of the total affected area, 3.4 m ha are subjected to surface flooding mostly in the States of West Bengal, Orissa, Andhra Pradesh, Punjab, Uttar Pradesh, Gujarat, Tamilnadu and Kerala. The remaining 2.6 m ha has high water table. Attempts are being made to collect the information regarding area affected due to water logging in irrigated areas based on a uniform norm, as different States follow different norms with regard to the definition of water logged lands. Recently in the Central Ministry of Agriculture has estimated the area affected by waterlogging as 8.5 m ha. which has to be

firmed up by obtaining field data particularly in irrigated areas. Experience for the past 70 to 80 years in the Indo-Gangetic plains suggests effective remedies such as surface drainage to remove excess water; lining of canals to prevent seepage; and sinking of tubewells for lowering the water table. Pilot studies in Punjab and Haryana States in the sixties to determine the most effective methods of reclamation revealed that a combination of measures such as drains and tubewells can effectively reclaim water logged areas.

3. DEVELOPMENT BEFORE INDEPENDENCE OF THE COUNTRY (1947).

3.1 Almost all the civilisations which flourished in ancient times in the fertile river valley, have left behind an account of impressive flood protection works. The ancient flood control measures consisted of embankments along the rivers and tributories and channel improvements. Centuries ago, flood protection embankments were constructed in the Godavari, Krishna and Cauvery deltas of the South India, some of which are still existing. In the North India remnants of ancient embankments particularly in the Indo-Gangetic plain bear testimony to the efforts made in flood control technology over the ages. Early rulers in India paid special attention to the proper maintenance of the embankments which was so vital for sustaining agriculture production. During the latter part of the British Rule, there were impressive lengths of State-owned and private embankments in many States.The records indicate that the flood protection embankments were a common feature in the flood affected States of Bengal, Bihar, Orissa and Deltas of Andhra Pradesh.

3.2 At the time Independence (1947) there were 120 km of embankment along the river Damodar and another 3 500 km of embankments along various channels in Gangetic Delta of Sunderbans in West Bengal. In Orissa there were 1 209 km of embankments along the Mahanadi, 287 km along Brahmani and 160 km along Baitarni. In Bihar, there were 160 km length at embankments along the Gandak river and some stretches along the Ganga and other rivers. In Assam there were 11 km of embankments along the Brahmaputra and some stretches along its tributories. Tamil Nadu also had some embankments along the Cauvery river. In 1947 there were about 5 280 km of embankments in the country giving protection to 3 m ha.

4. DEVELOPMENT SINCE PLANNED ERA COMMENCED IN 1951.

4.1 With the commencement of the First Five Year Plan (1951-56), the traditional approach of constructing embankments was modified in as much as flood protection by moderation through flood space in storage reservoirs was adopted, besides embankments. Simultaneous to the inception of multipurpose projects in the Damodar and Mahanadi Valleys, the flood problem of Kosi in Bihar received the attention. During the first three years of the First Plan (1951-54), before adoption of National Policy on flood problem in 1954, a sum of Rs.14 million was spent on flood control programme which resulted in completion of 456 Km of embankments along the Ganga, Buri Gandak and other rivers in Bihar, 60 km along the Brahmaputra and 140 km along the other rivers in Assam.

4.2. NATIONAL POLICY ON FLOOD PROBLEM AND REMEDIES

4.2.1. With the devastating and unprecedented floods of 1954, the Govt. of India declared a National Policy on flood control which resulted in a comprehensive approach to the problem. In the initial policy statement of September 1954, the following outline of the programme of implementation was indicated.

i) Immediate phase (Within two years).

a) Embankments at related sites.

b) Revetments and spurs, as a measure of protection of towns against river erosion.

c) Intensive collection of data, investigation and preparation of project reports for short term phase.

ii) Short-term phase (from 3rd to 7th year)

a) Embankments .

b) Channel improvements.

iii) Long-term phase (from 8th to 12th year)

a) Construction of selected storage reservoirs.

b) Additional embankments wherever necessary.

iv) Beyond long term phase (after 12 years).

a) Other long term measures.

v) Inter-se priotity in the programme.

4.2.2. Although implementation of the programme, was the responsibility of State Govts,the policy frame indicated that the Govt.

of India would help the States to implement a systematic plan of flood control. Besides the programme indicated in the policy statement, flood warning and watershed management were also to be added as important measures needed. Subsequently a number of Committees both at official level and Ministers level recommended implementation of the programme from time to time and gave proper directions for the success of the programme.

4.3 The total investment on the flood control programme during the period 1951-1985 (Six Plan periods) was Rs. 9 760 million and the area protected from floods was assessed as 13 m ha. The Seventh Five Year Plan (1985-90) envisaged an investment of about Rs.9 470 million which was a big effort compared to the achievement in the first Six Five Years Plans. The achievement in the Seventh Plan in respect of additional area protected was 0.8 m ha.

4.4 **REVIEW OF THE PERFORMANCE IN THE FLOOD CONTROL SECTOR DURING THE PLANS.**

4.4.1. Although the investment for flood control has been increased from year to year in the successive Five Year Plans and more areas are protected, the estimated value of damage due to floods has been on the increase. It was estimated that the total relief expenditure in the Sixth Plan Period (1980-85) was Rs. 12 000 million against the investment of Rs. 7 800 million on the protection programme in the same period. One reason which is contributing to the increased damage is lack of maintenance of existing works. Increased maintenance grants are to be provided to keep the existing works in a fit state to withstand the on-slought of floods.

Non-Structural Measures for Flood Control.

4.4.2. The network of flood forecasting and warning centres that have been established have afforded great help in timely warning for evacuation of people in order to prevent loss of life and minimise damage to property.

4.4.3. The encroachment of flood plains inspite of various Laws controlling developments on these plains, has been one of the causes for increased flood damage. Enactment of suitable flood zoning Laws has been recommended to the States. States are preparing Master Plans to identify exact areas which will be affected by floods of different intensities. States will also prepare maps to delineate the flood affected areas in order to deal with the flood problem scientifically.

4.4.4. Drainage improvement for the areas affected with inundation due to floods was also implemented as a part of the flood control programme and the benefits in terms of area protected also include areas relieved of drainage congestion. The problem of drainage in irrigation project commands is being tackled as a part of the irrigation programme.

4.5. The strategy followed in the implementation of the programme in the Seventh Plan was as under :-

i) Preparation of Master Plan for flood Management, after collecting hydrological and meteorological data and carrying out field investigation to delineate the area prone to floods on maps of scale 1:50 000.

ii) Scientific evaluation of flood control measures to assist the area actually

protected would be continued. Field experiental Research Stations will be accelerated by the Research Institutes at the State and Central levels.

iii) For the introduction of flood plain zoning measures, the survey activities of the Survey of India would be continued.

iv) The maintenance of flood control works has been considerably hampered due to inadquate allocation of funds. In order to augment resources for maintenance, a flood cess may be imposed. Although some States have enacted legislation for imposing a flood cess, collection of revenue needs to accelerated.

v) The flood forecasting network would need to be extended to cover other inter-state rivers so far not covered by Central Agencies.

vi) Before taking up new embankment schemes, the effects of such existing work should be carefully studied so as to consider alternative measures along with the proposals for new embankments.

vii) Soil Conservation and afforestation programmes in the various river valleys should be intensified in order to reduce silt load in the rivers.

viii) Systematic studies of river morphology and river mechanics would be initiated for combating floods and river erosion.

5. PERSPECTIVE FOR EIGHTH PLAN AND BEYOND

5.1 It is estimated that by the end of the Seventh plan (1985-90) an area of about 13.8 m ha was protected. The Rashtriya Barh Ayog (1980) estimated an investment of about Rs.50 000 million for protecting the entire flood

prone area of 32 m ha. In the period 1980 - 90 (Sixth and Seventh Plans) an investment of Rs. 17 000 million was made on the programme. Since the long-term measures such as detention dams would need heavy investment compared to the short-term measures such as embankments, anti-erosion schemes etc., further Five year plans have to earmark funds of higher magnitude for long term measures. If the Master Plans of flood affected river basins are prepared urgently, a proper perspective plan could be prepared so as to at least protect chronically flood affected areas by the turn of the present century.

5.2 The National Water Policy (1987), envisages the following steps for flood control and management :-

"There should be a master plan for flood control and management for each flood prone basin. Sound water shed management through extensive soil conservation, catchment area treatment, preservation of forest and increasing forest areas and the construction of check dams should be promoted to reduce the intensity of floods. Adequate flood cushion should be provided in water storage projects wherever feasible, to facilitate better flood management. An extensive network of flood forecasting stations should be established for timely warning to the settlements in flood plains, alongwith the regulation of settlements and economic activity in flood zones, to minimize the loss of life and property on account of floods. While physical flood protection works like embankments and dykes will continue to be necessary, the emphasis should be on non-structural measures for minimisation of losses such as flood plain zoning, so as to reduce the recurring expenditure on flood relief."

The future development in the flood control sector has to take into account the elements of

the above policy for implementation. Tne strategy for future development should cover the following structural and non-structural measures, emphasis being more on non-structural measures.

STRUCTURAL

Reservoirs, detention basins, embankments and sea walls, channel improvement/drainage improvement, diversion of flood waters and watershed management.

NON-STRUCTURAL

Flood forecasting, warning and preparedness, flood plain regulations, Flood proofing and development policy to dissuade investment in flood plains.

III WATER LAWS AND IRRIGATION ACTS

1.1. Water resources development for irrigation, flood control, drainage, etc., is the responsibility of the State Governments under the constitution of India, which came into force from 1950 Entry 17, List II, i.e., State List in the Seventh Schedule of Constitution is as follows :

"17 Water, that is to say water supplies, irrigation, canals, drainage and embankments, water storage and water power subject to the provision of entry 56 of List I."

1.2. According to entry 56 of List I, the Central Government has been charged with the responsibility for "Regulation and development of inter-state rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest."

1.3. Under Article 262 of the Constitution, Parliament has been authorised to provide by law for the adjudication of dispute or complaint with respect to the use, distribution or control of the water of, or in, any inter-state river or river valley and to provide "that neither the Supreme Court nor any other Court shall excercise jurisdiction in respect of any such dispute or complaint."

1.4. As enjoined in the constitution, Parliament enacted the River Boards' Act, 1956 which authorises, the Government of India, in consultation with the interested States to set up advisory River Boards on the inter-state rivers. As a part of the planning process established in 1951 in connection with the Five

year Plans, the State Governments do not undertake any new major and medium projects unless it has first been cleared by National Planning Commission and Government of India and included in the Five Year Plan. The Central loan assistance is subject to the above overall condition and thus enables Central Government indirectly to guide and influence the pattern of development.

1.5. Under the Constitutional provision, Parliament has also enacted the Inter-state Water Disputes Act,1956, which provides for adjudication of such disputes. Before setting up of Tribunals for inter-state water disputes, the Central Government makes every attempt to resolve the disputes by mutual agreement among the concerned States. Where such efforts fail, Tribunals were set up which have given their verdict in the past e.g. Krishna, Godavari, Narmada.

IRRIGATION ACTS ENACTED BY THE STATES' LEGISLATURES

1.6. Water being a State subject under the Constitution, projects for development of water resources have to be planned, implemented and operated by the State Governments. For regulation and Control of River waters, water legislation was introduced as early as in 1873. Since then every State Government has passed Irrigation Act applicable to its boundaries. Such acts have been amended from time to time as considered necessary. The Irrigation Administration covers such matters as supply of water for irrigation, construction of field channels on the irrigation system, flood control, drainage, prevention of water logging, requisition of labour in emergency protection of irrigation systems, unauthorised irrigation, settlement of disputes among irrigators, assessment of water rates and betterment levy, role of irrigation panchayats and other similar

institutions in the administration of irrigation systems.

1.7. The National Irrigation Commission (1972) had recommended division of the country into 4 distinct regions with a fair degree of homogeniety for the purpose of irrigation administration. The Commission also recommended the consolidation of existing irrigation Laws and suggested framing of model laws. The Central Government, has accordingly, circulated a model Irrigation bill for adoption with such modification as considered necessary to suit the local condition. This is expected to ensure a degree of uniformity with regard to the basic aspects of irrigation administration. Some States have already adopted the modified bill and others are considering adoption of the same in the respective States.

1.8. As regards ground water legislation, which also falls within the preview of States, the Government of India, Ministry of Agriculture had set up a Working Group for finalising the draft Model Bill on Ground Water in late sixties. This was finalised and circulated to the States for consideration. The draft bill provides for the establishment of Ground Water Authority in each state to regulate the extraction and/or use of Ground water in notified areas, to excercise grant of permit to extract and use ground water in notified areas, accomplish registration of existing users, grant licences for sinking wells and also allow cancellation of permits, certificates of registration, licences, etc.

IV. ORGANISATION FOR DEVELOPMENT OF IRRIGATION, DRAINAGE AND FLOOD CONTROL

1. Irrigation being a State subject under the Constitution, irrigation and drainage projects are planned, constructed and operated by the State Governments. While major and medium irrigation schemes are looked after by the State Irrigation Departments, minor irrigation schemes are dealt with by the State Agricultural Department/Minor Irrigation Department which are also responsible for development of ground water through the coordination by the Central Ground Water Board. The Central Government acts as a co-ordinator and promoter of development in these fields. The Central Ministry of Water Resources with the assistance of Central Water Commission and Central Ground Water Board plays an important role in formulating the national policy and in coordinating the activities of the States. It also deals with Inter-State and International problems in the use of water. The Central Water Commission attached to the Ministry of Water Resources functions as a repository of technical information in regard to water resources development in the country and carries out all technical work in connection with water resources development. It provides at the national level, facilities for investigation, design, and execution of various projects and assists as well as conducts various type of research work in the field of water resources. It also carries out technical examination of major and medium projects received from the States before they are approved by the National Planning Commission for implementation under the national Five Year Economic Development Plans. The Central Ground Water Board attached to the Ministry of Water Resources is responsible for exploration, assessment, development and regulation of ground water exploitation.

2. Since early 1980s, the major reservoir projects are subjected to scrutiny from the environmental and forest angle from the Central Ministry of Environment & Forest under the Forest Conservation Act 1980 and later under the Environmental Protection Act of 1986. These statutory clearances are obtained before such projects are approved by Planning Commission for implementation.

3. Control Boards have been set up for large projects particularly the Inter-state projects undertaken in different parts of the country. These Boards include besides representatives of the State Governments concerned, those of Central Ministries of Water Resources, Finance and Central Water Commission. These Boards periodically review the progress of projects and give direction for speedy implementation by taking steps to remove bottlenecks for progress.

4. **WAPCOS**

India, being a leading country in the World in irrigation development, has offered assistance to a number of countries in Asia and Africa in the field of water resources development. For this purpose the Government of India has set up a Consultancy Organisation called Water and Power Consultancy Services (India) Ltd., (WAPCOS). The company provides conprehensive inter-desciplinary coverage of all facets of consultancy ranging from concept to completion to operation and maintenance. The company has registered with International Organizations like World Bank, Asian Development Bank, FAO, etc. It has extensive experience of working in tropical, semi-arid and arid zone. The engineering and Consultancy Services are tailored to the requirement of the clients keeping in view climatic, topographic, socio-economic and environmental conditions prevalent in the area. The company has offered

Consultancy Services to a number of countries in Asia and Africa besides assisting the states in India for preparing feasibility report of projects aided by International Financial Agencies and external donor Countries.

Annexure - I

MAJOR IRRIGATION-PROJECTS COMPLETED IN THE VARIOUS FIVE YEAR AND ANNUAL PLANS

	Esti. cost on completion in Rs. Million	Irrigation potential in million hectares
I. First Five Year Plan (1951-56)		
1. Lower Bhavani (Tamil Nadu)	103	0.08
II. Second Five Year Plan (1956-61)		
2. Malampuzha (Kerala)	58	0.04
3. Ghod (Maharashtra)	56	0.02
4. Harike (Punjab)	91	0.01
5. Sirhind Feeder (Punjab)	67	No direct benefit
6. Manimuthar	53	0.08
III. Third Five Year Plan (1961-66)		
7. Kurnool-Cuddapah Canal(Andhra Pradesh)	80	0.12
8. Badua Reservoir (Bihar)	63	0.04
9. Shetrunji Palitana (Gujarat)	70	0.03
10. Hathmathi(Gujarat)	56	0.03
11. Bhakra Nangal (Punjab, Haryana & Rajasthan)	1763	1.44
12. Matatila (Uttar Pradesh)	125	0.16
13. Sardasagar (Stage II) (Uttar Pradesh)	74	0.07
IV. Annual Plans (1966-69)		
14. Dantiwada (Gujarat)	127	0.04
V. Fourth Five Year Plan (1969-74)		
15. Kaddam (Andhra Pradesh)	84	0.12
16. Tungbhadra Low Level Canal (Andhra Pradesh)	135	0.06

Annexure I (Contd.)

		Esti. cost on completion in Rs. Million	Irrigation potential in million hectares
17.	Tungbhadra High Level Canal Stage I (Andhra Pradesh and Karnataka)	201	0.04
18.	Sone Barrage Remodelling Works and Link Channels (Bihar)	161	0.12
19.	Purna (Maharashtra)	196	0.06
20.	Vir (Maharashtra)	54	0.02
21.	Girna (Maharashtra)	150	0.06
22.	Pus (Maharashtra)	50	0.01
23.	Hirakund (Orissa)	828	0.25
VI.	Fifth Five Year Plan (1974-78)		
24.	Chandan Reservoir (Bihar)	141	0.06
25.	Ghataprabha Stage I (Karnataka)	72	0.09
26.	Ghataprabha Stage II (Karnataka)	653	0.05
27.	Haripur Reservoir (Uttar Pradesh)	65	0.02
VII.	Annual Plans (1978-80)		
28.	Tawi Lift Canal (Jammu & Kashmir)	74	0.01
VIII.	Sixth Five Year Plan (1980-85)		
29.	Kosi Barrage and Eastern Canals(Bihar)	NA	0.43
30.	Rajpur Canal (Bihar)	-	-
31.	Gandak (Bihar & Uttar Pradesh)	-	-
32.	Sone High Level Canal (Bihar)	NA	0.16
33.	Kakrapara (Gujarat)	234	0.20
34.	Mahi Stage I (Gujarat)	436-	
			0.21
35.	Mahi Kadana (Gujarat)	985-	
36.	Ukai (Gujarat)	1364	0.13
37.	Sewani Lift (Haryana)	238	0.05
38.	Western Jamuna Canal Remodelling (Augmentation Canal) (Haryana)	158	0.05
39.	Chambal (Madhya Pradesh & Rajasthan)	1268	0.50
40.	Bhander Canal (Madhya Pradesh)	24	0.04

Annexure I (Contd.)

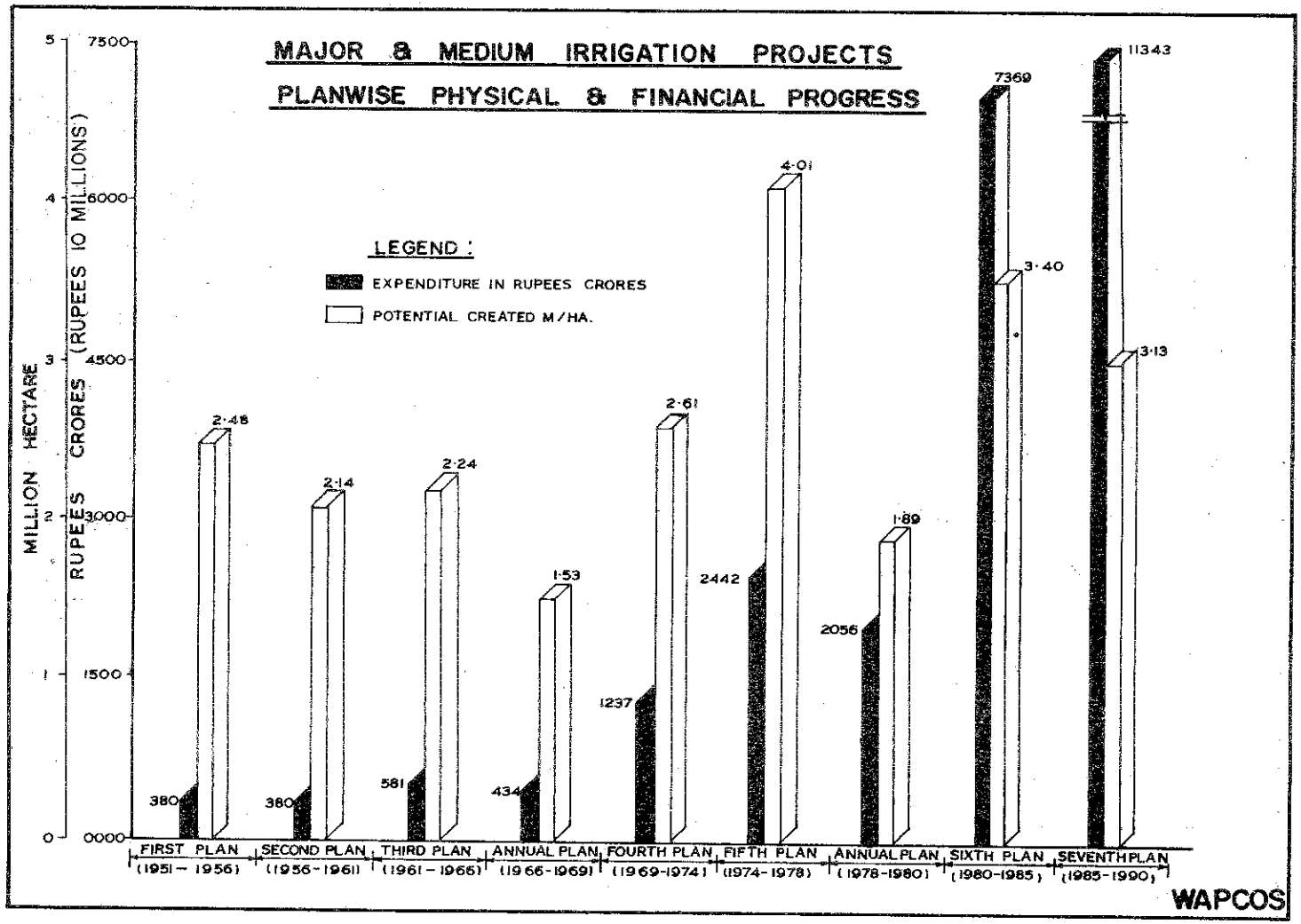
		Esti. cost on completion in Rs. Million	Irrigation potential in million hectares
41.	Tawa (Madhya Pradesh)	1021	0.29
42.	Barna (Madhya Pradesh)	161	0.06
43.	Nasdeo Right Bank Canal (Madhya Pradesh)	143	0.04
44.	Sukta (Madhya Pradesh)	126	0.02
45.	Bagh (Maharashtra)	NA	0.03
46.	Mula (Maharashtra)	323	0.09
47.	Itiadoh (Maharashtra)	NA	0.04
48.	Kal (Maharashtra)	86	0.01
49.	Tulshi (Maharashtra)	73	0.01
50.	Mahanadi Delta (Orissa)	706	0.56
51.	Salandi (Orissa)	164	0.06
52.	Chittar Pattanamkal (Tamil Nadu)	77	0.01
53.	Modernisation of Periyar Vaigai System (Stage I) (Tamil Nadu)	519	0.01
54.	Ramganga Dam (Uttar Pradesh)	1372	0.59
55.	Adwa Dam (Uttar Pradesh)	81	0.02
56.	East Baigul Reservoir (Uttar Pradesh)	77	0.02
57.	Dorighat Sahayak (Uttar Pradesh)	112	0.05
58.	Parallel Lower Ganga Canal (Uttar Pradesh)	494	0.09
59.	Stregthening Sarda Sagar (Uttar Pradesh)	64	Stabilising existing irrigation only
60.	Muyurakshi (West Bengal)	205	0.25
IX	Seventh Five Year Plan (1985-90)		
61.	Vamsadhara Stage I (Andhra Pradesh)	520	0.02
62.	Improvement to Nizam Sagar Stage I (Andhra Pradesh)	302	Stabilises existing Irrigation
63.	Singur (Andhra Pradesh)	1046	0.02
64.	Upper Kiul Reservoir (Bihar)	636	0.01
65.	Western Jamuna Canal Remodelling (Haryana)	125	0.25

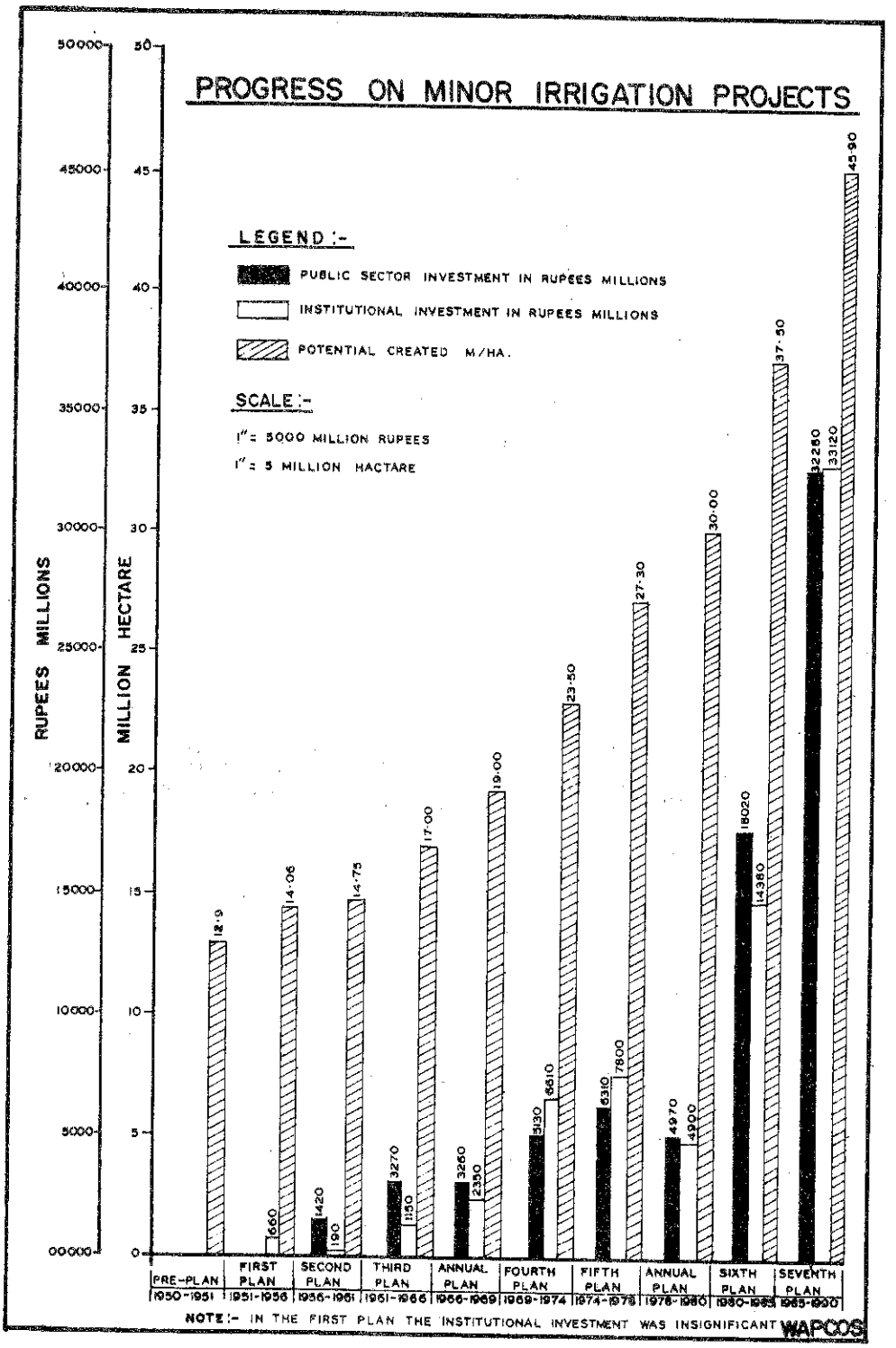
Annexure I (Contd.)

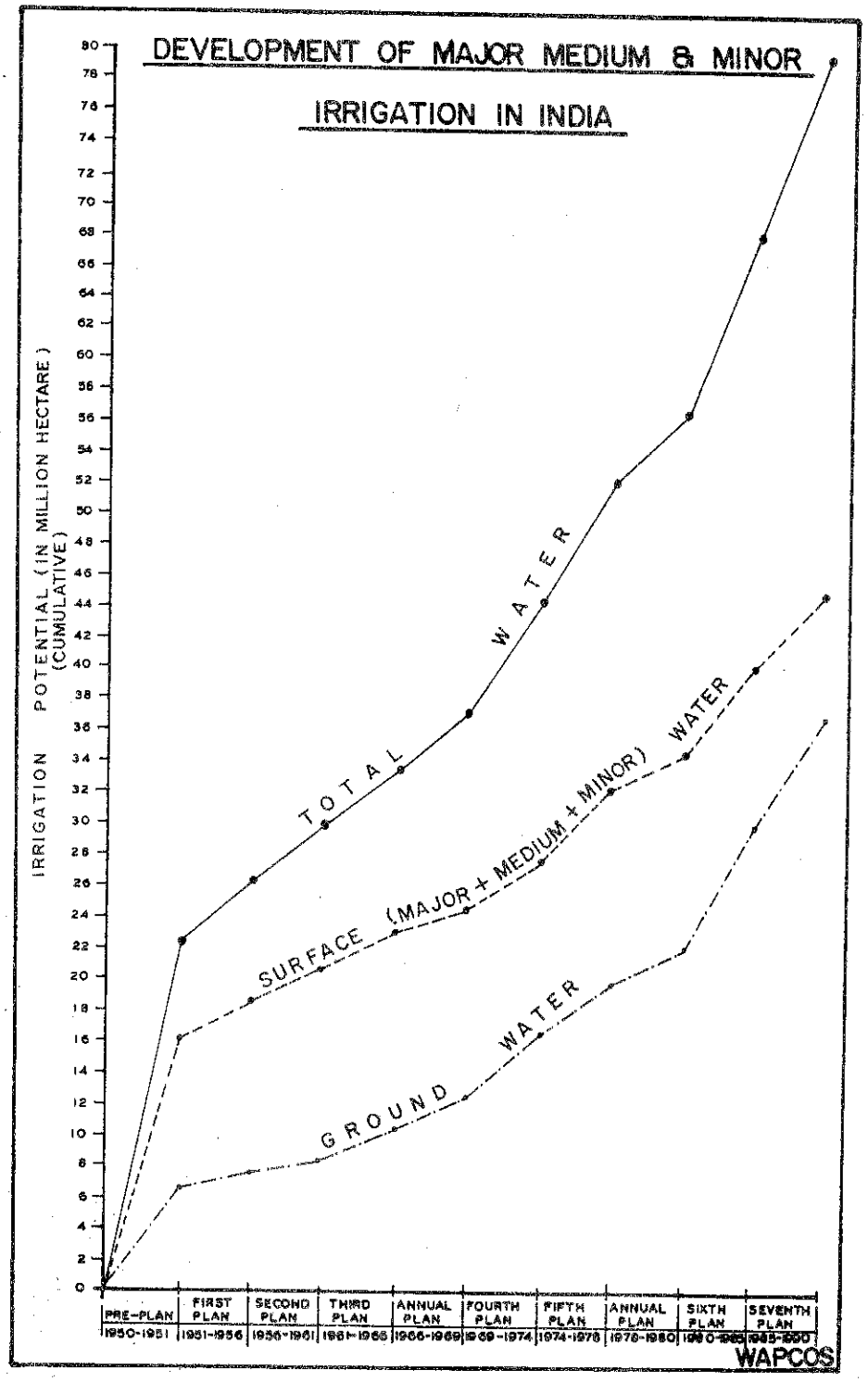
		Esti. cost on completion in Rs. Million	Irrigation potential in million hectares
66.	Loharu Lift (Haryana)	491	0.07
67.	Scheme for Installation of 1500 Sprinkler Irrigation sets (Haryana)	375	0.02
68.	Bhadra (Karnataka)	660	0.11
69.	Periyar Valley (Kerala)	730	0.08
70.	Chitturpuzha (Kerala)	208	0.03
71.	Pamba (Kerala)	634	0.05
72.	Kuthiadi (Kerala)	550	0.04
73.	Kallada (Kerala)	3738	0.09
74.	Manjra (Maharashtra)	322	0.02
75.	Kalisarar (Madhya Pradesh & Maharashtra)	102	0.01
76.	Jayakwadi Stage I (Maharashtra)	3081	0.02
77.	Pench (Mahashtra)	1768	0.09
78.	Gated Weir at Khodasi (Maharashtra)	32	No additional benefit
79.	Loktak Lift (Manipur)	288	0.04
80.	Anandpur Barrage (Orissa)	185	0.04
81.	Mahanadi Birupa Barrage(Orissa)	130.7	No direct benefit
82.	Extension of Non-perennial irrigation to areas under Upper Bari Doab tract (Punjab)	9.2	0.23
83.	Indira Gandhi Nahar Canal Stage I (Rajasthan)	2550	0.59
84.	Mahi Bajaj Sagar (Rajasthan)	3825	0.13
85.	Raising Kota Barrage(Rajasthan)	6	No direct benefit
86.	Modernisation of Periyar Vaigai system Stage II (Tamil Nadu)	950	0.01
87.	Parambikulan Aliyar (Tamil Nadu)	643	0.10
88.	Parambikulan Aliyar (Tamil Nadu) Ayacut Extension	313	0.06
89.	New Okhla Barrage (Haryana, U.P. & Rajasthan)	403	No direct benefit
90.	Remodelling Bhimgoda Head Works(U.P.)	341	- do -

Annexure I (Contd.)

		Esti.cost in completion Rs. Million	Irrigation potential in million hectares
91.	Shahjad Dam (Uttar Pradesh)	334	0.02
92.	Madho Tanda (Uttar Pradesh)	41	0.02
93.	Kosi Irrigation (Uttar Pradesh)	173	0.05
94.	Suheli (Uttar Pradesh)	76	0.02
95.	Raising Meja Dam (Uttar Pradesh)	336	0.02
96.	Kangsabathi (West Bengal)	1320	0.40


MAJOR & MEDIUM IRRIGATION PROJECTS
PLANWISE PHYSICAL & FINANCIAL PROGRESS
LEGEND :
EXPENDITURE IN RUPEES CRORES
POTENTIAL CREATED M/HA.
MILLION HECTARE
RUPEES CRORES (RUPEES IO MILLIONS)
0
1
2
3
4
5
0000
1500
3000
4500
6000
7500
380
2·48
380
2·14
581
2·24
434
1·53
1237
2·61
2442
4·01
2056
1·89
7369
3·40
11343
3·13
FIRST PLAN (1951 – 1956)
SECOND PLAN (1956-1961)
THIRD PLAN (1961 – 1966)
ANNUAL PLAN (1966-1969)
FOURTH PLAN (1969-1974)
FIFTH PLAN (1974-1978)
ANNUAL PLAN (1978-1980)
SIXTH PLAN (1980-1985)
SEVENTH PLAN (1985-1990)
WAPCOS


PROGRESS ON MINOR IRRIGATION PROJECTS
LEGEND :-
PUBLIC SECTOR INVESTMENT IN RUPEES MILLIONS
INSTITUTIONAL INVESTMENT IN RUPEES MILLIONS
POTENTIAL CREATED M/HA.
SCALE :-
1" = 5000 MILLION RUPEES
1" = 5 MILLION HACTARE
RUPEES MILLIONS
MILLION HECTARE
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
00000
50
45
40
35
30
25
20
15
10
5
0
12·9
660
1420
190
14·06
3270
1150
14·75
3260
2350
17·00
5130
6610
19·00
6310
7800
23·50
4970
4900
27·30
18020
14380
30·00
32260
33120
37·50
45·90
PRE-PLAN 1950-1951
FIRST PLAN 1951-1956
SECOND PLAN 1956-1961
THIRD PLAN 1961-1966
ANNUAL PLAN 1966-1969
FOURTH PLAN 1969-1974
FIFTH PLAN 1974-1978
ANNUAL PLAN 1978-1980
SIXTH PLAN 1980-1985
SEVENTH PLAN 1985-1990
NOTE :- IN THE FIRST PLAN THE INSTITUTIONAL INVESTMENT WAS INSIGNIFICANT
WAPCOS


DEVELOPMENT OF MAJOR MEDIUM & MINOR
IRRIGATION IN INDIA
IRRIGATION POTENTIAL (IN MILLION HECTARE)
(CUMULATIVE)
TOTAL WATER
SURFACE (MAJOR + MEDIUM + MINOR) WATER
GROUND WATER
PRE-PLAN 1950-1951
FIRST PLAN 1951-1956
SECOND PLAN 1956-1961
THIRD PLAN 1961-1966
ANNUAL PLAN 1966-1969
FOURTH PLAN 1969-1974
FIFTH PLAN 1974-1978
ANNUAL PLAN 1978-1980
SIXTH PLAN
SEVENTH PLAN
WAPCOS

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