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TOPIC PAPER

INTEGRATED APPROACHES TO WATER RESOURCES MANAGEMENT IN RURAL AREAS IN THE ESCAP REGION

BY

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ABSTRACT

Integrated approaches to water resources management in rural areas in the ESCAP region

This paper places water resources management at the centre of rural development strategies and argues for an integrated multidisciplinary approach. Technical aspects of this approach are reviewed, including the assesament of water resources by type, the means to increase availability, and the need for complementary information on land, topography and soils. Factors determining water requirements for agricultural and other purposes in rural areas are also briefly discussed, and environmental and other problems associated with different types of water resources projects are considered. The setting up of national bodies to co-ordinate all aspects of water resources management is proposed.

In annexes the experiences of India and Sri Lanka in water resources management are briefly described. The dimensions of the tasks, as well as the current administrative arrangements, are reviewed in each case. Brief descriptions are provided of ongoing water management projects. In India, the Rajasthan Canal and Western Jamuna Canal projects; and the Coimbatore ground water and tank irrigation modernization projects (both in Tamil Nadu State). In Sri Lanka, the tank modernization and Mahaweli Ganga Development projects are described.

A further annex describes national rural water supply programmes in Bangladesh, Burma, India, Nepal, Pakistan, Sri Lanka and Thailand.

Contents

I. INTRODUCTION

The improvement of the quality of life of human beings is the most important objective of any development policy. Basic needs of food, shelter, clean water, employment, health, education and social security are fostered by the promotion of appropriate development activities. Nevertheless rural areas in the ESCAP region have generally continued to remain at subsistence levels even though efforts have long been made to improve their social and economic conditions.

The United Nations Conference on Human Settlements (Habitat) Vancouver, 1976 stressed that "Planning for rural areas should aim to stimulate their economic and social institutions, improve general living conditions and overcome disadvantages of scattered populations".

The Conference further noted that in the less developed countries, more than half the population does not have reasonable access to safe and ample water supply. During the current decade, the United Nations and its agencies have, through a series of conferences, spotlighted the unsatisfactory situation in most developing countries and urged the improvement of these conditions and the attainment of certain goals by the year 1990.

Rational use of water resources requires an integrated approach in which, aspects of water quality and quantity, environment and the physical quality of life of man are all associated. The activities relating to water development programmes should take into consideration all environmental and ecological aspects so as to preserve the water quality and quantity required to satisfy human needs for present and future generations. It has been recognized that even with the most optimistic assumptions about the future rates of industrialization and economic growth in developing countries, the capacity to absorb the rural manpower in non-agricultural sectors will remain limited. The bulk of the rural population will therefore be dependent, in the short and medium terms, on agriculture and allied occupations. Agriculture will continue to be the mainstay of the rural economy and will have to play a major role in raising the level of productive employment in the countries of the region.

The annual rate of increase in population projected up to 1985 for countries in the region varies from 1.5 per cent to about 2.5 per cent. Apart from a few countries like Burma and Thailand, most countries of the region are food importers and the food deficits are increasing because food production has been increasing almost everywhere less rapidly than food demand.

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In several countries, most of the reasonably available land is already arable or in permanent crops. Only in a few countries, like Indonesia, the scope for expansion of cultivable land is still considerable. For most of the ESCAP region, the strategy for the technological transformation of agriculture must therefore be focussed on increasing land productivity rather than on increasing the amount of land under cultivation.

Land productivity can be increased by multiple cropping as well as by increasing the yield per crop. The utilization of water resources for irrigation will, in most areas of the region, be the key to the strategy for obtaining increased productivity of the land and will sometimes create opportunities for aquatic production.

In the short term, there is an immediate need for modernization of existing irrigation systems which are already constructed and for improving their compatibility with aquatic production. The distribution system down to the individual farm has to be properly planned and laid out. In most countries, the planning, by the formulators of the schemes, stops at the main canal. The farmers are left to their own devices to adopt make-shift arrangements to take water to their farms. Properly constructed drainage systems exist only rarely. This situation must be remedied if controlled irrigation is to be practised for exploiting the potential of high yielding varieties of crops. Irrigation systems should be so designed as to create ponds for enhancing fishery production.

The long term strategy would be the implementation of new irrigation schemes which would be planned to exploit the water resource potential after taking into consideration all of the environmental factors that would govern such development. Use of surface water, (with and without pumping), should of course be based on the hydrological potentials of the project area. In several areas, ground-water sources can also be used to advantage either for independent irrigation development or to supplement surface water sources, especially, in times of drought. A large percentage of the developing world's irrigated areas (about 50 per cent is in the ESCAP region and it is possible at least to double this extent by proper husbanding of the water resources.

In view of the large capital outlay usually required to implement a strategy for new irrigation development, appropriate technology to suit the factor endowments in each country or drainage basin has to be adopted. Adoption of labour intensive construction methods can utilize the large labour force in rural areas and, at the same time, effect saving of the

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limited foreign exchange resources. Coupled with the efficient use of water is the provision of fertilizers and pesticides for the attaining of the increased yields from the cropping. Both the latter need to be carefully regulated lest the fishery potential of the locality be needlessly eliminated. Adequate credit will be necessary as the demand for agricultural and aquacultural inputs will increase with the realization of the advantages of intensive cropping systems and a stabilized water supply.

The culture and traditions differ among countries in the region. Some of the rural societies are flexible and are receptive to new ideas and innovations whereas others are conservative and rigid. In the latter type of society new technologies may be resisted because the hierarchical basis of the community may be endangered. Community activity and social attitudes must change if agricultural and associated fishery progress is to be achieved. Agrarian and aquacultural reforms are a necessity, specially because small farmers and aquaculturists abound in the region.

II. INTEGRATED APPROACHES TO WATER RESOURCES MANAGEMENT

It will not be an exaggeration to state that not less than 50 per cent of the population in the ESCAP region live below the line of poverty. GNP or per capita annual income is no longer a yardstick to measure the economic and social well-being of a country. Reduction in the inequalities of income groups is now considered a main objective of development and improving the standards of health, education, welfare, etc. as part of development. In short, the index of development is directly linked to quality of life.

It has been estimated that about 70 per cent of the population in the ESCAP region lives in rural areas. The main economic activity in these rural areas is agricultural production where land, water and labour are essential inputs to production. It has been the experience that project approach in preference to programme approach to development has been unsuccessful. Water is a scarce resource in most countries. The management of water resources, therefore, becomes crucial in the development of rural areas where agriculture is the main economic activity. Water has most often been a catalyst in development. Water resources should be managed in such a way that it would be the main link in an integrated development programme for improving the quality of life in the rural areas.

The complexity of the socio-economic and environmental considerations of water resource management and its developmental corollaries leads to the conclusion that an ecosystem approach must be the basis of future projects.

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Furthermore, existing projects can advantageously be evaluated as to their successes and failures, again from an ecosystemic viewpoint. Much can be learned from unanticipated results of existing projects. The ecosystem approach to water resource management is a comparatively new approach. ("An ecological system or ecosystem is any unit of nature in which living organisms and nonliving substances interact with an exchange of materials between living and non-living parts.[1/])

The health of an ecosystem and its parts depends on the interactions of these parts. Major man-made environmental changes as in water management schemes are disruptive to natural functions in such systems, often cataclysmically so and have led to human suffering water management schemes produce environmental changes; hence only integrated, ecosystemic approaches to their planning and implementation can help avoid against wasteful, damaging and irreparable results.

1. Storage of water

Most countries of the region experience seasonal rainfalls over short periods followed by long periods of drought. Maximum utilization of the direct rainfall coupled with provision of adequate storages will therefore be necessary. Construction of dams across streams and rivers for the creation of storage reservoirs has been carried out for centuries in several countries in the region. These reservoirs are usually located in rural areas, (where land values are low thereby minimizing cost of land submergence,) for the direct benefit of the rural population. However, the rural environment is sometimes seriously affected. People are dehoused, health problems arise, wildlife is endangered, lands downstream of the reservoir become water-logged and the entire landscape is transformed. These open reservoirs also lose large quantities of water by evaporation and evapotranspiration.

Ideal storage conditions, as far as the environment is concerned, could be found underground. The water in underground aquifers is called "ground water". These underground aquifers exist in varying quantities depending on the geological characteristics of each area. The location of suitable aquifers and the extraction from them need special, (often energy-expensive), techniques. With dwindling surface-water resources and scarcity of land for open reservoirs, increasing attention is now being paid to the use of ground water.

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1/ "The Ecosystem Approach", Report of the Great Lakes Research Advisory Board of the International Joint Commission, Canada and the United States 1978, p. 49.

2. Steps to increase water availability for use

All water that is received as rainfall (or snow-melt) cannot be harnessed by open reservoirs or ground-water aquifers. A fair percentage of the water is lost by evaporation, surface runoff, and stream flow to the ocean. However, steps including the following, can be taken to minimize such escapes:

(i) Adoption of soil conservation measures such as ploughing and contour-bunding to retard runoff and induce recharging of groundwater aquifers. These measures will also reduce soil erosion and consequent siltation of reservoirs.

(ii) Afforestation of land, specially the steep areas, has the effect of slowing down runoff and reducing sheet erosion and flash floods. This would also mean that clearing of steep lands for human use, excessive grazing by cattle and other activities that would reduce the vegetative cover like "slash and burn", should be avoided.

(iii) Cloud seeding methods have been employed to induce rain at times when stored water is not available for use.

(iv) Special steps are sometimes adopted to prevent seepage losses as well as evaporation losses from reservoirs and canals.

3. Controlled use of water

In most countries of the region, water resource development schemes are sponsored and implemented by the State or group of States. Little, if any, direct charge is made on the beneficiary, especially in irrigation schemes, for the quantum of water used. In most countries, a token charge is based on the acreage served, and even then the recovery is not in proportion to the investment and recurrent expenditure incurred by the State. The service by the State is considered to be "welfare" activity designed to increase food supply and promote better living conditions in the rural areas, and also to achieve the objective of redistribution of income to poorer sections of the country.

The foregoing situation is however fast undergoing charge. Acute shortage of water for meeting the requirements of agriculture has led in most countries to strict control and conservation methods. These methods include lining of canals for the reduction of seepage losses, provision of adequate control structures in the canal system, improved farm preparation to attain uniform irrigation over the irrigated area, enforcement of rotational irrigation systems, and selection of suitable cropping patterns to match the soils. Framing and enforcement of suitable water legistation is also playing an important part in promoting rational use of water.

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In countries where water availability is less than the requirement for irrigation of available land, cropping intensity is sacrificed for benefitting a larger area. This policy decision tends to spread the benefit of irrigation water over a larger population. In such a situation, use of water has tended to be economical even though full use is not made of the land potential.

4. Public participation

As most water resources development projects are State-sponsored, officials of the State exercise control over farmer activities. The officials are generally entrusted with: (i) the task of supplying, or maintaining, the supplies of agricultural inputs, (ii) arranging credit, (iii) arranging or supervising marketing, and (iv) looking after the general welfare of the farming community.

Farmers have thus become dependent on the officials and have often tended to lose initiative and self-reliance. For sustained and improved development, self-reliance is very essential. Farmers' associations, co-operative societies, cultivation committees and other similar popular organizations are being developed so that officials can withdraw from a project after initial years of development.

5. Formulation of projects within a programme

In implementing a programme for action, well formulated and eco-systemically planned projects are necessary. An over-all plan for the use of water has to be prepared after an assessment of the water and land resources along with ecological study of existing land-use patterns of the area to be developed. If the area to be developed is a water-deficit area, diversion from adjacent surplus areas may be considered.

The total needs of the population in the area to be served has to be given consideration. Irrigation water supply, community water supply, water requirements for inland fisheries and agro-based industries, have to be assessed and plans formulated to meet such demands. Along with the formulation of proposals for the use of water, complementary activities such as provision of adequate housing, health and educational facilities, roads and communication, marketing and recreational facilities have to be provided, if the development programme is to be successful.

III. NEED FOR MULTI-DISCIPLINARY APPROACH TO PLANNING

Several countries in the region had developed irrigation schemes dating back to many centuries. These traditional irrigation schemes utilized both surface and ground water. The "Persian Wheel", tank irrigation schemes, and minor river diversion schemes helped to maintain the rural population at a fairly comfortable standard of living. These rural schemes, in isolated village settlements, were self-contained units which were capable of meeting the basic needs of the village population.

1. Engineering approach to irrigation schemes

With the explosive increase in population, limited availability of land resources, many rural people have now been reduced to subsistence level farmers. The Governments, in a desire to produce more food for an ever-increasing population, planned ambitious irrigation schemes. These schemes were masterpieces in engineering design and construction. Large reservoirs and canals have often been constructed at high cost to the economy and ecology. In many instances, farmers were left to their own devices to take the water to their farms. Traditional farm inputs like organic manure and animal power for ploughing, usually proved inadequate to meet the new demands. Supplies of artificial fertilizers and of mechanical farm power could not be obtained readily, for want of capital resources. In some instances, soils were not suited for the type of cultivation undertaken and excessive irrigation and poor drainage facilities added to the deterioration, including salinization of the soils. Credit and marketing systems also were not geared to meet an intensive and systematic method of farming. In short, the irrigation projects persistently failed to achieve the levels of production envisaged.

2. Multi-disciplinary approach to irrigation schemes

The need for a multi-disciplinary approach to planning of irrigation projects has long been realized in the region. (Please refer to the "Lower Mekong River Basin and Mahaweli Ganga Development in Annex II.) Engineers, scientists, rural planning architects, economists, credit and marketing specialists, agronomists, ecologists, sociologists and others are required to work as a team for proper formulation of projects. The farmer and the people concerned are consulted at every important stage of decision-making. The service organizations and the infrastructure facilities are carefully planned to ensure a smooth production capability. The farmer is made to concentrate on his production activity with all inputs, more or less, supplied at his door step. Credit facilities are so arranged that the farmer is in a

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position to secure farm inputs at the required periods without being exploited by profit-motivated traders, middle men and others. Agricultural and fishery extension workers are generally provided by State Agriculture Departments so that the farmer gets the necessary advice and guidance in his farming activities. The marketing of the farm products normally poses problems to the farmers thereby proving to be a disincentive to production. This has been overcome by various methods in different countries, viz., guaranteed minimum prices by State, supervised market auctions of produce, stockpiling by State or State-aided organizations, etc.

IV. ASSESSMENT OF WATER RESOURCES

1. Hydrology

Precipitation is the basic source of fresh water supplies. In most countries of the region, rainfall measurement stations have been established and rainfall records are available for long periods of time. The average rainfall, in any basin, can be computed by giving weight factors to the precipitation at the station in proportion to the area the station is likely to influence, and then finding the weighted average.

Stream flow measurements are usually made at convenient and strategic locations in streams to estimate availability of water for development purposes. Automatic river stage measuring devices or simple gauge post measurements are used to obtain data regarding stream flows. Stage-discharge relationships are worked out for each station periodically to co-relate the stream flows with the stage heights.

Evaporation and evapotranspiration losses affect the availability of water. In evaporation, water is lost directly from the water surface by vaporization. Transpiration is the process by which roots of plants take in water from the soil and release it to the air as vapour. Evaporation can be measured by continuous measurement of the water surface derived from measurement in a standard evaporation pan.

In most countries of the region, hydro-metereological data, including precipitation and evaporation, are available for representative locations. Stream flow records are also maintained in several countries. Though these records are available for several years, yet in some cases, the data available may not be reliable. Further, flow records at sufficiently close intervals are not available during times of flood storms so that computation of probable maximum flood by statistical methods may not be feasible. Generally, the data on precipitation are found to be more reliable.

2. Ground water

Ground water has been increasingly used in recent years. Development of scientific methods for location of ground water coupled with improved design of drilling equipment has promoted the use of ground water to augment the fast diminishing sources of surface water. In several countries, conjunctive use of ground water with surface water sources is being adopted for optimization of agricultural production. In several arid and semi-arid regions, ground water also forms the main source for community water supply, especially when long periods of drought cause the surface water sources to dry up.

The availability of ground water in any catchment can be estimated by studying the water balance in the catchment. However, the procedures for locating the aquifers is more complicated, especially in hard rock areas. Geological mapping, geophysical and seismic investigations followed by exploratory drilling, pumping tests and maintenance of records of recharge rates have to be carried out using sophisticated instruments and skilled personnel. Control of exploitation of the aquifers is very essential if serious problems are to be avoided in later years.

In arid or semi-arid zones, where the annual evaporation is higher than the precipitation ground-water aquifers are likely to be recharged during heavy rainstorms. The extent of ground-water storage has to be carefully assessed and exploited so as to evenly distribute the available fresh water during dry periods and even carried over to subsequent dry years.

In humid tropical climates, the exploitation should guard against: (a) seawater intrusion, (b) subsidence and compactions of aquifers caused by excessive pumping.

Artificial recharging of ground-water aquifers has been practised in some industrial countries including Japan. Techniques of recharging applicable for introduction to developing countries have yet to be evaluated for general usage. However, incidental recharging of aquifers takes place when large storage reservoirs are constructed or when irrigation (specially paddy irrigation with standing water) is practised on a large scale.

For the present, investigation and development of ground water is best carried out by agencies of the Government. An adequate legislative framework should be available to control the rate of exploitation from the aquifer. Over pumping could lead to the depletion of the aquifer, saltwater intrusion and even to land subsidence.

/Developing

Developing countries in the region need technical assistance and managerial guidance for evolving a balanced programme of exploitation of their ground-water resources. Co-operation from the United Nations agencies and from more advanced countries in the region is necessary to plan out a balanced programme of development.

3. Water quality

The quality of water available for utilization is a very important factor which has sometimes been ignored during the initial stages of project formulation.

Water quality varies during different seasons and is also affected by industrial and town affluents. Its use for irrigation, community water supply systems and industrial purposes needs to be carefully considered.

The suitability of water for irrigation is assessed from the following factors: conductivity, content of soluble salts, nature of soil to be irrigated, drainage availability and type of crops to be grown.

For drinking and domestic use, water either low (total dissolved solids $\leq$150ppm) or moderate (total dissolved solids 150-500 ppm) in mineral content is acceptable. In addition, the iron content should be $\leq$1.5 ppm and also the water should be free from bacteriologic contamination and poisonous elements as well as chemical components that import undesirable flavours and odours.

Domestic sewage has been identified as a pollutant of water in many countries. Present methods of sewage disposal, either raw or improperly treated, to inland waters has led to worsening of the quality of water.

The use of large quantities of fertilizers, pesticides and herbicides in intensive agricultural farm management tends to increase the concentration of harmful chemicals in the water.

Salinity of water could often be increased in inland waters as a result of intensive use of water for irrigation and the increase in salt concentration arising from evaporation. Intensive animal husbandry practices have also been identified as a contributory factor for the deterioration of water quality.

The need for effective treatment of effluents before discharging to lakes and waterways has become very urgent in the context of increase in human activity in most rural areas. As the use of fertilizers, insecticides and herbicides cannot be limited, the reuse of drainage water has to be carefully planned out so that health hazards are minimized. Water quality tests have to be carried out periodically to monitor the use of chemicals.

/Equipment

Equipment for the recording of basic parameters on water quality are not in widespread use in most countries of the ESCAP region. There is a need to share information in experiences gained so far and to introduce an effective system of monitoring and control of the quality of water.

V. LAND RESOURCES

Land, in most countries of the region, is a scarce resource. In general, rural areas occupy a major part of each country and these areas sustain the majority of the population by producing their food requirements. The base for practically all development in rural areas is the use of land and water for agricultural production. Water used rationally on the land can help increase agricultural production to meet the demands for food in the region. But a planned approach is necessary in determining the land and water use strategies in each country. The available land has to be set apart for definite uses by an advanced system of land use planning in an ecological context. The normal usage in most countries can be classified as follows:

(i) Non-arable hills and hill slopes sometimes wooded to prevent soil erosion.

(ii) Arable land which is cultivated or left fallow for want of water resources.

(iii) Forest lands which are maintained to support the fauna and flora and also to supply the timber necessary for man's uses.

(iv) Area occupied by lakes and inland water ways. These could include man made lakes and canals, lagoons, river water ways etc.

(v) Land occupied for cities, villages dwelling purposes, public utilities roadways etc.

(vi) Natural pastures where livestock can be maintained.

(vii) Desert areas, swamps and marshes.

For each country, a judicious approach to land use planning is necessary so as to demarcate the use of land for the required purposes without endangering the environment.

Topographical maps are required for a planned approach to the use of land. Most countries of the region have topographical maps to different scales and containing varied information such as contour heights, natural streams etc. Aerial photographs are also available in most countries. These topographical maps and aerial photographs can be used for preliminary planning for development activities. However more detail ground surveys or contour maps prepared from aerial photographs are required for detail planning of projects.

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For effective land use planning, soil survey maps are required. Some countries have reconnaisance-type soil maps prepared to scales of about 1:50,000. These scale maps are normally prepared by interpretation of aerial photographs coupled to a limited extent with verification by field checking.

When any specified area is planned for project development, a detailed soil map to scale of 1:5,000 or 1:10,000 should be prepared using field investigation data. Planning of irrigation and drainage systems require detailed soil maps so that the varieties of crops, the quantum of irrigation water and drainages can be determined.

For general irrigated agriculture, the most satisfactory soils are the deep well-drained alluvial deposits of medium or medium to fine texture that are readily tilled and highly productive. Such soils permit easy development of root systems, proper circulation of air and water through the root zones and have good moisture holding capacity for plant use between irrigations. Heavy clay soils are hard to cultivate, are likely to be inadequately aerated and do not permit ready penetration of water to the root systems. In irrigating heavy clay soils, water must be held on the field surfaces for long periods, often resulting in large losses of water by evaporation and lateral seepage. Clay soils are very suitable for cultivation of rice, where continuous flooding is necessary during the growing season.

Deep soils are preferable to shallow soils as they provide more storage for moisture between irrigation and also more space for the root systems.

Most irrigable soils are composed of inorganic or mineral materials with a small percentage of organic matter and humus in the surface layers. This organic matter in soils is supplied by vegetation and in turn supplies the plant nutrients.

Soil structure, that is the arrangement and coherence of the soil grains, is an important factor in successful irrigation. Soils in which the different particles cling together in groups are desirable as such arrangement of particles facilitate air and water circulation through the soil as well as permit the development of adequate root systems.

Permeability of the soil is also an important property as it governs the movement of moisture through the soil mass. Maintenance of adequate soil permeability is essential for continued production of crops in irrigated lands.

/Acidity

Acidity/Alkalinity (pH.value) of the soil are also important factors to be considered. Soils which are neutral (pH = 7) or near neutral are preferable for most farm crops. Some crops grow best on soils that are slightly acidic (pH < 7) while others prefer slightly alkaline soils. Special treatment of soils will be required if the soils are too acidic or too alkaline.

VI. AGRICULTURAL WATER REQUIREMENTS

Water requirements for agricultural purposes depend on climate, soil type, crop season, nature of crops to be grown, and finally, the type of irrigation system adopted.

In most countries of the region, it is possible to grow crops throughout the year. Usually the crops to be grown will depend on the demand for the crop, which is controlled by market forces and national priorities. The irrigation requirement will be the actual crop-water requirement less the effective rainfall during the crop season. Recent agricultural research has produced several plant varieties of shortened growing season in place of the traditional varieties which need water for longer periods. For example, several new varieties of rice have now been successfully introduced cutting short the irrigation period by 4 to 6 weeks, without any reduction in crop yields. Of course the choice of cropping pattern has to be carefully made so as to optimize the benefits from the available water, and other resources. Crops like rice, which require large quantities of water are more appropriately grown in the rainy wet periods so that the best use is made of the available direct rainfall. In permeable soils, it might be wasteful of scarce water resources were rice to be grown during rainfall-deficit periods or locations. Alternatively crops such as gram, sesame (gingelly) can be successfully grown with very little water during dry periods. The choice of crops and cropping patterns, apart from considerations of water availability, will depend on the market forces. No farmer can be persuaded to raise a crop which will not bring him an adequate return for his efforts unless he farms solely for subsistence.

Several types of irrigation systems can be laid out. "Drip" irrigation which has recently been introduced consumes the least amount of water per crop. Sprinkler irrigation, which is generally practised for high value crops, is also a practical method of irrigation. However basin or flood irrigation is usually adopted for growing rice where standing water is a necessary feature.

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In addition to the actual crop water requirements, there are losses that must be provided for. The conveyance losses in canals can range from 20 and 50 per cent. Farm application efficiency depends on the farmer as well as on the design and layout of the farm and water application procedures.

It has also been found that during the first few years of irrigated cultivation, water requirements are ordinarily much more than when soil conditions are stabilized after some seasons of cultivation.

In designing a project, all the foregoing factors and others must be judiciously evaluated and integrated so as to evolve a satisfactory development programme that is environmentally as well as economically feasible.

VII. RURAL COMMUNITY WATER SUPPLIES

1. Community and industrial needs

Provision of community water supply for the rural population has often not been given adequate attention. Statistics compiled for southeast Asia by the W.H.O. indicates that approximately 50 per cent of the urban population have access to piped water while less than 20 per cent of the rural population had the benefit of such supplies. This situation exists inspite of the fact that a vast majority of the population in the region lived in rural areas.

In most countries, ground-water sources have been a principal source of supply. Open dug wells are commonly in use. Streams, irrigation canals and other surface water sources are also frequently used. These latter sources of water cannot be considered to be safe. Diarrhoea and enteric diseases arising from polluted water supplies are known to be major contributory factors causing illness and death among children in the region.

The United Nations Water Conference (Mar del Plata, 1977) stressed the need to attach high priority to meeting the 1990 target for providing all peoples with safe water and a step-by-step approach to implement this goal was suggested.

Statistics of progress of provision of water supplies to rural communities in the region are very meagre. The rural communities are so geographically dispersed that provision of wholesome water supplies to such small communities proves to be expensive. In some countries of the ESCAP region, cluster type of settlements are being planned and executed as part of an integrated approach to planning of vast irrigation schemes. Rural water supply schemes may best be planned as an integrated package deal in a programme of water resource development for agriculture and livestock.

/Rural

Rural water supply schemes utilize rivers, streams, irrigation canals and small reservoirs from where the water is treated by chemical coagulation, sedimentation and filtration and finally chlorination, before supply to the consumer. In areas with good ground-water aquifers, deep tube wells are used for pumping to overhead storage tanks. For very small communities, shallow tube wells with hand pumps are also being provided to individual families or groups of families. In order to reduce initial investment costs, it may be desirable to adopt simple treatment procedures without specifying expensive and sophisticated equipment for such purposes. However, care is required to maintain minimum standards of water quality.

Maintenance of rural water supply schemes is often neglected. After the construction phase, several water supply schemes have failed to serve the purposes for which they were intended. Careful monitoring of the operation as well as the use by the consumer is necessary if the benefits are to be sustained. Training of staff for operation as well as for monitoring the schemes should be considered to be an important aspect of project planning. It has often been found that staff from rural areas are better suited for this type of work.

The United Nations Agencies (WHO, UNDP, UNICEF) have been providing assistance in the form of services of consultants, training programmes for staff and finance research activities.

A determined effort has to be made by all countries to achieve the goal set by the United Nations Water Conference. Statistics of existing facilities available has to be gathered and a planned step-by-step rational programme of investments should be made during the next decade.

VIII. IRRIGATION PROJECTS

In most countries of the region, irrigation projects are essential parts of water resource development schemes. Irrigation reservoirs or river diversions form the basis of most of them. Pumped irrigation projects either from ground-water sources or surface sources also exist. Increased utilization of the water resources could be made by (a) increase of stream flow by water-shed management;(b) cloud seeding; (c) artificial recharge of ground water.

Sometimes a reservoir is chosen for irrigation water storage because it appears to be the only feasible and economical means of reaching a goal. Reservoir projects produce major environmental changes and also have significant economic effects such as redistribution of land, income and employment opportunities. Certain people may be adversely affected, as when they have

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to be relocated. The decision to proceed with a project should be made after careful analysis of the likely impacts, good and bad, in the area. Though prediction of the impacts is often difficult and fraught with uncertainties, yet it must be made so as to provide a basis for comparing the proposed project with other alternatives.

The magnitude of the project to be developed has sometimes been the subject of debate. Obviously, each class of project has its own merits and demerits and often a general consensus of opinion cannot be reached. The important factor, that the planner needs to keep in mind, is that the project has to satisfy and fit in with the environment and needs of the people.

Large scale projects usually have long gestation periods. The investigations, planning, formulation of proposals and the arrangements for financing for such projects may take four or five years or longer. The construction of the engineering works and the development of the land for irrigation may proceed for ten years or more depending on the magnitude of the project and the extent of land development and resettlement work involved. The deferred benefits on the large capital investment may be considered, in usual economic analysis, to be a poor return and therefore not viable. If in a particular country or area, there are sufficiently large numbers of feasible small scale projects to satisfy the water requirements for agricultural and other requirements, then the choice is likely to be the group of small scale projects. This type of situation does not exist in several areas. For example, transformation of the Rajasthan desert into flourishing farm lands and settlements would not be possible by the implementation of small scale projects. (See case study in Annex I.)

Invariably, large irrigation projects are conceived as components of multi-purpose projects thereby reducing the cost of water for agricultural purposes. Benefits from hydro-power production, flood control, inland fisheries, navigation and recreational facilities afforded by the project can justify a major portion of the investment. The cost of water for a unit of farm area can, in such multi purposes projects, be even less than that in a minor irrigation project.

Large scale irrigation projects often include provision of roads and communications, hospitals, schools, market places and other facilities which inflate the cost. These additional costs often come to be justified as, development of roads and communication increase land values in the project area. Additional health, education and related facilities generally have to be provided for the existing and increasing population. Without such facilities,

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whether with or without the project, quality of life of the population cannot be improved. If without a large scale project, the desired improvement to the quality of life in the area may not be achievable, the option available to the planner is obvious. However, it is repeated, serious notice should be taken of the environmental effects of such large projects.

Effects of submergence of large parts of valuable land for reservoirs, displacing human population, reducing the habitat available for wildlife, clearing large extent of land for farming, raising of the water table in areas below the reservoirs (sometimes resulting in water logging), health hazards such as schistosomiasis, water pollution by extensive use of artificial fertilizers, pesticides, and herbicides have to be carefully analysed during planning of a project. The harmful effects of some of these factors can be reduced by careful study, evaluation of alternatives and taking of precautionary measures.

Development of Minor Irrigation Projects can play a very useful role in the development of an area. These projects are usually designed to satisfy village level or other local demands. For example, a small farming community may be dependent on rainfed agriculture for its livelihood. This type of community in most countries of the region, is composed of small farmers, living below the poverty line. If topography permits and the minimum water resources are available, it may be possible to construct a small irrigation reservoir in order to provide supplemental irrigation to cover periods without rainfall. The time period and capital required for such a project would be small and the benefits can be achieved almost immediately. The water stored in such minor reservoirs can also prove to be very useful for domestic cattle in times of drought as well as for communal fish production.

Examples exist where the area submerged by small irrigation reservoirs constructed at village level being even larger than the area irrigated under them. These shallow reservoirs, in effect, become large scale evaporation pans. This type of situation has to be avoided.

Tube wells have been cited as classic examples of quick-yielding investment falling within the scope of minor projects. Provided that the skills, technical know how and drilling equipment are available, tubewells can be considered favourably. Success of a tubewell often leads to proliferation of tubewells in the adjacent areas. In course of time, the over exploitation results in depletion of the ground-water aquifer and a collapse of ground water supply in the area. If a tube well programme is envisaged, a proper study of the water balances in the area has to be undertaken, before

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a development programme is embarked on. Such a study may take two or more years depending on the size of the catchment basin under consideration.

In most countries of the region, farmers are not well versed in technical skills and management abilities. Village level projects therefore, go into disrepair very quickly as a result of lack of proper maintenance and improper operation. Training of people at village level should therefore form part of the programme for such projects, a vigorous and continuing input is required.

Size of reservoir, and the design of the component features are decided on engineering data as well as assessment of the environmental impact in the area. Until recently, construction of the reservoir and perhaps the main canal were considered ultimate goals in development projects. The beneficiary i.e. the farmer, was required to devise his own methods to take water to his farm. Several schemes have been delayed by this type of approach and invariably the anticipated project benefits were never realized.

In a new approach to irrigation development, well laid out channel systems are constructed by the project authorities so as to take the water right up to the farmland. Some authorities even develop the farm on a scientific basis for the farmer so that he can have a ready-made site. In these instances, the farmer has only to look after the recurrent seasonal inputs for his cultivation.

When the canal system has been constructed and the farm developed, the use of water in the system has to be carefully managed, so that the maximum use can be made of the scarce and costly water resource. The farmers have to be collectively involved in the planning and management of the water. They have to be taught the correct use of water and careful monitoring must be carried out so as to optimize its use. In some countries, measurement of water used by individual farmers is carried out so as to charge for the use of water. Though this economic procedure may reduce consumption of water, in the developing countries, where small farms are predominant, this type of economic control may not be feasible. Collective responsibility and management appear to be suitable goals at which to aim.

Use of ground water can be an important addition to the direct canal system from the reservoirs. Pumping from the enriched water table in the irrigated area could supplement the direct irrigation especially at the tail end of the scheme or during times of drought.

/Cloud

Cloud seeding to supplement the water resources has been tried out in some countries with limited success. There has been insufficient evaluation of the success of this type of development.

IX. FARM SETTLEMENTS

In most water resources development schemes, the project areas are in generally undeveloped parts of the country. Some have therefore served to settle landless people from thickly populated rural areas where competition for the scarce land and employment opportunities is very great. Thus new villages have to be developed to make the scheme workable. Most settlers desire to remain as close as possible to their original homes or family or clan groupings, although a significant minority opts to use relocation to seek a new way of life. Sociological studies to ascertain the background of the settlers in their original habitat are necessary to minimize disruption.

It has been the experience in some countries that community leadership is not available among the new settlers. Selection procedures have to be evolved so as to include, for the new communities, a sufficient number of settlers who have shown leadership qualities in their original villages.

The farm settlements should be carefully planned so that reasonable amenities are available to the settler. Generally, these facilities should be better than in their former places of abode. Well laid out roads are essential for providing a satisfactory transport system. Schools for the education of the children, hospitals and health services, postal services, community water supplies, domestic sewage and waste handling facilities, rural electrification (though considered a luxury in most developing countries) have all to be planned ahead and made available to the settler if his physical quality of life is to be improved. Failure to provide such facilities and services may, in the long run, affect the viability of the project.

Farm sizes should be adequate to provide the farmer an income to enjoy the commonly accepted reasonable standards of living in the country. It would be an unfruitful exercise to restrict farm sizes and continue the farmer's previously depressed living conditions in the new village areas. In contrast, the farm sizes should not be so large that the farmer cannot tackle his farm operations with his family labour supplemented by occasional use of hired labour or farm machinery. It is commonly acknowledged to be the best if the farmer has ownership of his land so as to encourage him to develop and maintain the land in good productive status.

/Agrarian

Agrarian reforms have been introduced in several countries of the region. Historically large landowners exploited farm labour. Classically the farm labourer, apart from his wages, had little interest in the farm. Farms were neglected as the big landlord had sufficient income, even with low production in the farm, to lead a luxurious life. National production efforts were seriously affected under these conditions. By a series of land reform laws, Governments have placed a ceiling on the land holding of each individual. Under such an arrangement excess land holdings had to be sold to others or in some countries the State expropriated the excess lands and distributed them to landless peasants. The production from such redistributed lands has typically increased in areas where high levels of management skills were not required.

Farm operations have become very costly ventures for the small farmer. The working capital for the normal inputs (viz. hire of farm machinery and labour, purchase of seeds, fertilizers, pesticides, herbicides) often exceeds the financial reserves and borrowing power of the farmer. Agricultural credit with low interest has to be arranged through banks or other rural institutions. The farmer usually runs severe risks when he operates on agricultural credit, as an unforeseen drought or pest attack can leave him penniless. In some countries, crop insurance schemes, for the payment of a small premium, assure the farmer of compensation for any such loss that he may sustain.

Agricultural research and extension services should reach the farmer regularly. Training programmes should be arranged so that receptive farmers could be given adequate training in the latest techniques in cultivation and other allied subjects. These farmers, after training, could by example, disseminate the detailed knowledge that they acquire during the training programmes.

Marketing is an important function that has to be catered for by the project planners. Even the best of land and ample water resources will not encourage the farmer to produce if an adequate market is not available to him. In some countries "price support", "guaranteed prices" for purchase by State and other forms of price determinations are made to assure the farmer of a minimum income for his labour and risks.

X. REHABILITATION OF EXISTING SCHEMES

Millions of hectares of land are under irrigated cultivation in the countries of the region. The production from these lands is so varied that a conclusion can be reached that if adequate attention is paid to these areas,

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the output could be increased considerably. Most countries have realized this situation and have, in addition to extending the irrigated area with new schemes, embarked on rehabilitation of the existing schemes. Such rehabilitation is, per unit of production, less costly as the infrastructure is already available.

The irrigation systems in most old schemes are outmoded in that there is insufficient control of water and it is not possible for the operating agency to monitor its supply right up to the farm. Seepage losses from canals (unlined) in permeable formations are considerable. Collective and individual responsibility for the use of the scarce water resources has usually not been established. Timely farm operations are not carried out thereby resulting in over use of water and loss of crops resulting from pest attack, etc. Road (or track) access to the farm is inadequate resulting in increased cost of transport of farm input and produce. Package programmes to remedy the above situations have been successfully introduced in several countries.

XI. PROTECTION OF ENVIRONMENT

The impact on the environment resulting from water resource development in rural areas has to be carefully assessed in the earliest feasibility analysis stage.

An early step to be considered in many projects is the management of the catchment areas of streams. This is specially important in steep areas where considerable erosion can take place if the vegetative cover is removed. Clearing by man and uncontrolled grazing by cattle has to be prevented or reduced to the minimum. In already cleared areas or sparsely wooded areas, afforestation should be made. Arrest of soil erosion and promotion of ground water recharge can be achieved by the construction of contour bunds and contour ploughing in steep areas. These methods reduce quick runoff of rainfall and also reduce flash flood hazards considerably. Stream flows may also be prolonged thereby so as to be available for use for longer periods.

In most countries of the region, reservoirs have to be constructed to store the water for use during periods of drought and for flood control. The siting of reservoirs should be in unpopulated or sparsely populated areas so that uprooting of people from their usual environment is kept to a minimum. Adequate steps should be taken to find alternate reserves for wildlife affected by the reservoirs. The reservoirs should be so designed that water logging of the lands downstream of the reservoir is avoided. Compensation water has to be

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delivered to the stream below the reservoir so that the normal activity in the lower areas is not seriously affected and to take advantage of recent experience which has shown that periodical flushing of pools of stagnant water in stream beds helps kill the larvae of malaria-carrying mosquitoes.

In irrigation projects, large extents of jungle may be cleared for agricultural development. It would be wise to preserve certain areas to act as wind belts and to preserve plant and animal species diversity. Lands unsuitable for agriculture (within a development area) should be left under tree cover or where necessary replanted with suitable useful trees.

The irrigation systems and the farm preparation techniques should be so evolved as to prevent water-logging or soil erosion. Adequate drainage systems should be constructed so that water-logging and salinization do not make lands unsuitable for agriculture.

Indiscriminate use of agro-chemicals tend to pollute the water draining from farms to the reservoirs, streams, and rivers. Continuous monitoring of pesticide use and water quality is necessary.

Diversion of water from areas of surplus to areas of deficit can help to improve the environment in the latter area considerably. In some countries where deserts have been thus transformed, people, who were living below poverty line are now able to live happily and contribute surplus from their share of production to the rest of the country. For many, a new life and a new meaning to life has been introduced in these arid areas.

Uncontrolled ground-water exploitation can lead to several problems. In coastal areas, salt water intrusion into the fresh water aquifer has occurred. Overexploitation of the aquifer has lead to lowering of water table with undesirable consequences. Sometimes land subsidence has resulted.

XII. INSTITUTIONAL ARRANGEMENTS

For effective water resources planning, development and management, a suitable institutional framework has to be established in each country. The type of institutional arrangement has to be evolved to suit the needs of each individual country. Smaller countries could possibly have a centrally controlled system while the larger countries will have to have decentralized arrangements with some form of central direction and co-ordination. Most of the problems of developing countries in the region, with respect to water resource management, can be traced to organizational, administrative, political, managerial or financial weaknesses than to technical factors. Each country has to develop its own management practices to suit the traditions of the country.

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"There is certainly no single correct way to organize and administer a river basin programme. The plan of organization must in each case be fitted into the general governmental structure and into the cultural patterns and political traditions of the countries and regions which are involved."[2/]

In most countries several Ministries or Agencies are required to deal with water resources planning and management. Some of these Ministries could be grouped as follows:

Ministries of Planning and Finance	- For long term plans, financing.
Ministries of Agriculture and Works	- For irrigation and related water use, flood control.
Ministry of Power	- Hydro-power development.
Ministry of Health	- For community water supplies.
Ministry of Tourism	- For environmental aspects related to recreational facilities.

Several agencies under these Ministries are entrusted with the task of spearheading the development activities connected with the use of water. Effective co-ordination has to be established for the proper utilization of resources.

At the operational level, co-ordination is still more important. Co-ordination of the activities of the users (farmers, village level officials etc.) have to be effected for the proper use of the facilities. This is usually effected through village-level committees, farmers organizations and other similar group organizations. These village-level organizations have to be built around traditional groupings in order to avoid social and political conflicts. It would be unwise to transplant a system functioning efficiently in one country or region into another area where in the management of village level activities is very essential to maintain the facilities at high levels of efficiency.

Pricing policies for the use of water can play an important role in effective water management. It has been demonstrated, in some of the developed countries that economic use of water would result if the beneficiaries were to be charged proportionately for the water supplied or in some instances if they were to be permitted to sell the water that they are able to save from their quota. In most countries of the region metering of water for agricultural use, where most of the wastage occurs, is not practicable. The farmers in the region are mostly "small farmers" cultivating small parcels of land. Installing water meters and administering a system of water charges on a

/quantitative

2/ United Nations, Integrated River Basin Development (E70.11 A.4).

quantitative basis under these conditions is not practical. The solution may be in the establishment of a system of levying charges collectively on a group of farmers. It may be tried out in an area where the social conditions permit such experimentation. This system can be coupled with a programme of grant of bonus of rewards for consumption below a fixed minimum.

XIII. WATER LAWS

Water legislation is necessary to give effect to water policies of each country. In several countries, traditional customs and practices have been embodied in the legislation for control and use of water. It has been an accepted finding that the water legislation should suit the situation existing in each individual country, and in some cases the legislation may have to change from State to State in the larger countries. Modernization and economic progress bring about situations which are not governed by traditional systems or practices that existed in the past. For example, exploitation of ground water plays an important role in meeting the demands for water during the present era. Currently available heavy duty pumps could deplete the ground-water aquifer, with serious consequences for the future, unless adequate legislation is available to control the rate of exploitation. Some countries of the region have already framed "Water Codes" and other legislation to control and regulate the use of water.

Some of the main topics to be included in such legislation[3/] are:

(i) Definition of national objectives with respect to water.

(ii) Data collection. (Duties of both individuals and public bodies.)

(iii) Control and ownership of water; means of acquiring water rights.

(iv) Priorities as between regions, uses and users and in relation to other natural resources.

(v) Conditions of use - Quantity, quality, pricing, protection of environment, reuse, engineering works and their operation.

(vi) Water resources administration - Duties of various bodies like farmer's associations etc., participation of users.

(vii) Judicial aspects of water.

In most countries of the region, state or state-sponsored institutions are responsible for the harnessing of the water resources. The beneficiaries i.e. the users, are usually not alive to their responsibilities as water users resulting in several expensive water resource development projects not achieving their objectives. Legislation alone will not be sufficient for effective and

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3/ Guillermo J. Cano, Water Law and Legislation: How to use them to obtain optimum results from water resources (Paper No. E/CONF 70/A.1, United Nations Water Conference 1977).

optimum utilization of such resources. Public enlightenment and active joint participation have been found to be very essential for the success of such development projects.

XIV. TRAINING PROGRAMMES

One of the recommendations[4/] of a Panel of Consultants made to the United Nations Water Conference 1977 was:

> "It is recommended that, in conjunction with the formulation of Agricultural Water Development Programmes, and immediately following the Water Conference, the present and future needs for trained manpower should be assessed. These requirements should not be limited only to directly water-related activities, but should include supporting disciplines in agriculture and associated subjects and the development of necessary inter-disciplinary skills. The manpower needs for the three distinct components of technical training, extension services and research must be evaluated at national level. Additionally, where necessary, attention must be given to the improvement of basic levels of formal education to facilitate subsequent training".

The largest user of water is the agricultural sector. It is here that most of the savings in water could be effected by proper water management. Adequately trained staff to advise the farmers and monitor the use of water is not available in most countries. Some countries have already commenced establishing Water Management Training Centres. For example, "The Water Management Training Centre" was established in 1975 at Munoz by the National Irrigation Administration of the Republic of the Philippines. During the first phase of its programme, the Centre is proceeding with the training of technicians to manage the water use in the country's vast irrigation schemes. The training programme planned by the Centre covers the broad topics of irrigation water management, irrigated rice crop management and human resource management. In addition to lectures and seminars in the lecture rooms, field demonstrations, on the job training for one season each at the training centres irrigation district and the trainees irrigation district are provided by this centre.

Well planned out training programmes, in which the management staff as well as the farmers have to be trained, would pay rich dividends in the future.

XV. CONCLUSION

A very large part of the rural population in the developing countries in the ESCAP region continues to live at subsistence levels. The economic activity in these rural areas is based on agriculture. Development of water

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4/ "Water for agriculture", United Nations Water Conference 1977 (Paper No. E/CONF 70/11).

resources projects appears to be one of the main ways of improving their quality of life. In order to make such development schemes useful and productive, integrated approaches are necessary in their planning as exemplified, for example, by the long term study and planning effort of the United Nations Mekong Secretariat and the International Mekong Committee for the vast Mekong River Basin. A concerted effort has to be made by the responsible institutions and interested agencies in order to ensure that multidisciplinary integration takes place to assure optimal use of water and to promote the living standards in these areas. Annexes to the present paper serve to illustrate possible approaches to development of management of water resources.

/Annex I

Annex I

SOME IMPRESSIONS OF WATER RESOURCES MANAGEMENT IN INDIA

A. GENERAL SITUATION

1. Introduction

The total geographical area of India is reckoned to be 328 million hectares supporting a population of over 600 million people. India lies partly in tropical and partly in subtropical regions. Snowfall is experienced only in the mountain ranges in the north; general climate of the country is warm. Rainfall is generally experienced in the monsoon months. Annual rainfall varies from about 100 mm in the arid regions of Rajasthan to 6,350 mm in Assam. Currently about 41 million hectares are irrigated and it has been estimated that ultimately this figure could be raised to 100 million hectares.

2. Water policy

India has a federal structure of government and state governments have exclusive powers to formulate and administer laws with regard to usage of both surface and ground water. However, these laws are subject to control at the Centre with regard to interstate rivers.

It has been estimated that out of the 1,500 million acre feet of surface-water resources, only about 540 million acre feet is utilizable on a dependable basis. About 200 million acre feet (i.e. about 40 per cent of the utilizable water) is being utilized at present.

The ground-water potential has been estimated to be about 220 million acre feet of which about 50 per cent is being utilized.

Ninety per cent of water use is for irrigation purposes and planners believe that this position will continue in the future. "The major problem in India is, however, of unequal regional development. About one third of the area of the country is drought prone. Water policies, therefore, have to have major thrust on removing or minimizing the balances in the development of the rural areas on the one hand and promoting in general, the economic development of the vast population, nearly three-fourths of which inhabit the rural areas. India has extensive cultivable lands, sunshine almost throughout the year and large rural population engaged on dry farming. There is tremendous scope for increasing productivity of land by extending irrigation facilities. Where

water resources are insufficient to meet the irrigation requirements of cultivable land, which is often the case, the policy should aim at securing the maximum crop production per unit of water. In drought prone areas, the emphasis should be generally on the maximum area served for ensuring the greatest good of the largest number. Where, however, water is in plenty, its use could be so planned as to have maximum production, from the limited area available for application of water. These problems are, of course, subject to the cost effectiveness of the schemes and are also subject to the national policies relating to social and environmental considerations".[a/] The planners have also noted that policies cannot be rigid with respect to time or location, and have to be reviewed periodically for modifications that changing circumstances may require.

3. Planning for water resources development

Water development schemes are prepared within the scope of long-term perspective plans, by the respective state governments. The Planning Commission at the Centre scrutinizes and approves the annual plans of the state governments. The Centre provides loans or grants to the state government, and is able to control and monitor development of the states.

In general, multipurpose development projects are preferred as substantial cost economies can be achieved. River basin commissions are set up to deal with the efficient implementation and operation of the projects.

The need to improve the efficiency of the existing irrigation systems has been recognized. Programmes for "modernization" of existing canal systems and "command area" development are being implemented so that equitable and effective distribution of the scarce water resources could take place. Adequate drainages, both surface and sub-surface, are being planned in order to avoid problems arising from water logging and salinity. Steps have been taken to introduce legislation to control over-exploitation of ground water aquifers.

4. Water legislation

Each state has its own set of laws for irrigation management and administration. However, the Central Government, for the purpose of having a greater degree of uniformity, has prepared a model irrigation bill for consideration for adoption by each state.

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a/ C.C. Patal, "Water policy with special reference to inter-State and international rivers in India" (New Delhi, Department of Irrigation).

A draft model bill on ground water has also been circulated by the Centre to all state governments for consideration by the latter.

The National Commission on Floods has been set up to review flood control policies and flood control works and to prepare guidelines for the preparation of effective flood control plans.

The Water (Prevention and Control of Pollution) Act 1974 makes comprehensive provisions for prevention and control of water pollution. This Act is already effective in most states.

5. Interstate rivers

The utilization of the water resources of interstate rivers is planned to conform to national water policies. Rational decisions are made on the sharing of such resources so that each state can plan its own development programmes.

6. International rivers

The water resources of several rivers are shared on the basis of agreements concluded with the neighbouring countries, viz. Bangladesh, Bhutan, Nepal and Pakistan.

I. IRRIGATION MANAGEMENT

1. Need for irrigation

Most of the arable lands in India have a tropical climate with high temperatures and monsoonal rainfall. Except in a small portion in the south and the western Himalayas, rainfall is concentrated in the monsoon period of about three to four months (June-September). The rest of the period is practically dry.

The large rural population depend on agriculture for their sustenance. Crops to suit the rainfall and climatic conditions in each area are grown extensively, but in the long-term, the increase in agricultural production has scarcely kept pace with the increase in population.

Irrigation has been practised from prehistoric times. Several small reservoirs, specially in states like Karnataka and Tamil Nadu (south India), and river diversion schemes had been in existence for centuries. Colossal irrigation schemes have been constructed in the past few decades to increase the extents under cultivation.

2. Classification of irrigation schemes

Irrigation schemes are classified into three main categories viz. major, medium and minor.

Major irrigation schemes are those the initial cost of which exceed Rs 50 million ($US 6.3 million). These schemes are under the direct control of the State Irrigation Departments (in some cases Public Works Department (PWD)). The headworks, main, branch and distributary canals are constructed and maintained by the state while the field water courses are the responsibility of the cultivators.

Medium irrigation schemes are those the initial cost of which is between Rs 50 million and Rs 2.5 million. These schemes are also maintained by the state departments as in the case of major schemes.

Minor irrigation schemes are those which cost less than Rs 2.5 million. These are under the control of the Revenue Departments and the maintenance work is carried out by the state departments after a recent decision by the Government.

3. Administration of irrigation schemes

At the Centre, the Department of Irrigation under the Ministry of Agriculture and Irrigation is responsible, with the help of the Central Water and Power Commission, for examining and advising the Planning Commission on all major and medium projects that are proposed by the state governments. Minor projects are processed through the Department of Agriculture or Department of Rural Development.

The State Irrigation Department (in some states the irrigation wing of the PWD), under the direction of the Chief Engineer is responsible for all irrigation development in the state. In some cases, when large projects are involved, separate chief engineers are in charge of such projects. An executive engineer, under the supervision of a superintending engineer heads the executive unit for the development in an administrative area. Each executive unit, generally carries out all investigations, planning, design, construction, operation and maintenance of irrigation projects in its area of administration.

4. Current status of some irrigation schemes

The need for modernizing the old irrigation schemes had been felt for some time. It became increasingly apparent, when compared with currently planned

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irrigation schemes, that systematic improvements have to be effected to these schemes if the resources of the schemes were to be utilized fully. A central team, constituted by the Irrigation Department (of the Central Government) to study some of the representative irrigation schemes, observed the following:

"(i) Absence of mechanical arrangements to lift up the shutters on the Weir to vertical position, after the passage of floods, resulting in wastage of water in the river.

(ii) Inability of canals to draw the full discharge, due to breaches or lack of proper maintenance.

(iii) Heavy transmission losses in certain canals or reaches of canals.

(iv) Absence of sufficient closure of canals for taking up maintenance work, leading to poor maintenance of canals.

(v) Presence of uncontrolled direct outlets from canals and branches, resulting in wastage of water.

(vi) Unplanned location of canal outlets leading to inefficient distribution of water.

(vii) Inadequacy of canal regulators and escapes for efficient functioning and supply of water.

(viii) Lack of adequate drainage facilities, causing problems of water logging.

(ix) Absence of field channels, resulting in wastage of water.

(x) Lack of inadequate use of available ground water resources in conjunction with canal supplies.

(xi) Absence of adequate water measuring devices for proper accounting of water diverted at various points in the canal system, rendering it difficult to assess the adequacy or otherwise of irrigation supplies made for crops".[b/]

The central team, prepared a set of guidelines for remedying the above defects and further recommended among others the following important steps:

(a) Reuse of drainage water for irrigation and necessity for the construction of pick up structures;

(b) Adoption of measures to increase utilization of ground water of the command area;

(c) Adoption of sprinkler irrigation techniques, ground water reacharging programmes;

(d) Modification of cropping patterns to suit soil conditions and to optimize farm income;

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b/ C.C. Patal and K.S. Murthy, "Irrigation management and operation" (New Delhi, Government of India publication).

(e) Provide adequate:

(i) extension services (demonstration farms etc.);

(ii) Agricultural inputs (credit, seed, fertiliser etc.);

(iii) Infrastructure facilities like roads, agro-processing, markets communications etc.;

(f) Improve farm development works;

(g) Provide adequate training facilities for operational and maintenance officers;

(h) Revise existing legislation, rules and procedures for better administration of irrigation systems.

Most of the recommendations have been accepted and are being implemented by state governments.

II. FLOOD CONTROL

1. Nature of flooding

During the southwest monsoon period (June-September) heavy intensity rainfalls cause flooding in several of the major rivers in India. Flooding is generally caused by the inadequacy of the river channel to carry the heavy discharges occurring during times of heavy rainfall. The problem is further aggregated by rivers changing their courses, silting of river beds and obstructions to river flow resulting from landslides and earth quakes. In certain areas, like Andhra Pradesh, cyclones accompanied by heavy rainfall often lead to flooding.

2. Flood damages

Annually, some part or other is affected by floods. It has been estimated that, on an average about 7.5 million hectares are affected annually by floods causing over Rs 2,000 million ($US 250 million) in damages. Of this amount, Rs 1,500 million ($US 190 million) is estimated to be the value of losses of crops. As this loss especially affects the lower income groups, floods cause severe hardships and misery in the country.

3. Suggested solutions to the flood problem

Boards or committees were set up in each region, affected by floods, to study the nature of floods and devise systems of flood control. The general nature of the solutions available are:

(a) Improvements of river channel by desilting or dredging. These methods are costly;

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(b) Construction of detention reservoirs. For these reservoirs to be effective, they have to be located immediately above the flood plain, but invariably suitable sites are not available. Reservoirs located in the upper catchments have only a marginal effect in reducing flood peaks;

(c) Providing diversion canals to carry the water to other outlets. This method is generally not very practical for application;

(d) Construction of embankments. This method has been adopted in several places and has proved very effective. This method too has its drawback as overtopping and breaching of embankments can cause serious damage to the protected areas;

(e) Limitation of development in the areas subject to floods. Though this is being practised, social problems in enforcing such restrictions have invariably negatived such steps;

(f) Flood forecasting and warning systems have generally been adopted whereby the preparedness of the people in the affected areas have, to a great extent, reduced loss of life and serious damage to property;

(g) On a long term basis, catchment protection has been proposed for adoption. Reafforestation and soil conservation programmes in the upper catchments can reduce the siltation problems and also reduce the flood run-off.

B. PROJECT EXPERIENCES

III. RAJASTHAN CANAL PROJECT

1. The project

The Rajasthan Canal takes off from the Harike Barrage, located on Beas River, immediately below the confluence with the Sultej river. The first reach of the canal, 204 km in length, is called the Rajasthan Feeder and traverses Punjab state conveying 467 m^3/sec (16,500 cusecs) of water for the irrigation of about 640,000 hectares. The Rajasthan Main canal, which takes over from the Feeder canal, is 189 km in length and traverses the semi-arid to arid regions of Rajasthan state. When the work commenced in 1958, the estimated cost of the project was Rs 660 million ($US 83 million) (stage I only).

Consequent to the signing of the Indus Water Treaty with Pakistan, the share of Ravi-Beas water to Rajasthan increased to 9,860 million cubic metres (8 m ac ft).

The intensity of irrigation originally proposed was 78 per cent. A decision was then taken to line all canals up to minors and the cost estimates were revised. The saving in water was expected to permit the intensity of cultivation to increase to 11 per cent. The extent under cultivation was also

/increased

increased to 1,250,000 hectares. The revised cost estimate for stage I of the project is Rs 1,840 million. Work in stage I is expected to be completed in financial year 1979-1980.

A little over 500,000 hectares has already been provided with irrigation. The intensity of irrigation achieved so far has been about 86 per cent.

2. Command area development

The state government set up a Command Area Authority in July 1974 with responsibility for water utilization and Integrated Area Development in Command Area of Rajasthan Canal. The 11-member Board functions under the chairmanship of the Area Development Commissioner.

The functions and responsibilities of the Command Area Authority as set out in the Order dated 25 July 1974 were:

(a) Maintenance and efficient operation of the water delivery system from the source to the farm outlet;

(b) Planning and executing programmes of land development within a catchment (Chuk) including realignment and lining of water courses, land levelling, soil reclamation, provision of field channel etc. through institutional finance and otherwise;

(c) Enforcement of proper system of Warabandi and fair distribution of water to individual fields;

(d) Development of ground water to supplement surface irrigation;

(e) Selection and introduction of suitable cropping patterns;

(f) Supply of all inputs and services including credit;

(g) Development of marketing and processing facilities and communication;

(h) Preparation of individual programmes of action for small farmers, marginal farmers and agricultural labourers;

(i) Diversification of agriculture through livestock development, horticulture, farm forestry etc;

(j) Programme of protective forestry for canals, roads and farms, pasture development of uncommanded lands, fuel wood plantation etc;

(k) Town planning, rural housing, development of existing and new villages and marketing centres.

3. World Bank assisted programme

A six-year World Bank assisted programme of intensive development of 200,000 hectares was commenced in October 1974. Under this programme, lining

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of canals, realignment and lining of water courses, farm levelling, pasture development, provision of market roads, district roads, afforestation, village water supply and intensive agricultural extension services are being executed. About 40 to 50 per cent of the work has been completed by early 1979.

4. Agricultural extension programme

The project area is divided into several districts under the charge of a district extension officer.

Hanumangarh District (666,555 hectares), a typical district extension officer's area has the following:

District extension officer	- 1
Assistant agriculture officers	- 8
Village extension workers	- 62
Subject matter specialists	- Plant protection - 1 Extension methods - 1 (Note: Subject matter specialists at project level are also available for training extension workers etc.)

The number of farm families in the district is 11,922. Each village extension worker covers the 200 families allotted to him weekly on fixed days (Monday to Thursday). Group discussions, mass meetings, field days and cinema shows are also arranged for communication of technical information to the farmers.

Demonstrations are laid out on the fields of contact farmers, where a 0.25 hectare plot is cultivated according to recommended practices and new techniques. A control plot of the same size where the farmer adopts his own techniques and practices is maintained and compared for yields, costs etc.

5. Observations

(1) The proposal to irrigate such a vast extent of desert area arises from the basic concept of using the water in drought prone areas for serving the maximum area for "ensuring the greatest good of the largest number". Developing and irrigating desert areas, where sand dunes have to be levelled to develop the farmland, calls for a great deal of effort under trying conditions. Perhaps better returns may have been obtained if the development had been limited to a part of the area and higher intensity of cultivation

planned for. In that event, some parts of Rajasthan would have remained as desert for ever.

(2) The decision to save conveyance losses in canals by lining even the minors and water courses in the desert terrain where water is a very scarce commodity was necessary.

(3) Canal lining is being done with clay tiles and cement mortar joints. Tiles are manufactured in the project area by the project authorities and were chosen because other forms of lining like concrete were too costly - concrete aggregate cannot be found in the project area.

(4) Suratgarh Agricultural Farm (11,000 ha) and Jetsar Agricultural Farm (13,000 ha), run by the Central Agricultural Farm Corporation, have shown that a variety of crops can be grown economically in the project area including rice, wheat, gram, cotton, groundnut and a series of other grain crops are grown. Even potatoes are being cultivated successfully on an experimental basis.

These farms, perhaps the largest state-owned individual farms in this part of the world, are being maintained (reportedly at a profit) for seed multiplication to meet the needs of the vast acreage under cultivation in Rajasthan canal project area.

(5) Although the project authorities have proposed to carry out land levelling and farm preparation for the farmers on a cost recoverable basis (long term) the farmers prefer to do it themselves. The reluctance, is reportedly, the high cost of work when undertaken by the project authorities. The farmers use camel-drawn equipment to level the land (in some cases tractors are used). Studies have shown that larger quantities of water are required for irrigation when some farmers do not prepare the lands for efficient irrigation.

(6) The field water courses maintain full supply for seven days in the week followed by full closure for the next seven days. The canal capacity is based on 2.4 cusecs for 1,000 acres. A patawarri (irrigation employee paid by the state) is responsible for preparing the irrigation roster under each water course. Each water course irrigates about 300 ha and a patawarri is responsible for about eight water courses. The seven-day irrigation period is shared on a time basis by the farmers in proportion to the land extents owned. All irrigation disputes are decided on by the executive

/engineer,

engineer, whose ruling is subject to appeal to the superintending engineer. The superintending engineer's ruling is final and can be set aside only by the High Court.

(7) Water rates are charged on different tariffs on the basis of crops on the following schedule:

		Rs
1.	Sugar cane	40
2.	Paddy	22
3.	Orchard and vegetables	16
4.	Cotton	15
5.	Wheat and other cereals	15
6.	Oil seeds and gram	10

The patawarri prepares the schedules of rates leviable in his area. Preparation of these lists are supervised by a zilador who is responsible for the work of about 6 to 8 patawarris. The assistant engineer of the area is required to test-check about 10 per cent of these schedules while the executive engineer is required to test-check about 5 per cent of the schedules.

(8) Revenue collection is reportedly excellent. Against a scheduled charge of Rs 13 million in 1977-1978 the collection was actually Rs 12.98 million.

(9) Afforestation in the sand dune areas and the clearing of canals and roads, have shown a remarkable reduction in soil erosion by wind action.

(10) Provision of village roads and improvements to villages and rural housing has not kept pace with agricultural development.

(11) Village water supply is being provided by "diggies" (i.e. concrete lined wells about 40 ft in diameter which are fed by the irrigation canals. Water is chlorinated and a hand pump is provided for use of the community. About 2,000 cubic metres of water is provided for 14 days for a population of 1,000 persons.

(12) Though there is a ceiling limit on size of land holdings, it is evident that by a system of sales and releases, the intent of the legislation has been defeated.

(13) Mundis (market places) have been established in most places where the farmers can dispose of their produce. A system of auctioning, supervised by a marketing committee, ensures a fair price to the farmer. Representatives of the Food Corporation of India and the Cotton Corporation of India purchase the produce at a floor price if the bidders at the auction do not offer a reasonable price.

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(4) The effectiveness of the extension services and the provision of better irrigation facilities can be judged from the increased yields as shown below:

	Yield in quintals (100 kg) per hectare		
	1975/1976	1976/1977	1977/1978
Wheat	18.57	25.50	26.02
Gram	10.22	10.26	10.30
Mustard	7.22	8.05	8.75
Cotton	12.02	12.69	13.23
Paddy	31.01	37.81	42.06

IV. AUGMENTATION CANAL PROJECT - WESTERN JAMUNA CANAL IN HARYANA STATE

1. The project

The Western Jamuna Canal, taking off from the Tajewala Barrage across the River Jamuna was designed to convey 226 m^3/sec (8,000 cusecs) for the irrigation of about one million hectares. During the dry period (October to April), only about 56.6 m^3/sec (2,000 cusecs) were available for diversion, thereby causing serious scarcity of water for irrigation.

Investigations showed that the alluvial area, especially between the canal and the river had a large ground-water aquifer. It was therefore decided to construct an augmentation canal of capacity 127.4 m^3/sec (4,500 cusecs) from Yamuna Nagar to Munok covering a length of 75.25 km. This lined canal will be used to divert part of flows in the Western Jamuna canal, in which it will save conveyance losses. About 300 tubewells, bored in the strip between the river and the Western Jamuna Canal, are pumped to supply water to the Augmentation Canal. Some existing tubewells below the Western Jamuna canal are also connected so as to deliver water to the Augmentation Canal.

2. Observations

The first phase of the project for 160 tubewells to feed the 75 km length Augmentation Canal was completed in the brief period of about two years. A large fleet of heavy machinery along with about 6,000 men was mobilized for this work. The waterlogging of valuable crop land in this area was eliminated by the pumping from tubewells. It is reported that the pumping from the state

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tubewells so affected the water table, that private tubewells operated by individual farmers were seriously affected. This led to protests from the farmers causing the state to suspend operations on phase II of the development proposals. However, the lining of the Augmentation Canal saved about 500 cusecs in canal losses. The resultant saving in water and the supplemental water from the tubewell was able to increase the cropping by about 81,500 hectares. The accruing benefit was able to justify the capital investment in the project.

V. GROUND WATER PROJECT IN COIMBATORE - TAMIL NADU STATE

1. The project

The state of Tamil Nadu is underlain by hard rock formations over an area of 95,000 sq km (about 73 per cent of the total area of the state). The capability of storing and transmitting ground water in these areas are dependent on the fracture and joint systems and the disintegration of the rock formations. Frequent droughts and increased agricultural and industrial demands to meet the situation created by an increasing population had caused people to look for ground water to meet the shortages in surface-water supplies. In certain areas, open dug wells have been in existence for centuries.

Detailed scientific investigations were first undertaken, with UNDP assistance, in 1966-1972, in four selected areas viz; Madras City and its environs, the Palar alluvial basin, the Neyveli area and the Cauvery delta. The potential available in these areas was evaluated and steps have been taken to utilize the ground water under controlled conditions.

The movement of ground water and its development in hard rock areas is more complicated in comparison with the sedimentary and alluvial areas. Excessive pumping by farmers in some of these areas had lead to a sharp drop in ground water levels. The Central Ground Water Board set up, with assistance from SIDA (Swedish International Development Authority), a ground water project for carrying out water balance studies "to determine the quantitative aspects of groundwater potential with a view to plan its development and management on long term basis on sound scientific lines".

The project area covers an area of 8,145 sq km in three basins in Tamil Nadu and Kerala states. Investigations were commenced in 1975 and the project is scheduled for completion in mid-1979. The project area is underlain by hard crystalline rocks comprising granites, charnockites, gneisses and

/schists

schists with some quartzites, calc granulites, limestones and other types of highly metamorphosed rocks. Open dug wells have been in existence for over a century. Water levels have been dropping yearly, in some cases about a metre per year, in many parts of the project area resulting in deepening of wells. In some cases bore holes from the bottom of the dug wells have been drilled.

The main objectives of the project are:

(a) Determination of the water balance with due respect to quality as well as quantity;

(b) Optimizing of ground-water extraction structures (open wells, boreholes, subsurface dams), experiments to increase infiltration and subsurface storage of ground water, construction of exploratory boreholes and formulation of a programme for studying ground-water hydraulics in hard rock areas;

(c) Studying ground-water development and use with reference to water requirements for agriculture on different soils and for different crop rotations;

(d) Helping towards the establishment of a prototype water management system for the basin including training of staff.

The headquarters for the project operation is at Coimbatore.

2. Progress of investigations

(a) Hydro-metereological data have been gathered by establishing several new rainfall recording stations to supplement the stations already in existence. Four weather stations to record data on temperatures, wind velocities, evaporation, sunshine hours and soil temperatures have been established.

(b) Hydrological studies for assessment of surface run-off, return flows from irrigation water and canal seepage, surface water quality, sediment transport and evaluation of a mathematical model for one of the basins (Noyil Basin) are in progress. Several stream gauging stations have been established at representative locations to determine surface run off. Data on basin characteristics have been gathered to determine their effect on run off.

(c) Hydrogeological studies to determine the water bearing and water yielding properties of the rocks in the project area, location of aquifers and other recharge characteristics are in progress. These studies include geological mapping, preparation of inventories of representative wells, measurement of water level fluctuations, exploratory drilling, conducting pumping tests to determine hydraulic parameters of the aquifers, sampling and chemical analysis of water to test quality etc. About 40 exploratory boreholes and 40 observation wells involving a total depth of about 12,000 metres have been drilled so far.

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(d) Studies of the different types of soils in the project area have been made and soil maps for some of the areas have already been prepared. Comprehensive research programmes in collaboration with the Tamil Nadu and Kerala Agricultural Universities have already been established.

3. Observations

(a) Studies made so far indicate, except for small isolated areas, that weathered zones do not form potential aquifers as the water table lies below the weathered zone. Only the partly weathered and fractured rocks form the phreatic aquifers in most parts of the project area. The current ground-water exploitation from dug and dug-cum-borewells is from the phreatic aquifer.

(b) Ground water occurs under confined and semi-confined conditions in solution cavities in limestone and in the vertical to sub-vertical deep seated fractures which occur as long narrow zones in the basement rocks. Detection of these aquifers needs sophisticated techniques; random drilling by private agencies have resulted in a large percentage of failures.

(c) Hydrographs prepared for some of the wells (5 year records available) indicate that there is no drop in water level over the years except in one valley (Chinnathadagam Valley) where the rate of decline had been 1 to 1.5 metres. The cause for the decline in Chinnathadagam Valley has been established as over-extraction.

(d) Water samples tested during exploration work indicate that good quality water can be obtained from the deep aquifers.

(e) Construction of subsurface dams to improve the ground-water potential of small valleys in hard rock areas is a distinct possibility. The economic feasibility has yet to be established, however.

(f) Experimental drilling of horizontal bore holes in existing dug wells has shown that some of the old wells, where yields have decreased with age, could be increased considerably. In one well, two bore holes with a total length of about 48 metres gave a 100 per cent increase in yield. Incrustation like "Kankar" deposit in the fractures and on the walls of the well have been adduced as a possible reason for such situations.

VI. TANK IRRIGATION MODERNIZATION PROJECT IN TAMIL NADU STATE

1. The project

Tamil Nadu has already harnessed most of its economically utilizable surface-water resources. Even the ground-water resources, that can be easily located, have been utilized to meet the unsatisfied demand for water. Efficient use of water and or transbasin diversion from other states can help to meet this demand.

/About

About 3.7 million hectares, representing almost 50 per cent of the area under seasonal crops, are under irrigation; the cropping intensity is about 130 per cent.

The average rainfall in the state is about 950 mm. The eastern plains receive most of their rainfall, about 450 mm, during the northeast monsoon months of October-December while the western areas are affected by the southwest monsoon when a rainfall of about 300 mm is received. The central regions remain dry during most part of the year.

There are about 37,000 small and medium sized tanks (reservoirs) spread throughout the plains. These tanks had been in existence for centuries. Some of these tanks are augmented by canals tapping the seasonal flows in adjacent streams. Usually, the flood flows from these streams are directed into these canals, which feed a series of tanks periodically. At present, a rainfed crop with supplemental irrigation from the tanks is grown during the period August-November. A second crop is grown from December to March with water issued from the tanks.

Most of these tanks and the irrigation systems have to be modernized if the water is to be used efficiently. For the present, the state government proposes to modernize 490 tanks irrigating about 218,000 hectares (540,000 acres) over a period of 8 years at an estimated cost of Rs 1,190 millions. On completion of the modernization, it is estimated that about 55,000 hectares of additional lands can be brought under irrigation.

The improvements to be effected are noted to be:

(a) Tank bunds. Inadequate attention paid to the maintenance of the tank bunds has left the bunds in a weak condition. It is proposed to strengthen the bunds and also raise the bunds where necessary to provide sufficient free board.

(b) Feeder canals. Feeder canals will be reconditioned to carry the designed (or in some cases redesigned) flows to the tanks.

(c) Sluices. The existing sluices are old with ineffective control devices. In some cases, even the locations need to be changed. New sluices, at proper locations to meet the command area will be constructed so as to provide efficient releases of water.

(d) Spillways. The spillways have been designed on an empirical basis of flood estimation. Most of the spillways will be reconstructed after a proper scientific estimation of the floods that are to be dealt with.

(e) Irrigation distribution system. The main and branch canals will be reconditioned to proper standards. In order to conserve water,

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these canals will be concrete lined and provided with properly constructed pipe outlets for issuing water to the field water courses. Systems of field-to-field irrigation will be eliminated by the construction of field water courses to provide direct irrigation to lots of about 10 hectares in extent.

(f) Water distribution. At present, continuous field-to-field irrigation is practised. This results in wastage of water and depressed crop yields as applied fertilizer was carried away with the drainage water. The control of water was not in the hands of appropriate qualified authorities.

It is proposed to vest the control and issue of water up to 10 hectare blocks, to the PWD which will also be in charge of the tank and canal system. Rotational issue of water is proposed so as to save water.

2. Observations

(a) The project is still in the investigation stage. Typical designs and proposals have been prepared for some tanks while further investigations are proceeding. As soon as financing is assured, the authorities propose to proceed with the construction.

(b) Ground-water investigations are proceeding in several areas in Tamil Nadu. Conjunctive use of surface flows and ground water will help to consolidate the position further.

(c) A pilot project has been started in Periyar Vaigai command area in Madurai district to study the agricultural practices and irrigation techniques necessary to optimize production. The following shortcomings have been noted by the pilot project study team:

(i) Resulting from the field-to-field irrigation system, there is unequal distribution of water, with water deficiency at the tail end;

(ii) During the rainy season, drainage problems are noticed;

(iii) Lack of drop structures in the field channels cause canal erosion.

To solve some of the above problems, the following steps have been successfully introduced:

(1) Determination of suitable cropping patterns after soil surveys

(2) Lining of field canals where large seepages are noticed

(3) Construction of adequate control structures on the canals

(4) Land levelling and land shaping to ensure uniform irrigation

(5) Provision of field drainage channels to link with the main drainage streams.

(d) Water measurement devices have yet to be introduced. Lack of adequate data relating to past water usage does not permit the project authorities to plan rehabilitation proposals effectively.

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(e) Farmers have to be drawn into the planning process. For this purpose, a dialogue has to be established between the farmers and the project authorities.

(f) Proper attention has to be paid to agricultural extension services. Systems of agricultural credit and marketing have to be organized.

(g) A system of crop insurance may provide the necessary incentive to the farmers to adopt improved cultural practices.

/Annex II

Annex II

WATER RESOURCES MANAGEMENT IN SRI LANKA

A. GENERAL SITUATION

1. Climate

Sri Lanka is an island located in the Indian Ocean southeast of India, from which it is separated by the Palk Strait. The total area of Sri Lanka is 65,000 sq km (25,300 sq mi) of which the south central mountain zone covers 10,900 sq km and inland waters 869 sq km.

The island comprises a central massif sloping on all sides to the sea. The general level of the coastal plain varies from sea level to upwards of 122 m (400 ft) above sea level, while erosion remnants within the plain may rise up to 305 m (1,000 ft) or more. The south central highland region rises up to a general level of about 1,220 m (4,000 ft) above sea level with the highest peak at 2,525 m (8,282 ft) near Nuwara Eliya.

The island has a tropical climate characterized by high temperatures throughout the year. The mean annual temperature in the coastal plains is about 27 to 28°c; the mean temperature drops by about 3°c in the central hills. The average daily temperature range varies from about 8°c in the coastal areas to about 9°c in the central hills.

The distribution of rainfall is uneven and most of the precipitation occurs in two monsoon periods viz. northeast monsoon (October to February) and southwest monsoon (May to July). During the intermonsoonal periods, local thunder storms bring a certain amount of rainfall.

The southwest section of the island receives rainfall ranging from 2,500 to 5,000 mm while the rest of the island experiences rainfall amounting to 1,250-1,900 mm. The areas which have annual rainfalls below 1,900 mm are called the "dry zone" areas while the rest of the island is called the "wet zone".

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2. Land resources

The total land area of Sri Lanka is 65,600 sq km with land usage as follows:

	Percentage of total
Perennial croplands	12
Seasonal croplands	24
Garden lands and homestead	9
Forests (all types)	44.0
Grassland	5.4
Swamps and inland waters	
Unused lands etc.	5.6
	100.0

Source: Based on 1961 aerial survey.

At present, it is estimated that the forest lands will be about 35 per cent of the total area. The minimum requirements of forest reserves have been estimated to be about 30 per cent or 2 million hectares. Approximately 300,000 hectares can be used for further agricultural development. Soil surveys have shown that about 70 per cent of the total land area can be used for agricultural purposes while the balance of 30 per cent is best allowed to remain as forest lands.

3. General economy

The mid-year population in 1977 of the island has been estimated to be about 14 millions indicating an annual rate of increase of 1.7 per cent. The GNP at factor cost prices in 1977 was reckoned to be Rs 29,122 million. This represents a *per capita* income of approximately Rs 2,080 ($US 320). After adjusting for price increases, the *per capita* income in real terms (1959 prices) was Rs 855 ($US 132).

The agricultural sector contributed the largest share to the GNP, viz 32 per cent in 1977. The total value of all imports to the country in 1977 was Rs 6,007 million of which about 36 per cent consisted of food imports. On the other hand the total exports for 1977 was valued at Rs 6,638 million of which approximately 77 per cent consisted of agricultural products.

The dependence of the country on agriculture when judged by its contribution to GNP, and external trade is very obvious.

/Unemployment

Unemployment as well as under-employment have become serious problems in the country. It has been estimated that approximately 1 million persons are unemployed.

4. Water management policy

> "The two major problems facing our country are the unemployment problem and the need for import substitution in rice and other agricultural products.....The imports of rice, wheat flour and sugar alone cause a drain on the foreign exchange resources of the country amounting to Rs 2,200 million at pre-budget prices and approximately Rs 4,000 million at post budget prices. This Rs 4,000 million represents almost the capital budget of 1978. There are several other agricultural products-oil seeds, cotton and other fibre crops etc. which can substitute imports and provide a valuable source of export earnings as well as a source for the creation of Agro-industries in this country".[a/]

The above indicates the basis for the policy decisions regarding the management of water. Development of agriculture, especially in the "dry zone" cannot be achieved without a proper irrigation system. The management of water resources becomes a primary concern in the development process. In the past few decades, the policy for irrigation development had been concentrated on the restoration of abandoned irrigation tanks (resevoirs) and diversion schemes. The country has had a long tradition of irrigation where a large number of irrigation schemes helped to produce all the food that was required in the country. Internal wars, attacks by foreign invaders, diseases and floods combined to destroy several of the irrigation schemes. Towns and villages were abandoned and the population shifted to the "wet zone" where cultivation could be carriad on without the help of irrigation. This jungle grew up in places where previously there had been paddy fields. Commencing from the mid-1930s, the Government embarked on a programme of restoring these abandoned irrigation works and investigations revealed the existence of an elaborate network of irrigation reservoirs. Several of these reservoirs had their catchments augmented by intricate diversions from adjacent perennial rivers.

Re-use of water was practised extensively by the construction of a cascade of reservoirs on the same stream. The entire landscape in the dry zone was covered by reservoirs and paddy fields. All this development had been lost by neglect; jungle and wildlife grew in areas once inhabited by man.

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a/ Message from Hon. J. R. Jayawardena, Prime Minister (now President), in "Mahaweli Ganga Development-Sri Lanka" 1977).

A systematic programme of restoration of these ancient irrigation works, which was commenced in the 1930s has been completed. Jungle has been cleared and the tanks and irrigation systems restored. People were resettled in these project areas. At the outset, people had to be induced to settle in these areas and Large concessions and facilities were offered. An intensive health programme was worked out to eradicate disease in these jungle areas. At present, there is a clamour for land under these settlement schemes.

Alongside these restoration schemes, a few large irrigation (reservoir) schemes were also constructed to meet the need for irrigated land. In the recent past, irrigation schemes were designed to benefit as many as possible by providing the water for a cropping intensity of about 1 to 1.4.

The steep increase in population brought about an acute shortage of land for agriculture and other uses. This situation called for a change in the policy regarding land settlement and agricultural development. Recent policy attitudes can be summed up as follows:

(a) Modernize the existing irrigation schemes so as to ensure proper water and crop management. Irrigation efficiencies are to be improved by:

  (i) Constructing or reconditioning the conveyance system so as to minimize conveyance and operational losses;

  (ii) Proper on-farm development so as to ensure uniform irrigation and drainage of the farm;

  (iii) Adopting the most suitable cropping patterns and calendars in keeping with the nature of soils, climatic conditions etc.;

  (iv) Educating farmers in proper techniques of irrigation and farm management;

(b) Consolidate the conditions in the rural areas by the construction of minor irrigation schemes wherever this could be achieved without heavy investment. The entire economic activity of the villages would not depend on these irrigation schemes, but they would supplement village incomes through the increased agricultural production;

(c) Construct medium size resevoirs, in the dry zone, for the irrigation and settlement of people on lands under the scheme. Landless people in the district are settled on state land so as to enable them to contribute to national production. Since these schemes are normally located in the plains of the dry zone, they are essentially single purpose (irrigation) schemes without much scope for hydro-power development;

(d) Construction of transbasin diversion schemes where giant multi-purpose reservoirs are constructed in the wet zone and the

regulated surplus waters are diverted by transbasin canals to the deficit areas. Part of the cost of these expensive transbasin diversion schemes are borne by the hydro-power component of the scheme thereby making the agricultural component of the scheme viable. The additional water, so diverted to the deficit areas, is utilized to (i) increasing the intensity of cropping in the currently cultivated lands, (ii) opening up of new lands for development under irrigation. Such development includes the settlement of people who have had no land to cultivate in the past;

(e) Construction of minor pumped (low lift) irrigation schemes to enable quick development to meet the demand for irrigation water. These pumped irrigation schemes are usually designed for the cultivation of high value crops so as to afford adequate returns on the investment. Most of these schemes serve to settle unemployed youth who would otherwise be a burden to their parents and the State;

(f) Use of ground water for the cultivation of high value crops. Open dug wells had been functioning from early times. Ground-water investigations have been initiated to locate potential equifers for:

(i) Augmenting surface irrigation water during times of drought;

(ii) Developing semi-arid areas for high value crop production;

(g) Introduce land and institutional reforms to ensure proper management and production from the use of land and water resources. It has been realized that large agricultural land holdings in irrigated agriculture often failed to optimize the production. Hired farm labour, employed in such large farms, did not have a direct interest in the degree of production in these large farms. Adequate farm inputs, such as fertilizer, were not utilized at the appropriate periods. A ceiling on land holdings was introduced whereby an individual could hold a maximum of 10 hectares (25 acres) of irrigated lands. This step paved the way for intensifying the cultivation in such lands.

The setting up of agricultural productivity committees, cultivation committees, co-operatives, rural banks and other institutions for ensuring and regulating the activities of the farming community was another step to ensure proper agricultural production.

I. PROGRAMME FOR DEVELOPMENT

1. Assessment of water resources

Sri Lanka has a fairly dense hydro-metereological network covering the entire island and available records go back for several decades. Records of stream flows indicate that about 28 million acre feet (34 million m^3) of water is discharged into the ocean annual. The seasonal pattern of rainfall

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brings about problems in regulation and usage of the available water resources. In the "wet zone" areas where there is fairly even rainfall, crops can be grown almost throughout the year without the need for costly storage reservoirs. In the "dry zone" areas storage reservoirs are required for regulation of the stream flows. Even with these reservoirs, regulation capacity is insufficient to meet the demands for agriculture in the dry zone. In order to meet these deficits, diversions from surplus areas in the wet zone has to be effected. It has been estimated that the total water resources available for utilization will be sufficient to meet the needs of the country for the next few decades.

2. Present development

Paddy and other subsidiary food crops are grown on about 2 million acres (800,000 hectares) of land of which about 1,000,000 acres (400,000 hectares) are rainfed while the balance is irrigated. The irrigated lands utilize an estimated 6 million acre feet (7.5 million cubic metres) for cultivation. The cropping intensity is about 1.5 in average years. The irrigated lands are mostly for paddy cultivation from reservoir (tank) schemes. Some of these tanks date back to about 600 B.C. while several major reservoirs have been constructed in recent years viz. Senanayake Samudra (120,000 acres), Udavalawa Reservoir (60,000 acres). The Mahaweli Ganga, a river which has its source in the central hills (wet zone) wends its way to the ocean at Trincomalee, a sea port in the eastern plains of the dry zone area of the country. A development programme was launched in 1970 for the utilization of the water resources of the Mahaweli Ganga, the longest river in the island. The first project in this development is in the final stages of completion. (Details of the project are given in section IV below). Water has already been made available to supplement the water supplies to about 130,000 acres (52,000 hectares) of currently cultivated lands to ensure annual double cropping in place of the existing cropping intensity of 1.5 and for providing water for cultivation of about 70,000 acres (28,000 hectares) of new lands for two crops per annum. Further development is continuing.

The island's power is basically fed from hydro-power generation (300 MW installed capacity) with only about 60 MW of thermal generation.

Most of the community water supply projects are from surface-water sources. Open dug wells and village irrigation tanks and streams are tapped

to provide the much needed water for domestic purposes. During the past few years, ground-water sources have been increasingly utilized as a source for community water supplies.

3. Medium term plan for development

The current plan for development for utilization of water resources has the following components:

(a) Promoting efficient water management in existing irrigation schemes by introducing institutional changes and careful monitoring of water uses;

(b) Modernization of existing irrigation schemes by providing better irrigation and drainage systems;

(c) Construction of medium size single purpose reservoir schemes;

(d) Transbasin diversion schemes for the transfer of water from surplus (wet) areas to deficit areas.

Efficient water management in existing irrigation schemes

About 1 million acres (400,000 hectares) of lands receive irrigation water from the numerous irrigation schemes. The average cropping intensity is about 1.5 per annum but the irrigation efficiency in some areas has been found to be as low as 30 per cent. It has been found that better water distribution and efficient use of water could increase the cropping intensity to about 1.75 with little capital investment. The problems affecting the use of water have been identified and are discussed below:

(1) The farmers do not commence their wet season (maha) cultivation activities early enough to make the best use of rainfall for growing the crop. In most parts of Sri Lanka, the rainfall, except during exceptionally dry years, is sufficient to grow a crop of paddy during the wet season. A little irrigation water, during critical dry periods of the cultivation season, is all that is required to raise a crop of paddy. When the farmer misses the early part of the monsoon rains, the crop season extends into the subsequent dry season, when more water is required to sustain the crop. Education for the farmer, making arrangements for the supply of farm inputs at the appropriate times and persuasion of the farmer to improve his techniques of farming are to be adopted.

(2) Monitoring and control of water deliveries, coupled with education and participation of the farmer in water management can reduce water wastage considerably. Prior to the implementation of the programme, the authorities controlled the water issues up to the beginning of field

channels (farm channels leading up to each farm). The farmers were expected to use as much water as they needed, sometimes at the expense of their colleagues at the lower end of the channels. The present plan is to engage a "water distributor" (labour) to ensure timely issue and control of water to each channel. The farmers under each channel are required to nominate an individual who will prepare the irrigation calendar for all the farmers under the channel and ensure fair distribution of the available water. Education of the farmer so that he is competent to judge the frequencies of irrigation needed for his crop will ensure the elimination of over-irrigation.

(3) The crop grown should suit the soil and water availability. In pervious soils, it would be imprudent to grow a crop like paddy which needs standing water and it would not be desirable to grow dry-foot crops in heavy, poorly drained soils. Crop diversification and determination of the proper crop to be grown in any particular area has to be undertaken. However, the farmer who has been growing paddy traditionally is reluctant to change to other crops. Rice is the staple food of the people of Sri Lanka and consequently has a ready and easily accessible market. Most of the paddy farmers are not used to cultivation of other crops under irrigated conditions. Crop diversification in irrigation schemes cannot therefore be achieved successfully in a short time. Education of the farmer through the extension services, introduction of guaranteed or floor prices by the Government, provision of adequate marketing facilities and every form of assistance possible for the encouragement of crop diversification are being introduced.

(4) The existing irrigation laws were developed from the traidtional irrigation practices that had existed for centuries. The cultivators under each scheme gather at a meeting convened by the revenue authority of the district and decide their cultivation calendar and the connected farm operations. This democratic procedure, though successful in parts, has had its drawbacks. Enforcement of the decisions made at such meetings has become increasingly difficult. Fresh legislation for the introduction of agrarian services committees with joint farmer-official participation is being contemplated.

Modernization of existing irrigation systems

Most of the existing irrigation schemes were designed and constructed during periods when efficient water management was not given much emphasis. Water was not such a scarce commodity nor was land. Cropping intensities

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were low and so was the population. The demand for food grew with increased population and improved living standards. In order to increase the production, improved agricultural practices were introduced. Mechanical ploughing to shorten the period of farm operations, use of improved seed materials, chemical fertilizers and agrochemicals to achieve high yields, transplanting of paddy and other similar activities brought about a high increase in cost of farming operations. If these costly inputs are not matched by adequate and timely water supplies, the net result would be negative return to the farmer. This in its turn, proves to be a disincentive to production in the vital agricultural sector. The irrigation systems, as designed in the past, did not provide facilities for efficient distribution of water. The problems have been identified as follows:

(1) The conveyance losses in the irrigation systems were considerable, often as high as 30-40 per cent of the total water issues from the source. This meant that approximately 50 per cent of the farm water requirements was lost through seepage, embankment leakage and evaporation from the canal water surface. In some cases, losses also take place from evapo-transpiration if weeds and shrubs are allowed to grow along the canal sides. These losses can be cut down by 50 per cent or more by lining of canals, reduction of embankment leakage by ensuring proper consolidation of the banks and by clearing the canal of weeds. Lining of canals is a costly operation and proper evaluation of the economics of such a venture has to be made. Determination of canal losses over long stretches is a difficult operation. Time consuming work has to be undertaken before steps can be taken to implement proposals for such procedures.

(2) In order to monitor the use of water, it is necessary to know the quantum of water delivered at different locations. In practically all schemes, canal flow measuring devices are not available. Except for the estimation of flows at the source, there are no records of water use in different sections. Parshall flumes, notches and stick gauges are being introduced along the canals to measure the flows at important control points.

(3) It is not necessary to irrigate farms continuously. Rotational water issue has to be practised if unnecessary water losses to drainage are to be avoided. For this purpose, control and regulating structures are necessary. In most schemes, regulating structures are not available while the type of control structures when available are not efficient. The gates of these control structures have to be modified for efficient operation.

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(4) Land levelling and farm preparation techniques have to be improved. The present system of plot to plot irrigation results in uneven irrigation and consequent wastage of water. Relaying the farms and provision of farm ditches is a costly process which will also need the direct participation of the farmer.

(5) In several schemes, drainage lines have been blocked and in some cases obliterated by farmers. Adequate drainage has to be provided if good soil conditions are to be maintained.

(6) Access roads or tracks to individual farms are not available in most cases. This situation results in high cost of transport in moving farm inputs to the farm as well as the farm produce for marketing. Even maintenance and operational activities along the channels are made difficult.

Construction of medium scale irrigation reservoirs

There are several streams in the dry zone areas which could be harnessed for the irrigation of areas, sometimes extending up to 20,000 to 30,000 acres (8,000 to 12,000 hectares). These streams run dry during the dry months, April-September, but have considerable flows for the rest of the year. Reservoir sites have been investigated on several of these streams and it has been found that many of these reservoirs could be constructed economically to provide irrigation water to hitherto undeveloped areas.

The engineering works do not provide any extraordinary problems. The following considerations indicate some of the interesting aspects of such development schemes:

(1) The development area is usually in undeveloped jungle areas. Surveys and investigations therefore take considerable time.

(2) The soils in the project areas are not consistent. They vary from well drained reddish brown earths to poorly drained lower humic grey soils. Intensive soil investigations have to be carried out to determine cropping patterns that could be established in the project areas.

(3) Construction labour as well as farmers have to be settled in the project areas from adjacent areas. Amenities such as schools, roads, rural hospitals, postal facilities, marketing facilities etc. have to be provided. The provision of such facilities tend to increase the cost of the projects.

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(4) Unemployed and usually landless people are settled in these projects. The projects therefore serve as a means of income re-distribution, whereby the poorer sections of the people are given a chance to produce and better their standards of living.

(5) During the initial years of the project, the production from the farms is low. This can partly be attributed to the lack of farming experience of the settlers. However, after a few years, the production reaches the desired levels.

Transbasin diversion schemes

As stated earlier, dry zone areas are water deficit while the wet zone areas have surplus water. The wet zone areas have considerable hydropower potential which can be harnessed. The dry zone areas are in the plains with very good soils for growing irrigated crops. These conditions provide very suitable conditions for development. Hydropower schemes can be combined with transbasin diversions for agricultural purposes.

The dry zone areas awaiting such development are located in the southeast, northwest and north central areas. These areas already have a network of minor and major reservoir schemes where average cropping intensity is about 1.5 per annum while a minimum of two crops can be grown if sufficient water could be found. In addition large areas are undeveloped jungle land, awaiting reclamation.

A master plan has already been formulated for the utilization of the water resources of the Mahaweli Ganga, the largest river in the island. Under this plan, about 900,000 acres (360,000 hectares) of land in the north central regions will be provided with irrigation water by combining the water resources of the Mahaweli Ganga with those of the smaller streams in the development area itself. Of this area, about 250,000 acres (100,000 hectares) are already developed and irrigated from the schemes that have been constructed. This major development programme was commenced in 1970, and work is proceeding (see below).

Kelani Ganga, another major river which has its outlet to the sea in Colombo, has been studied for the purposes of diversion to the northwestern sector of the dry zone. In view of the large investment required for the implementation of the Mahaweli Ganga Development programme, this diversion project has been put back for a later date.

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The southeast dry zone sector can be served by the diversion of three large rivers, viz. Kalu Ganga, Gin Ganga, and Nilwala Ganga which flow into the ocean along the southwest coast. Though this possibility has been identified, detail studies have yet to be undertaken.

B. PROJECTS

II. TANK MODERNIZATION PROJECT

1. Introduction

About 500,000 acres (200,000 hectares) are irrigated in Sri Lanka under approximately two hundred medium size tank schemes. Deterioration of the irrigation systems, inadequate water management and lack of farm inputs have contributed to the schemes being not able to achieve the production potential possible under them. One of the key elements in the medium-term development programme is the reconditioning of these existing irrigation schemes and introducing better water management practices for achieving increased production.

2. The project

To achieve the objectives quoted above, the Government has selected five tanks with a total command area of 31,500 acres for development in an initial phase of a medium-term programme. The result of this pilot programme will decide the future programme for the other schemes. The five tanks selected are all located in the north central region of the island and practically all of them were constructed in the late 1950s. All five tank schemes were settlement schemes where each farmer was allotted a three-acre irrigated farm and a two-acre house lot where he could also have an unirrigated home garden. The details of the five tanks are as follows:

		Mahakandarawa	Nahawi Ilachchya	Pavatkulam	Vavuni kulam	Padaviya
1.	Tank capacity (ac ft)	34,000	32,500	27,000	35,000	85,000
2.	Catchment area (sq mi)	126	141	115	88	206
3.	Irrigated area (acres)	6,000	2,600	4,400	6,000	12,500
4.	Estimate inflow (75 per cent expectancy)	43,500	21,000	20,500	32,000	127,000
5.	Water availability per acre irrigated (ac ft)	7.2	8.0	4.6	5.3	10.2

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3. Water requirement

Crop water requirements were computed using a modified Penmen method. An over-all irrigation efficiency of 55 per cent has been assumed and the cultivation calendar is, after supply of all other inputs at the appropriate times, assumed to be so drawn that the best use is made of the effective rainfall.

For a crop of paddy, the water requirement has been computed as follows:

	Maha (wet season)						Yala (dry season)					
	Sep.	Oct.	Nov.	Dec.	Jan.	Total	Feb.	March	Apr.	May	Jun.	Total
Evapo-transpiration(in)	6.7	5.2	4.1	4.3	4.5		5.5	6.7	6.5	7.9	4.2	
Crop factor		1.00	1.15	1.20	0.9			1.0	1.15	1.20	0.90	
Consumptive use (in)		5.2	4.7	5.2	4.1	19.2	-	6.7	7.5	9.5	3.8	27.5
Land preparation (in)	4.0	2.0	-	-	-	6.0	4.0	2.0	-	-	-	6.0
Effective rainfall (in)	0.5	3.5	3.4	3.0	0.8	11.2	0.4	1.3	2.5	1.1	-	5.3
Net irrigation requirements (in)	3.5	3.7	1.3	2.2	3.3	14.0	3.6	7.4	5.0	8.4	3.8	28.2
Tank releases at 55 per cent over-all efficiency	6.4	6.7	2.4	4.0	6.0	25.5	6.6	13.5	9.1	15.3	6.9	51.4

The present cropping intensity is about 106 per cent. After the completion of the modernization, the cropping intensity is expected to increase to 156 per cent if all the agricultural inputs are maintained at the specified levels.

4. Project civil works

The works contemplated under this programme can be summarized as follows:

(a) Desilting and enlarging the entire water conveyance system;

(b) Repairing or reconstructing embankments to be used as farm roads;

(c) Provision of drains to improve drainage;

(d) Provision of canal lining where necessary;

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(e) Repairing and modifying existing structures in the irrigation system;

(f) Installing new regulators for facilitating water control;

(g) Constructing measuring devices to measure water flows at various key points in the irrigation canal system;

(h) Provision of construction camp facilities.

5. Agricultural inputs

Lack of farm power has been identified as one of the main constraints hindering timely cultivation based on a specified calendar. This shortage will be overcome by the provision of 150 four wheel tractors and 450 two wheel tractors.

The agricultural extension services will be reorganized so as to be able to meet the new demands anticipated in the future.

6. Costs, implementation period and financing

The project was estimated to cost $US 30 as summarized below:

		$US
1.	Civil works	8.7
2.	Construction equipment	5 6
3.	Agricultural equipment	5.6
4.	Administration	1.6
5.	Physical contingencies	1.7
6.	Price contingencies	6.8
	Total	30.0

The implementation of the project was scheduled for five years and the first year of construction has just been completed. The foreign exchange costs of the project are being financed jointly by International Bank for Reconstruction and Development and the United Kingdom Government.

7. Observations on the programme

(1) It was envisaged that construction work would be carried out on two schemes at a time when there will be a complete stoppage of all cultivation during the dry season. During the first year itself, this procedure could not be implemented as favourable weather conditions permitted a dry season cultivation in most areas. It was not possible to stop cultivation when water was available in the tanks.

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(2) Resulting from above, a fresh schedule of construction has been introduced, whereby work will be carried out in all schemes simultaneously. This has resulted in an increased need for construction equipment.

(3) In addition to construction or repair to structures along the canals, a review of the irrigation system revealed that certain channels had to be relocated in order to achieve an efficient water distribution system.

(4) Provision has not been made for the proper levelling of farms and avoidance of plot to plot irrigation. The project officials are attempting to persuade the farmers on this aspect of the work; they have achieved only limited success in their endeavours.

III. MAHAWELI GANGA DEVELOPMENT PROJECT

1. Introduction

The Mahaweli Ganga and its tributaries drain an area of some 4,000 square miles or roughly one sixth of the total land area of the island. The upper reaches of this largest (207 miles) river in the island falls within the "wet zone" area, while the lower reaches are in the plains in the northeastern sector of the "dry zone". The long-term mean annual yield of the Mahaweli Ganga is estimated to be about 7.0 million acre feet. Some irrigation development, specially on the main tributaries of the river had taken place in the past. On the main river, a diversion weir had been constructed in the late 1930s.

Investigations into the water resources potentials were commenced in the 1930s. However a systematic study was undertaken during the period 1964-1968 by a UNDP-FAO team when expatriate specialists worked with Sri Lanka engineers and scientists to formulate a master plan for the utilization of the water resources of the Mahaweli Ganga.

2. The master plan

The plan provides for the regulation of the Mahaweli Ganga and its tributaries, including some of the rivers in the adjacent basins, in order to supply about 6,400,000 acre-feet of water for the production of hydro-power and for irrigation.

Fifteen reservoirs are planned for construction for the development
1 of about 500 MW of hydro-power and the irrigation of 900,000 acres of land, of which some 246,000 acres are presently irrigated. The plan was scheduled for implementation in a 30-year period.

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The plan consist of several projects with each project being viable on its own, but fitting into a composite stage by stage development plan. Each project was planned on the basis that:

(a) It should be capable of being undertaken without financial commitment to other projects or without prejudice to subsequent development;

(b) It should meet the anticipated demand for power;

(c) It should be implemented within a suitable period, keeping in mind the ability of the country to reclaim and develop the land;

(d) It should be economically viable.

3. The first project

The first project in this vast development plan, called the "Polgolla Diversion Project" was commenced in 1970. A diversion weir was constructed across the main river, at Polgolla (four miles below Kandy), to divert 2,000 cusecs through a 5 mile long tunnel. A 40 mw power plant at the end of the diversion tunnel has its tail race discharging into Sudu Ganga, a tributary of Amban Ganga which itself is a tributary of the Mahaweli Ganga.

A concrete dam at a site called Bowatenna in the Amban Ganga regulates this diversion enabling a further diversion to take place into the adjacent Kala Oya Basin. The diversion from the Bowatenna Reservoir is utilized to provide supplemental irrigation water to 130,000 acres of presently cultivated land and for the development of 100,000 acres of new lands. The construction work on this project is scheduled for completion in 1979.

4. The accelerated programme

The continued import of a large percentage of the island's food requirements, the stagnation of the national economy and the vast unemployment problem prompted the Government of Sri Lanka to reconsider the implementation programme. The thirty year implementation schedule was considered to be too long and the country was impatient at the slow pace of development. If the Mahaweli development was to have any appreciable impact on the country, it was agrued, a quick programme of development was necessary. The implementation of a major part of the plan in a period of 5 to 6 years was considered necessary if the project was to solve the food and employment problems of the country.

In keeping with this policy programme, a fresh implementation schedule has been drawn up under which 5 major reservoirs will be constructed

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for the development of about 330,000 acres of new lands. These projects will also have an installed capacity of about 400 MW.

Feasibility and design studies are currently being conducted on all the five reservoir projects. Construction work on all five projects is scheduled to commence during the years 1979-1980.

5. Land development and water management

Land development

The accelerated programme envisages the supply of water to 330,000 acres of land which are now mostly in jungle. In order to obtain this farm area, a total of approximately 500,000 acres or more have to be cleared and developed. The area is mostly wooded and supports wildlife. The clearing of such large continuous areas is being carefully planned so as to allow wind belts and other greenery in the area. It is also proposed to allow corridors so that wildlife can have access to neighbouring wildlife sanctuaries.

The farm land and housing area will be cleared and levelled by the State so that the farmer will begin his farming career in the project with developed land being made available to him.

Settlement

In the first project to be implemented, each farmer is given an area of 2.5 acres of farm land and 0.5 acre of land for his housing. A study has already been undertaken in order to assess whether any changes are necessary to this unit of allocation. The minumum farm income, availability of family labour and the need for providing land for as many people as possible were some of the main considerations in determining the size of the allotment. Perhaps as the development proceeds, further consideration has to be given to the optimization of production and return from investment.

In previous settlement schemes, the dwelling areas were in "ribbon type" settlements spread along the main canals. But it was felt that this type of settlement did not promote cohesiveness in the villages. Further, provision of service facilities like water and electricity supplies, roads etc. were costly. A "cluster" or "neighbourhood" type of settlement is now being adopted, each cluster consisting of hamlets (100 farm families), villages (500 farm families) and townships (for 3,000 families).

The farmers are selected from predetermined areas on the basis of their experience in farming, quantum of land owned, age and family size, leadership qualities etc. However, initial preference is given to persons who have been displaced by project activities.

At the time of settlement, the farmer is granted a cash subsidy to enable him to build a temporary dwelling place. He is subsequently given loan facilities through commercial banks to enable him to build a permanent home.

Social infrastructure

The project works include the provision of several amenities to the settlements. Market roads connecting the farm to the settlements and trunk roads linking the settlements with outside urban centres are the first tasks of the project authorities. These roads provide mobility to the construction labour force during construction operations and subsequently enables the farmer to proceed with his farming activities without hindrance. Community water supply is provided by means of open dug wells where a group of 20 families are provided with one well.

Community facilities like schools, hospitals, post offices, market places, co-operatives, assembly halls, shops, grain stores etc. are provided to match the need of each unit. For example, the hamlet will have only a visiting dispensary while the township will be provided with a hospital.

The facilities provided are planned so that the settler would be happy in the new environment and be in a position to contribute usefully to the production effort.

Water management

The design of the canal system for irrigation has been based on the supply of water for two crops per annum. The cropping patterns will depend on the type of soil and the season. Rice is planned for cultivation in poorly drained areas while a combination of upland crops will be grown in well drained areas.

In view of the ready availability of manpower, manually operated control structures are provided for the distribution of water. Rotational water issue is to be introduced and a control on the quantum of water used by the farmer is to be effected on the basis of time period of irrigation. The water distribution functions are to be carried out jointly by the

project staff and the farmers. Each farmer is provided with a direct outlet from the field channel which serves his turn-out area.

Drainage channels are constructed by the State so that each farm can have an access to a drainage channel.

Observations

(1) The size of individual farms has been limited to 2.5 acres. Although this may be sufficient for the present, there is no scope for providing land for the next generation of farmers. Either the farms will be divided into small uneconomical units or there will have to be a shift of population to towns or other areas.

(2) Clearing of large areas of jungle deprives the settlers of the use of firewood as a source of energy. With the dwindling sources of petroleum products, efforts have to be made to provide the necessary timber in the area. A careful programme of afforestation in the areas adjacent to the project has to be initiated.

(3) As paddy is the traditional crop grown by the Sri Lanka farmer, he tends to grow paddy even in well drained soils where large quantities of water are required for its cultivation. A system of guaranteed prices for crops other than paddy has to be effectively implemented if the farmer is to be persuaded to grow upland crops in well drained soils. If this is not done, the cropping intensity planned for cannot be realized.

(4) The use of large quantities of fertilizers and agrochemicals
111 may lead to pollution of the ground-water aquifers which is used for community water supplies. Careful monitoring of the ground water has to be carried out.

(5) Stagnant pools of water in the project area may provide breeding grounds for malarial mosquitoes. Proper surface drainage systems have to be provided to avoid standing water.

(6) Deployment of heavy machinery for construction work has to be restructured to a minimum, so that the large unemployed labour can be engaged. This should not, however, be allowed to affect the quality or the planned time schedule for the project.

(7) Seasonal farm labour may prove to be a constraint in the future. This problem has to be studied in detail and appropriate solutions determined. It may be necessary (a) to mechanize certain farm operations, (b) provide migrant labour from neighbouring areas or (c) settle sufficient numbers of families outside the farms to provide a source of farm labour.

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(8) Farmer's organization and leadership qualities among the settlers have to be fostered so that the farmers can manage their own affairs without being dependent on the State for all management functions.

/Annex III

Annex III

NATIONAL RURAL WATER SUPPLY PROGRAMMES IN SELECTED ASIAN COUNTRIES a/

Bangladesh

The population of Bangladesh in 1975 was estimated at 82.5 millions, of which more than 75 million (91 per cent) were rural dwellers. Safe water was available to approximately 26 per cent of the rural population in 1973, almost exclusively from tubewells and hand pumps. This percentage is expected to increase to 33 per cent by 1980, notwithstanding the 3.3 per cent rate of annual population increase. Facilities for excreta disposal are virtually non-existent in rural areas and contamination of surface water sources is widespread. Organized programmes for the improvement of village sanitation are just beginning and it is expected that greater attention and more resources, both government and individual, will be applied to rural sanitation in the future.

Rural water supply and sanitation projects are implemented through the Directorate of Public Health Engineering (DPHE) which is under the Ministry of Local Government, Rural Development and Cooperatives. Funds are allocated in accordance with a programme and budget approved by the National Planning Commission. While the Government maintains major responsibility for programme planning and budgeting as well as project financing and implementation, there are a number of organizational levels for the administration of non-urban areas. Over the whole country there are:

4	divisions, headed by Divisional Commissioners
19	districts, headed by Deputy Commissioners
62	sub-divisions, headed by Sub-division Officers
413	Thanas, headed by Circle Officers (for development projects) and Police Officers
4,285	Unions administered by Union Parishads (councils)
63,000	Villages

The First Five-Year National Plan (1973 to 1978) placed substantial emphasis on the provision of rural water supplies and sanitation. Over the plan period it was intended to allocate $US 58 million for construction of rural water supply and sanitation schemes.

/Burma

a/ This annex was prepared by N.C. Thanh and B.N. Lohani of Environmental Engineering Division, Asian Institute of Technology, Bangkok.

Burma

The 1972 census showed that Burma's population was nearly 29 million, with a recent population growth rate of 2.4 per cent. Eighty-five per cent of the population live in rural areas but only about 13 per cent of these had reasonable access to safe water by the end of 1972. Present plans call for additional rural water supplies for only 120,000 people annually. Little has been done to encourage rural sanitation, which is poor in Burma.

Burma is made up of five federal states: Shan, Kachin, Kasen, Kayah and the Chin Special Division. Each state is divided into administrative districts, each with a deputy commissioner assisted by sub-divisional officers and township officers. Village headmen act as government representatives at the local level.

Major responsibilities for rural water supply and sanitation at the national and local level lie with the Department of Health, Ministry of Health and the Agriculture Mechanization Department, Ministry of Agriculture, although there is little co-ordination between them. The Ministry of Agriculture is the leading agency in the planning and development of rural water supply but there has been no systematic development of this sector in the past. Communities with population below 5,000 are generally considered rural and those with health problems associated with lack of safe water, water scarce areas, and locations where the chemical content in the water is excessive are given priority in selection of project areas.

In the First Four-Year National Plan (1971-1975) the rural water supply programme had low priority. Out of the 1972-1973 allocation of expenditure for social welfare projects, which was 6 per cent (equivalent to $US 104 million) of the total national budget estimate, funds for rural water supply were only 0.04 per cent (or $US 42,000) of the social welfare budget in that year. This level of investment is likely to continue for several years because the social sector has been given low priority in the second Four-Year National Plan.

India

The 1975 population of India was estimated to be 596 million, of which about 480 million (81 per cent) lived in rural areas. The rural population live in 576,000 villages, 3,000 towns and several thousand hamlets, which are associated with villages for census and other purposes but need to be considered separately for purposes of water supply and sanitation. The

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rate of rural population growth is now 2.2 per cent per annum, as the result of an increasingly successful family planning programme.

The country is divided into 21 autonomous States and 9 Union Territories. Responsibility for implementation of state water supply and sanitation programmes is assigned to different ministries in different States and, under the various ministries, is allocated to a specific department. Responsible departments include those of Public Works, Irrigation, Public Health, Panchayats, Local Self Government and Community Development. In one State, an autonomous board carries out the programme. These operating agencies are allocated funds from the State Government according to the National Plan. In their over-all budgeting, each State will allocate Federal and State funds to different sectors, depending on the revenue-earning capacity of the sector. The Federal budget, which includes external aid pooled with Federal revenue, is allocated to most States in the forms of 30 per cent grant and 70 per cent loan (the exception is for mountainous areas) and a State would normally not apply the loan portion to the rural water supply and sanitation programme.

At the Central Government level, the Central Public Health and Environmental Engineering Organization (CPHEEO) of the Ministry of Works and Housing administers the national input to all water supply and sanitation programme in the country and the Planning Commission is responsible for over-all development. The CPHEEO carries out generalized planning but the detailed design and construction of projects is done by the appropriate department of a State Government. Operation and maintenance is the responsibility of the Panchayats except for piped supplies, which are usually the responsibility of the state engineering organization. The costs of operation and maintenance are either fully borne or heavily subsidized by the State Governments. Villagers in India have come to accept water supply as a service supplied free by the Government and this attitude will be difficult to change.

It is estimated that only about 10 per cent of the villages in India have a protected water supply. In 90,000 villages there is either no adequate water source within 1.6 km or the depth to the ground-water table exceeds 15 metres. In an additional 62,000 villages there are health problems which are related to water. These villages are referred to as "scarcity and difficult" or "health problem" villages and, in the Government's Fifth Plan (1974-1979), the total Federal and State allocation for rural water

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supply, Rs 5,740 million ($US 718 million), has been restricted to means for improving water supply conditions in these communities. In spite of this allocation, it will not be possible to cover all "scarcity or problem" villages, nor will the water supply needs of the annual increase in rural population be met by this level of funding.

Although rural sanitation was part of the National Water Supply and Sanitation Programme, it has received a low priority from the States. Absence of drainage and excreta disposal systems in nearly all villages often leads to insanitary conditions and the vast majority of rural people still defaecate in the fields. This causes health hazards, particularly where surface water sources are utilized for drinking. Some States have subsidized the construction of water-sealed latrines by paying 75 per cent of the cost to participating villagers.

In the Fifth National Development Plan, the concept of integrated area development at the district level has been accepted by the Government for the future approach to rural development. No specific programme or agencies have been set up to implement this strategy and it remains to be seen how the States will react to the Federal proposal.

Indonesia

The population of the Republic of Indonesia was estimated in 1975 at 132 million, of which about 108 million (82 per cent) live in rural areas in approximately 58,000 villages. The rural population with safe water supplies was estimated in 1975 to be about 2.9 per cent of the 108 million. At the same time, an estimated 4.7 per cent of the rural population was considered to have use of facilities for the safe disposal of excreta in rural areas.

There are 26 Provinces in the country, each with a Legislature and Governor. The Provinces are divided into Regencies (Kabupatens) and Municipalities (kotamadyas), each with a legislature, and these levels of government are autonomous. The next level is the Sub-district (Kecamatan) and below this level is the village (Desa).

The responsibility for all aspects of the Central Government's concern for rural water supply and sanitation is vested in the Directorate of Hygiene and Sanitation (DHS) which is under the Directorate General of Communicable Diseases Control, Ministry of Health. Projects formulated by DHS are submitted

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to the National Development Planning Board (Bappenas) for approval and allocation of funds for project implementation. In each Province there is a Provincial Department of Health whose Division of Hygiene and Sanitation has responsibility for rural water supply and sanitation projects. Projects may be initiated and undertaken without reference to the Central Government, provided that funding is acquired independently of the Central Government.

At the Kabupaten and Kotamadya levels there are Health, Sanitation and Public Works Divisions which participate jointly with Central and Provincial Governments in rural water supply and sanitation programmes. These divisions have the authority to implement projects without reference to Provincial or Central Governments when funding is provided by the Kabupaten. For piped water systems, the local contribution is generally 1, 2 or 3 times the Central Government budget allocation.

The Second Five-Year Plan (or Repelita II) for Indonesia (1974-1979) provides an allocation of Rp 14 billion ($US 23 million) for rural water supply and sanitation, which is 0.3 per cent of the total plan outlay in the development budget. The projected rate of spending over the plan period has now been exceeded because of the INPRES (Presidential Instruction) programme which has earmarked additional funds for water and sanitation projects in rural areas ($US 4 million for 1974/1975 and tentatively $US 7 million for 1975/1976). In spite of the impetus given to rural water supply and sanitation by INPRES and the availability of funding, water supply projects undertaken thus far can be considered as pilot projects for training of staff and for demonstrating methodology. The shortage of technical manpower in operating agencies is, at present, the most limiting factor in expanding the rural water supply and sanitation programme.

Rural sanitation, particularly the construction of latrines, was formerly based primarily on the initiative of the Provincial and Kabupaten Health Departments. Future planning provides for Central Government funding of a latrine programme, which will include both communal and individual family units.

Nepal

The last census in 1971 reported a population of 11.56 million with a rural component of 11.1 million (96 per cent). The annual growth rate of the total population was 1.8 per cent from 1961 to 1971. Rural water supply is provided almost exclusively in the form of gravity piped systems.

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There are at present some 105 rural piped water supply systems in operation in the country and these serve a population of 405,400 (3.65 per cent of the rural population). Rural sanitation programme have been almost non-existent in the past but excreta disposal projects are now being introduced.

The National Planning Commission maintains responsibility for rural water supply and sanitation programme planning and budgeting. Implementation, however, is now the responsibility of the Department of Water Supply and Sewerage in the Ministry of Water and Power of communities over 3,000 population and the Remote Area and Local Development Department, in the Ministry of Home and Panchayat for communities under 3,000 population, with the involvement of 75 district panchayats consisting of 16 urban (nagar) panchayats and 3,916 village (gram) panchayats. All projects carried out by the Remote Area and Local Development Department include local contributions from villagers in the form of manpower, locally available resources etc.

Rural water supply was emphasized in the Third Five-Year Plan (1965-1970) so that out of a total allotment of $US 2.3 million, $US 0.66 million (about 29 per cent) was for rural areas. In the Fourth Five-Year Plan (1970-1975) $US 2.8 million was allocated for urban and rural water supply. The Fifth Five-Year Plan (1975/1976-1980/1981) proposes the following rural water supply programmes:

(i) Remote Area and Local Development Department to supply an additional 108,000 population (in communities under 3,000) by the construction of 175 piped water systems at an estimated budget of £US 1.7 million.

(ii) Department of Water Supply and Sewerage to supply an additional 463,000 minimum to 564,600 maximum population (in communities over 3,000) by the construction of 90 to 108 piped water supply systems with a budget of $US 0.8 million.

In August 1975, a draft "Project Formulation for Development of Water Supply and Excreta Disposal" was prepared with the collaboration of WHO and this involved both Departments in the provision of services for rural areas.

Pakistan

The 1975 population of Pakistan was of the order of 70 million, with approximately 80 per cent living in rural areas in more than 25,000 villages. Up to 1975, only about 5 per cent of the rural population was served by protected water supplies and, essentially, no rural sanitation programme had been initiated. With a population growth rate of 3.3 per cent per annum,

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the problems of meeting the increasing demands for rural water supply and sanitation are servere. The Federal Planning Commission has set 1980 targets for the Fifth Five-Year Plan (1975 to 1980) as 24 per cent coverage of the rural population for water supply services and 10 per cent for sanitation.

Although the Federal Government frame policy set targets and allocated federal funds for rural water supply and (in the future) sanitation, they leave the execution of programmes entirely in the hands of Provincial Governments. Pakistan is divided into four major provinces, Baluchistan, North West Frontier, Punjab and Sind, and incorporates Azad Kashmir and Gilgit Agency. Administratively, the Provinces are divided into Districts, Tehsils (3-4 per district) and Union Councils (average 30 per Tehsil, each representing 3-10 villages). Provincial Governments have a high degree of autonomy and the allocation of both provincial and federal funds is the responsibility of Provincial Assemblies. Thus, the rural water supply programme in Pakistan is administered by the Provinces. Fortunately, each Province has the same Departments responsible for rural water supply and sanitation. In each Province, the Department of Local Government and Social Welfare administers these programmes and executes them through the Public Health Engineering Department (PHED) and the People's Works Programme (PWF). However, the problems of supplying water to rural communities differ in various parts of the four Provinces by reason of geographical and sociological differences.

Provincial PHEDs have the responsibility for both rural and urban water supply and sanitation and, in the rural context, have concentrated on larger schemes of water supply, usually involving some form of distribution system. Most schemes completed have been for populations between 5,000 and 10,000 but some villages with populations between 2,000 and 5,000 have been served. The entire capital cost of these schemes is born by the Provincial Governments, together with the costs of operation and maintenance for the first two years. After two years, in principle, local rural councils (Union Councils) are responsible for operation and maintenance but in most cases they do not have the technical for financial capability of accepting this responsibility and PHED continues to assist.

In addition to their major responsibility for rural water supply and sanitation, PHEDs are also expected to act as operating agencies in this sector for other agencies involved in rural development. A programme of

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rural water supply assisted by a $US 15 million loan from USAID and involving a Pakistan Government investment of $US 46 million over the next five years will be implemented by PHEDs. Over recent years, the budgets allocated by Provincial Governments for rural water supply have been increasing and are now straining the technical capabilities of the Departments. Shortages of qualified professional staff is the major constraint to expanding present programmes and this, in part, is due to recruitment of Pakistani engineers for service in other countries, principally Saudi Arabia.

The People's Work Programme in each Province has the objective of improving socio-economic conditions in rural and urban communities. Various categories of development project are eligible for support under PWD, including "Drinking Water Supply" and "Sewage and Sanitation", but their main programme has been in construction of rural link roads. The PWD Directorates administer Provincial Government funds and co-ordinate operating agencies. In the rural water supply sector, they should be co-ordinating with PHEDs but, in fact, are actually implementing schemes for rural communities with populations of less than 2,000.

Sri Lanka

The 1971 census indicated that Sri Lanka's population was 12.71 million of which 9.87 million (77.7 per cent) lived in rural areas in 24,794 communities. Rural population growth had reached a level of 1.8 per cent at that time. Almost 6,000 of the rural communities (population 1.13 million) are called estate villages, while the remaining 18,838 communities are termed rural villages, governed by village committees. By 1972, almost 1.5 million people in rural communities (15 per cent of the rural population) had access to safe water supply, between 66 and 75 per cent of these being served by standposts. It is estimated that in 1973, 1.15 million housing units in rural areas (64 per cent of total rural housing) had latrine facilities.

There is a two-tier system of Government in Sri Lanka including the Central Government and Local Government. Administratively, the country is divided into 9 Provinces, 22 Districts, 157 DRO[1/] Divisions, and 3,614 GA[2/] Divisions and the Local Government administration in rural areas is in the hands of 542 village committees, representing groups of villages.

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1/ District Revenue Officer.
2/ Government Agent.

The agencies responsible for rural water supply and sanitation are: the Department of Water Supply and Drainage (DWSD) of the Ministry of Irrigation, Power and Highways; the Territorial Civil Engineering Organization (TCEO) under the Ministry of Irrigation, Power and Highways; local authorities whose interests are looked after by the Ministry of Local Government, Public Administration and Home Affairs; the Department of Health in the Ministry of Health; and the Division of Public Health Engineering in the Department of Building, Ministry of Housing. DWSD provides assistance for the establishment of piped water supply, sewerage and drainage and carries out investigation, design, construction and, in many causes, operation and maintenance. TCEO undertakes the same functions but only for small schemes. Local authorities are mainly responsible for operation and maintenance of schemes within their own areas but have done investigation, design and construction of some of their schemes. The Department of Health is responsible for the water-seal latrine programme. Problems in the organization and management of water supply and sewerage in the country have resulted in the Government creating an autonomous National Water Supply and Drainage Board.

The Government of Sri Lanka first placed emphasis on water supply projects benefiting rural areas in the late 1960s even though there was no national plan for this sector. In the current Five-Year National Plan (1972-1976) the importance of piped water supply and sewerage in improving preventive health services in rural areas was stressed and 30 per cent of the total plan outlay on water supply and sanitation was allocated for rural areas. However, this allocation was only 0.35 per cent of the Plan's total outlay on development works. In the past, rural water supply projects were financed entirely by the Government but, under the present system of financing, local authorities have to bear 42.5 per cent of the capital cost of all rural schemes sponsored by Government and costing more than $US 3,350. Local authorities invariably have to raise loans to meet their share of capital costs. For schemes costing less than Rs 20,000 the Ministry of Local Government has the discretion to waive the local authority's share.

Thailand

The 1970 census in Thailand showed the population to be 36.2 million, of which 30.8 million (85 per cent) were rural. Communities of less than 5,000 people are regarded as villages and there are 50,000 such villages in the country. The average annual growth rate for the rural population has

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been worked out by national authorities at 3 per cent but there are signs that family planning programmes are having an effect in reducing this, perhaps to 2.5 per cent by 1977. It has been estimated that about 10 per cent of the rural population had access to safe water in 1970 and the figure was expected to increase to 15 per cent by 1976. The present general policy is to provide tubewells or sanitary wells equipped with hand pumps for rural communities, supplemented by piped systems wherever feasible. A water-seal latrine programme has been very successful in all regions of the country and by 1972 almost 14 million people were provided with this form of sanitation in the house (20.4 per cent of all village houses).

Thailand has a highly centralized system of Government and, administratively, the country is divided into four regions: north, northeast, central and south. There are 72 Provinces (Changwats) divided into Districts (Amphors) and each of these has 8 to 10 Sub-districts (Tambons). A Sub-district will comprise 5 to 10 villages (Mubans). District capitals and larger Sub-districts have municipal bodies and other Sub-Districts have Tambon Councils.

The National Economic and Social Development Board (NESDB) is responsible to the Prime Minister for the over-all development plan of the entire country and now produces Five-Year National Plans. At the national level, the responsibility for rural water supply and sanitation is shared by several agencies. The Department of Public Health Promotion in the Ministry of Public Health, the Department of Public Works in the Ministry of Interior, the Department of Mineral Resources in the Ministry of Industry and the Accelerated Rural Development Office in the Ministry of Interior have responsibility for villages with population between 500 and 5,000. Villages with a population less than 500 are looked after by the Department of Medical and Health Services in the Ministry of Public Health and the Department of Local Administration in the Ministry of Interior. Added to these are the Department of Community Development in the Ministry of Interior, the Royal Irrigation Department in the Ministry of Agriculture & Cooperatives and the Border Patrol Service of the Ministry of Interior, which also play minor roles in rural water supply and sanitation.

In April 1966 the Government started the "Community Water Supply Project" which had the objective of providing safe water to the entire rural population. The Second National Plan (1967-1971) particularly recognized the need for increased investment in potable water supply throughout Thailand

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but at the end of the Plan period it was admitted that potable water schemes for smaller villages were still inadequate, despite the number of Government agencies involved in that field. Only 0.8 per cent of the total outlay of the Second Plan was allocated to water supply and sanitation for rural areas, while 1.1 per cent was allocated for urban water supply and sanitation. In the Third National Plan (1972-1976) the share of water supply and sanitation investment for rural areas was 1 per cent of the total outlay, half that allocated to urban areas. However, there has been a progressive increase in spending on rural water supply and sanitation in recent years: $US 4.67 million in 1972 and $US 6.1 million in 1974. The budget for the Environmental Health Division (dealing only with piped water supply for the larger rural communities) increased from $US 1.2 million in 1971 to $US 1.6 million in 1974. As evidence of the Government's intentions of promoting the development of rural areas, the budget allocated to the principal Departments involved in rural water supply and sanitation in the Third Five-Year Plan (1977-1981) has been raised to $US 57.8 million from $US 25.3 million in the Second Five-Year Plan.

In Thailand the people's contribution towards water supply schemes has, in many cases, been more than 50 per cent of the capital cost. The balance is made up by Government as an outright grant. The entire cost of operation and maintenance is supposed to be borne by beneficiaries but, for piped water supply systems, has been heavily subsidized by the Government.

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