**Management of Water-Resources in South Asia**

**INTRODUCTION**

South Asian Region consists of Pakistan, India, Nepal, Bhutan, Bangladesh, Sri Lanka

and Maldives. The map of the region is given in Figure-1. The region has high- altitude

mountain terrains, sub–mountainous tracts, large flood-plains, with a network of rivers

and streams, deserts and large coastal areas. The famous Indus and Gangetic civilizations thrived and prospered in this region.

Agriculture has been the main pursuit in the region since human civilization began. Land

and water have been the primary resources for this activity since primeval times. Initially, the human settlements were built near the water-bodies, like rivers and lakes. Human beings learnt from experience that water is a basic input in raising crops. Agriculture continued to be mainly carried out under rain-fed conditions. Irrigated agriculture started much later. As primary structures, wells and karezes (sub-surface irrigation ditches) are known to have been built in various parts of the world, including South Asia. These Structures helped an assured production of crops and also helped to raise farm-productivity. With expansion in human population, the land and water-resources came under pressure. The disasters, like drought, disease, insect hazards (locust and others), resulted in crop damages, many a times leading to famines. In addition, the process of degradation of land and water-resources, through salinization, water-logging, industrial effluents and other environmental hazards, is an on-going process and is a major threat to agriculture. There is a need for a judicious management of these scarce resources. A number of efforts were initiated in the South Asian region, particularly during the last millennium, for the proper management/use of land and water-resources. This becomes more demanding at a time when large fertile tracts of agricultural land are falling victim to rapid industrialization, urbanization and other non-farm uses. Similarly, management of water-resources is of prime importance for fostering activities of agriculture sector on commercial lines.



**SOUTH ASIAN SCENARIO**

**Population**

The population of the world is 6 billion, Asia 4 billion and South Asia 1.56billion. The population of South Asia was 21.7 % of the world population and 36.0 % of Asian population. The data is as in Table-1.1.The world has a population of 43% engaged in agricultural discipline. However, Asian involvement in agriculture is 53% while South Asia has 56% of the total population working in agriculture sector.

**Land**

The cropped area of the world is about 1512 million ha. The cropped area in Asia is 557.6 million ha and South Asian cropped area is 204.8 million ha. This makes 12.6 % of the world-cropped area and 36.7 of the Asian cropped area. The cropped area in South Asia is 40% irrigated (82.6 million ha) and 60 % rainfed (122.2 million ha).

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| **Major Crop** |  **Distribution with respect to cropped area** |
| Rice | 22.6% |
| wheat | 14% |
| Coarse grains | 12.1% |
| Pulses | 10.5% |
| Cotton | 4.5% |
| Oil seeds | 4.5% |
| beans | 3.8% |
| Sugarcane | 2% |
| Plantations having high commercial value(tea, coconut and rubber) | 1.5% |

**Water Requirements of Important Crops**

In South Asia, the crops are grown both under irrigated and rainfed conditions. It is little

difficult to work out the exact requirement to be supplemented to the crops through the

irrigation-network, in addition to rains. However, in the background of requirement of crops in Pakistan, the water requirements have been worked out for the 8 important crops at 1166 million-acre feet (MAF). About 63.6 % are required for rice alone; wheat 9.8 %, coarse grains 6.8%, pulses 5.7%, sugarcane 5.9 %. The water-requirement for these five crops makes 92 % of the water requirements.

 C**OUNTRY PROFILE**

The water resource profile of the South Asian Countries is as follows:

**BANGLADESH**

The cultivated area of Bangladesh is 8.8 million ha. The country has a high density of

Population of 834 inhabitants per km2. The average holding per farm household in 1983

was 0.9 ha. Nearly 24 per cent of farm households own less than 0.2 ha and another 46

per cent own up to 1.0 ha. Agriculture is mainly carried out under conventional subsistence farming practices. Rice is the main crop, occupying an area of 10.5 million ha, which makes 90 % of the area under cereal crops. Other important crops grown in the country are pulses, oilseeds, jute and sugar cane. Recently a plan has been prepared to introduce and expand cotton-production in the country to meet domestic requirements and to sustain the exports of garments and other textile made ups.

Bangladesh has a tropical monsoon climate. About 80 per cent of the total rainfall occurs in the monsoon and the average annual rainfall over the country is 2320 mm. Being a deltaic country, cyclone cause heavy damage to the agricultural economy and structures. Floods, cyclones and droughts are a common feature of the climate pattern in Bangladesh.

Government’s main emphasis in Bangladesh is the expansion of small-scale irrigation.

At present, irrigation is practiced for rice (71 per cent) and wheat (9 per cent), which

Together occupy 80 per cent of the irrigated land. Irrigation is mainly used in the dry season. Because of its low-lying topography, about 22 per cent of the area of the country is flooded each year. Flood control and drainage are used to reduce the depth of flooding or eliminate, through ‘controlled flooding’ high and untimely floods in order to provide greater security for crop production.

Water-management and flood-protection occupy a pivotal position in the planning process of Bangladesh. The major emphasis in Bangladesh is on the following issues:

• Improving use efficiency of existing facilities with an effective O&M;

• De-Silting of rivers and channels;

• Integrated flood control / drainage;

• Participation of water-users in the planning and design of new irrigation/drainage

**BHUTAN**

Bhutan is a Himalayan country with a rugged mountain terrain. Climate ranges from hot

And humid subtropical conditions in the south to the incessant ice and snow in Himalayas. The only dam in the country is the Chukka hydropower dam. Most rivers are deeply incised into the landscape, a fact that greatly limits the possibilities for run-of-the-river irrigation. The total water-withdrawal was estimated at 16.2 thousand-acre feet in 1987.The cultivated area in Bhutan is 160 thousand ha. Out of this, about 1 thousand ha are irrigated and rest is dependent upon rains. The irrigated area is mostly under rice crop.

The irrigation-management strategy mainly focuses on:

• Sustainable improvements in water-delivery and use-efficiency;

• Diversifying the range of irrigation from mono-cropped rice system to multi-crop system;

• Increasing the role of water-users and the private sector, and to reduce recurrent

government investments in irrigation schemes.

**INDIA**

The total cultivable area of India is estimated at 169.5 million ha, or about 57 per cent of

the land area. The cropping intensity is 130 per cent. The major cereals grown in India are wheat, rice, and coarse grains. Ninety one per cent of the farmers have land holdings less than 4 ha. The average farm size is estimated at 1.57 ha. The rainfall in India is brought about by the monsoon system and western disturbances.The average rainfall is 1170 mm. There are places, which get world’s highest rainfall of 12,500 mm. On the other extreme, there are places like Rajasthan, Gujarat, Saurashtra and Kutch, which get less than 150-mm rainfall. Most of these areas have undergone extensive drought conditions, with massive human and livestock migration. This called for an intervention from the Government to address the drudgeries of masses in these areas. Temperature variations are also marked.The major sources of water in India are rainfall and the glacier melts. India has the largest irrigated area of the world, size of the irrigated area is 59 million ha. Irrigation is mainly concentrated in the north of the country, along the Indus and Ganges rivers.Uttar Pradesh (22 per cent of the irrigated area), Rajasthan (9 per cent) Madhya Pradesh (9 per cent) and Punjab (8 per cent) Liberal subsidies on electricity and its abundant supplies has helped to foster both production and productivity of crops. This situation has resulted in huge inefficient use of water at the farm.

The average overall water-use efficiency in canal irrigation systems is estimated at 40 per cent Water allocation priority has been given to drinking water, followed by irrigation, hydropower, navigation and industrial or other uses in the order. All the states are required to develop their state water-policy within the framework of the national water-policy and, accordingly, set up a master plan for water-resources development.

All rivers in their upper reaches have good quality of water. Like elsewhere, the deterioration in quality of water starts downstream through domestic, industrial and agricultural pollutants. These pollutants also affect groundwater. The mining of groundwater in drought-hit states has resulted in lowering of water-table in large number of Indian States to very low levels. This is mainly because of the conditions of non-recharging of water in current drought conditions that forced a large number of the farming communities to migrate from water starving areas to water sanctuaries. Indian policy of providing heavy subsidy on electric

tariff has also been responsible for this situation.

**MALDIVES**

The total cultivated area of Maldives is estimated at 3000 ha. Permanent crops as coconut and aeronaut are grown on an area of 2000 ha and annual field-crops as maize, sorghum,cassava, onion and chilies are grown on an area of 1000 ha.

The islands have a tropical climate with two monsoons, which are:

• The southwest monsoon from May to September;

• The northeast monsoon from November to March.

The precipitation is uniformly distributed between April - December. The January – March is a dry period. The mean annual rainfall is 1883 mm. The islands do not have any rivers. Rainwater is collected through water-harvesting on a small scale and used for drinking purposes. Maldives finds it extremely difficult to obtain suitable drinkable water. Three desalination plants are in operation, with a total production of 1000 m³/d.

**NEPAL**

Nepal is a land locked Himalayan State located entirely in the Ganges basin. The cultivable area of Nepal is estimated at 2.96 million ha. One third of this area is in the Terai plain, 8 per cent in the Siwalik, 48 per cent in the mountain and hill region and 10 per cent in the high Himalayas. Agriculture contributed 40 per cent of GDP in 1996 and employed more than 93 per cent of the economically active population of the country. The main agricultural exports are rice, pulses and jute.

The mean annual rainfall is 1500 mm. There are two rainy seasons in Nepal: one in the

Summer (June to September) when the southwest monsoon brings more than 75 per cent of the total rainfall, and the other in winter (December to February) accounting for less than 25 per cent of the total.

The surface-water resources produced internally are estimated at 168 MAF water. The

Ground water-resources have not been fully assessed. A rough estimate is made by assuming a ground water-resource equivalent to ten per cent of surface-water, i.e. approximately 17 MAF. This makes Nepal one of the Asian countries with the highest level of water-resources per in habitant. The total dam-capacity of Nepal is 69 thousand-acre feet. This is a small fraction of the potential dam-capacity of 117 MAF. The irrigated area in Nepal is 1.14 million ha. Irrigation is mainly done by flooding. Ninety one per cent area is dependent on surface-water and 9 per cent on groundwater. The Department of Irrigation is responsible for the management of the irrigation programs. The main irrigated crop is paddy in summer, followed by wheat crop in winter.

**PAKISTAN**

Rainfall activity over Pakistan occurs mainly in two distinct periods, namely summer (June to September, the monsoon season) and winter (December to March). More rains fall during the monsoon season than during the winter season.

The annual flow of water in the Indus River system, on an average, is 140 MAF. The flow during summer is 118 MAF (84%) and in winter is 22 MAF (16). Indus is the Main River contributing 65% of water supplies, with Jhelum giving 17% and Chenab 19%. In the light of Indus-Basin Water-Treaty, Pakistan has built a series of link canals to divert water fromthe western rivers, to provide water to the Southern Punjab. Pakistan has built a reservoir capacity of 18 MAF water to cater for the needs during periods of scarcity, mainly winter crops. About 4 MAF capacity has already been reduced through sedimentation. The alluvial plains of Pakistan have a sweet-water aquifer of 50 MAF. Out of this, 40 MAF is being exploited through 600,000 tube wells mainly in private sector. The Ministry of Food and Agriculture is in the process of promoting cropping pattern/production practices that minimize the requirements of irrigation-water, without compromise on farm-productivity/profitability.A flow of 10 MAF is required to maintain ecology in the deltaic region and to avoid intrusion of sea water. There was not much water available for the purpose during the drought encountered over the last three years. As a result, the seawater intruded, causing damage to farmlands.

**SRI LANKA**

Sri Lanka receives rainfall mainly through two monsoons. The rainfall-intensity varies

markedly across the island. Based on rainfall, several agro-climatic regions (wet zone,

intermediate zone, dry zone and arid zone) can be recognized. There is considerable

variation around the mean annual rainfall of 2000 mm. The highest rainfalls are in the

central highlands. Groundwater resources have been extensively used. Sri Lanka’s largest aquifer extends over 200 km in the northwestern and northern coastal areas. There are about 15000 tube-wells in the country. The quality of the groundwater is generally fairly good and relatively constant throughout the year. However, in some parts of the country (northern and northwestern coastal areas) excessive concentrations of iron and nitrates (due to agro-chemicals and fertilizers) have been reported. Furthermore, due to uncontrolled extraction of groundwater for domestic and agricultural uses, intrusion of brackish water has occurred in the coastal areas.

Groundwater is an important source of water for irrigation and domestic use. It is

Increasingly used as drinking water, especially in small towns and rural areas. The total

Water-demand is estimated to be 9.3 MAF. Of this, 90 per cent is for agriculture, 7 per cent for domestic purposes and 3 per cent for industrial purposes.

The total cultivated area of Sri Lanka is 1.9 million ha. Out of this 0.7 million ha are

irrigated and rest is dependent upon rains. Of this cultivated area, 1 million ha are under

permanent crops such as tea, rubber and coconut. Annual crops viz. paddy, sugar cane, maize, green gram, green chilies and cowpeas, are grown on 0.9 million ha.The irrigationsystems in Sri Lanka are designed mainly for paddy (0.8 million ha) cultivation. Other irrigated crops are chilies (15000 ha), sweet potato, banana and green gram.

In Sri Lanka, irrigation-schemes can be classed as minor, medium or major, depending

on the area they serve. Minor schemes provide facilities for less than 80 ha. In 1995, they served about 200 000 ha. Medium schemes provide facilities for areas of 80-400 ha. In 1995, they served 61 000 ha. Major schemes provide facilities for more than 400 ha. In1995, they served 309 000 ha.The participation of water-users has been adopted in irrigation schemes in recent years. A Water Resources Council has been established inSri Lanka, to oversee the implementation of the action-plan of water management.

**ISSUES AND OPPORTUNITIES FOR SOUTH ASIA**

**Climate**

The climate is the biggest factor affecting availability of water. The South Asian Region

has two distinct rainfall systems. In summer, the southwestern system brings rainfall to

this region. In winter, Bangladesh and adjoining areas of India get rainfall from the North

Eastern monsoon system. Pakistan and other parts of the region get rainfall from the

western weather system. La-Nina (dry spell) and El-Nino (wet spell) are the two distinct

phenomena that effect the availability of water extraordinarily. The details are as follows:

a. La-Nina: This is a situation of low or no rainfall resulting in drought. The South Asian

Region suffered from this phenomenon during last 3-4 years resulted in a drought in the

region, severely affecting the economy of the countries in the region.

The effects of drought are of universal nature, affecting vast areas in a country or the

region. There were areas in the region, particularly in arid and semi-arid climate, where

there was acute shortage of water. In these areas, the crops were damaged. The pastures dried up. Even drinking water became a problem. There was massive human and livestock migration. The damage to the livestock was substantial. A large number of crops, especially in rainfed area were damaged, affecting the GDP.

**Short-Term Measures**

* The Governments should assess the extent of damage/likely damage and declare affected areas as calamity-hit, to cope with the extra-ordinary situation.
* The Governments should provide a relief package, providing food for the human Being and feed/fodders for the animals.
* Vaccination programs may be carried out for livestock.
* The elite animals of good breeds of livestock may be taken to sanctuaries, to avoid the risk of loss of such breeds.
* Governments may provide credit-line, to enable the farmers to buy seeds, fertilizers, bullocks, farm machinery and farming inputs.

**Long-Term Measures**

* Governments should undertake to build up water-supply schemes in the desert/

Affected areas, through arranging pipeline supplies in remote water-deficit areas.

* Build up a network of roads, to facilitate the movement of goods and relief supplies in the drought-stricken areas.
* The scientists should come up with a package of crop-production practices and

Technologies that are low water-requiring, particularly crop-varieties that have less thirst for water.

**b. El-Nino**: This is a situation of high rainfall, often resulting in floods. The effects of floods are localized in nature and show a corridor effect, around the inundating creeks and rivers. The coverage of floods is not of the same large dimension as in droughts. The floods are quite common in the countries of the region and damage standing crops,

Households, farms, irrigation structures and communication links. The opportunities for a solution to this type of situation are proposed as follows:

 **On short-term basis**

The Governments may provide relief to the effectives and take other appropriate measures, as reported earlier.

**On long-term basis**

The Governments should plan for mitigating the effects of floods, through building of structures and reservoirs to pond the water overflowing from the Banks of rivers and creeks. Sri Lanka has successfully diverted floods through building such structures.

**River System**

The region has a network of rivers and streams in almost all the countries. The rainfall

And the snowmelt from the glaciers is the two sources of water-supply in these rivers.

There is a wide fluctuation in the river-flows during wet and dry seasons of the year. The

Supplies peak up generally in monsoon and during snowmelts (July- September) while

The flows recede in dry season, particularly in winter. This situation calls for a judicious

Management of water-resources for raising crops during periods of scarcity, particularly

Winter crops. The rivers need to be tamed through construction of control-structures and water-reservoirs to offset the shortages in times of scarcity.

**Water-Reservoirs**

To tame the rivers, there is a necessity to build up water-reservoirs on the river systems. A large number of such reservoirs have already been built in various countries of the region, with a reservoir capacity of 248 MAF. These reservoirs are useful for a regular supply of water during periods of scarcity, for sustained production of crops.

In addition, these reservoirs have provided an important opportunity in hydel-power

Generation, fishing and a ground-water recharge of the adjoining areas. The situation has helped to raise farm-incomes and eradicate poverty.

**Groundwater**

The groundwater involves aspects of quantum and quality of subsurface water for human use and agricultural purposes. The South Asian Region has a good sweet-water aquifer. In addition, it has a large brackish subsurface-water profile.

Almost in all countries of the region, the supplementation of canal-water irrigation through subsurface water supplies is quite common. This water is pumped through shallow wells or deep tube wells or turbines for industrial, potable and agricultural purposes. A large number of these irrigation-programs are in both public and private sector. Some countries of the region have already handed over the public-sector tube wells to the benefiting water users.

Recharging of the subsurface water-aquifer is highly important to keep the pumping of

Water continued from this subsurface layer. However, the countries of the region in some areas have suffered in water-recharging programs on the following accounts:

a. Drought affected the rainfall and water-balance.

b. Subsidies in some countries on electric tariff and irrigation-equipment promoted in

Efficient use. There is a need to minimize/withdraw these subsidies, to optimize water use efficiency and to ensure that (inefficient) mining of water does not continue.

Water recharging is important for the countries of the region, especially in the arid and

Semi- arid areas where water depth has been lowered substantially, in much case to 40-

50 feet deep. In some places, the farmers have been mining fossilized water from depths of 800-1000 feet. This water has been used to grow crops which unfortunately did not fetch good prices in some years, inflicting huge losses to the farm economy. This is a classic case of onion-production in Baluchistan, Pakistan. Such situations are quite common in other countries of the South Asian Region. Governments of the region need to make policies for conservation of water-resources that optimize use efficiency.

**Institutional Development**

There is a need to assure that proper institutions are in place to carry out the various

Activities concerning water-resource development, distribution and on farm water

Management.

a. Water-Resources Development

The countries of the region in general, has already established, agencies that have

Complete water-mapping of surface-water available in various parts of their country. These agencies have already done useful work in water-resources development, through

Construction of a network of water-structures, such as reservoirs, dams, barrages, canals, link canals, lakes and ponds. These agencies in the regional countries, in many cases.

b. **Water Distribution-System**

A number of the countries of the region have established a scientific water-distribution

System to meet requirements of water for crops. The drought over the last 3-4 years has

Given very good learning experiences on judicious water-use system. The Agricultural

And Irrigation Departments were able to develop schedules for water-distribution system, depending upon crop-needs. This has helped to mitigate the ill effects of water-supplies, without much effect on productivity of crops.

c**. Water Conservation**

The Governments should aim at conserving the soil and water-resources to maximize the efficiency of use.

**Water Delivery-System**

The studies carried out by various institutions in Pakistan show that the water-losses in

Delivery from canal to watercourse outlets is about 40 % on an average. An equal amount of water is lost in the century-old watercourses. There is a need to minimize these losses in water-delivery through:

• Desilting of canals and minors.

• Renovation of water-courses, through brick lining and earthing improvement.

Pakistan and other countries of the region that are conscious of this situation have already launched on-farm water management programs, in the context of their farming situations. The countries of the region need to take up crash water-management programs, so as to quickly renovate water-delivery system, to improve efficiency of delivery.

**On Farm Programs**

A large number of fields are so uneven that the result is unequal distribution of water

Applied, patchy germination and poor crop-stands. There is a need for improving water use efficiency at the farm, to maximize productivity of crops. The following programs

Are being followed in Pakistan and some other countries of the region, to optimize water

At the farm:

• Precision leveling of land, in uneven fields.

• Sowing of crops on ridges and beds.

• Use of pressurized-irrigation systems for orchards, vegetables, floriculture and other

 High-valued crops.

Some countries of the region have used subsidies to promote use of drip and trickle irrigation systems. This generally leads to more efficient utilization of the scarce farmer sources.

**Water Pollution**

Most of the rivers and creeks in their upper reaches have good-quality water. As water

Flows downstream, the industrial and urban effluents load this water with heavy metals,

Injurious chemicals and biological pollutants. The quality of ground-water is also

Deteriorating rapidly. Cases of ill effects of such industrial effluents have been reported in Pakistan and other countries of the region. In Sri Lanka, the pollution with iron and nitrates has been reported. The salinization of subsurface water, through intrusion of seawater, has been reported in some countries of the region in coastal areas. This is an area that needs the attention of the Governments in the region, in the context of appropriate legislation and implementation of sound environmental policies.

**Participation of the Farming Communities**

Over the last two decades, in the countries of the region, there is a growing involvement

Of the farming communities in water-resource development, distribution and on-farm-water management programs. Water users’ associations have been organized and are actively involved in the planning and development programs of the water-sector in agriculture. These farmer organizations can be further involved in transformation of agricultural rural scenarios.

And their efficient utilization.

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