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WATER RESOURCES OF PAKISTAN

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BY

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ABSTRACT

Pakistan is suffering from drought conditions since year 2000 till June 2010, due to which reduction in river discharges and lesser rains occurred. The reliance on ground water increased remarkably and extensive pumping was observed during the period. The average annual flow across the rivers is 138 MAF. Based on the average annual flow data, provided by government of Sindh, the average escapage below Kotri is 31.35 MAF (1976-2011), whilst downstream Kotri requirement is only 8.6 MAF, also considering the raising of Mangla dam and future usage by India, there is still 17.87 MAF water available for future development. It is emphasized that construction of first additional mega reservoir will be replacement of lost storage capacity due to sedimentation and second additional large dam will add to storage capacity. Most of the developed semi-arid countries have already created enough water storage capacity while numbers of developing nations are bracing themselves for coping with this adversity. Unfortunately, Pakistan is little too late to respond to the call of time for development of reservoirs, after commissioning of Tarbela Dam in 1976 there is no remarkable addition to the storage capacity of the country and we have wasted about $149 billion worth of water to the sea till the end of 2010.

The history of water resource development starts back in 1947 when South Asia was divided into two independent states, there existed one of the most highly developed Irrigation System in the World and approximately 37 million acres of land received irrigation from the flow of the Indus system of Rivers. At the time of independence major portion of the Indus Basin formed a part of Pakistan and out of 37 million acres which received irrigation, 31 million acres fall in Pakistan. Starting from a population of about 30 million at the time of Independence in 1947, the current level is around 180 million to touch 225 million by 2025. Against this, the canal withdrawals in Indus Basin Irrigation System (IBIS) at the time of Independence were around 60 MAF, which progressively increased, almost keeping in view the population growth to 106 MAF during the period of 1976-81 immediately after the commissioning of Tarbela Dam. Later on, due to non-addition of any major reservoirs and sedimentation of existing ones, the canal withdrawals started stagnating. The average withdrawal figure dropped to 104 MAF by 2002 and currently stands around 102 MAF.

The present status of storage per capita in different semi arid countries shows that Pakistan with a figure of 150m^3 per capita is almost at the bottom with the carryover capacity of only 30 days. To integrate the available surface water in the system, a series of dams are needed, in a way that river flows are tamed in steps and reservoirs are managed in a cascading manner.

1. INTRODUCTION

Water is the essential component both for the existence of mankind and for the sustainable country's economic growth. Today emphasis on proper and balanced utilization of available

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water resources is more than ever before. Pakistan is suffering from drought conditions since year 2000 till June 2010, due to which reduction in river discharges and lesser rains occurred. The reliance on ground water increased remarkably and extensive pumping was observed during the period. However during year 2010 from July to September, there were severe floods and below Kotri flows were over 53 MAF. The situation necessitates conservation and integration of water resources to meet the water and energy requirements of the country.

Pakistan is situated in the western part of the Indo-Pak sub-continent. It is bounded on the west by Iran, on the northwest by Afghanistan, on the northeast by China and the disputed territory of Jammu and Kashmir, on the east by India and on the south by the Arabian Sea. The Indus Basin of the country which constitutes the mountain valley of the Indus river and its tributaries, the Indus plains, the Kachhi plain, desert areas of Sindh and the Rann of Kach. On the north, it is surrounded by Hindu Kush, on the northeast by Karakoram and Harmosh ranges, on the western side by Suleman and Kirthar ranges while Arabian Sea forms its southern boundary. The Himalayan Mountains have highest peaks in the world with vast deposits of snow and ice having the capacity to block and capture the monsoon winds and their moisture. Hindu Kush and Karakoram mountains form the great water, which separates the Indus Basin waters from that of the Central Asia.

The Indus Basin is irrigated by the river Indus and its major tributaries which flow in longitudinal valley in structural troughs parallel to the mountains and after cutting through the mountains flowing steep and confined channels emerge into the alluvial plains which stretch over a distance of some 1520 Km to the tidal delta near the Arabian Sea. The Indus river system consists of; Western Rivers, River Indus, River Kabul, River Jhelum, River Chenab and Eastern Rivers, River Ravi, River Sutlej and River Beas.

2. WATER RESOURCE DEVELOPMENT IN PAKISTAN

In August 1947 when South Asia was divided into two independent states, there existed one of the most highly developed Irrigation System in the World and approximately 37 million acres of land received irrigation from the flow of the Indus system of Rivers. At the time of independence major portion of the Indus Basin formed a part of Pakistan and out of 37 million acres which received irrigation, 31 million acres fall in Pakistan. The water dispute between two countries had risen soon after Independence. India stopped waters in irrigation canals on rivers Ravi and Sutlej being upper riparian. Direct negotiations between Parties failed to resolve the dispute. After protracted negotiations, under the office of World Bank, when the World Bank convinced that existing uses in Pakistan without storage could not be met by transfer of waters from Western Rivers and the storages on the Western Rivers were required for the purpose. The Indus Water Treaty was signed in 1960 under auspices of the World Bank. As per Indus Water Treaty, the waters of Eastern Rivers (Ravi, Sutlej and Beas) were vested to India while the waters of Western River vested to Pakistan.

Starting from a population of about 30 million at the time of Independence in 1947, the current level is around 180 million to touch 225 million by 2025. Against this, the canal withdrawals in Indus Basin Irrigation System (IBIS) at the time of Independence were around 60 MAF, which progressively increased, almost in keeping with the population growth to 106 MAF during the period of 1976-81 immediately after the commissioning of Tarbela Dam. Later on, due to non-addition of any major reservoir and sedimentation of existing ones (Table – 2), the canal withdrawals started stagnating. The average withdrawals figure dropped to 104 MAF by 2002 and currently stands around 102 MAF. The present status of storage per capita in different semi arid countries shows that Pakistan with a figure of $150m^3$ per capita is almost at the bottom with the carryover capacity of only 30 days.

3. AVERAGE ANNUAL FLOWS OF RIVERS OF INDUS BASIN

The catchment area of the Indus river system is 364,700 square miles, whereas, the average annual flows across the rivers are as given in Table-1.

Table-1: Average Annual Flows of Rivers of Indus Basin

(MAF)

River	Average Annual Flow (1922-61)	Average Annual Flow (1985-95)	Average Annual Flow (2000-09)	Average Annual Flow (2009-10)	Average Annual Flow (2010-11)
Indus	93	62.7	81.28	81.31	72.07
Jhelum	23	26.6	18.52	21.05	25.73
Chenab	26	27.5	22.52	17.90	25.80
Ravi	7	5	1.1	0.28	2.05
Sutlej	14	3.6	0.39	0.01	2.25
Kabul	26	23.4	18.9	17.4	28.61
Total	189.0	148.8	142.71	138.00	156.51

Source: WRM Directorate, WAPDA, Average Annual River Flows

Pakistan has three major reservoirs, which have original storage capacity of 15.74 MAF, but with the passage of time, these have lost almost 26% till 2009, of their storage capacity due to sedimentation as shown in Table - 2.

Table – 2: Reservoir Sedimentation

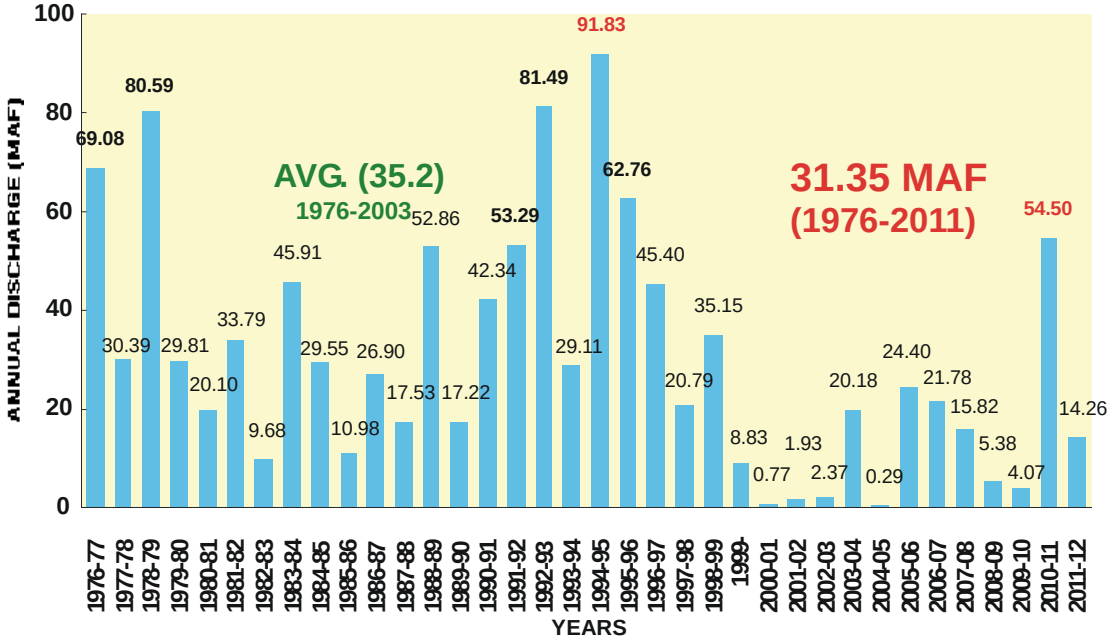
Reservoir	Storage Capacity		Storage Loss		
	Original	Year 2009	Year 2009	Year 2012	Year 2025
	MAF	MAF	MAF	MAF	MAF
Tarbela	9.68 (1974)	6.78 (70%)	2.90 (30%)	3.18 (33%)	4.30 (44%)
Mangla	5.34 (1967)	4.46 (83%)	0.88 (17%)	0.90 (17%)	1.14 (21%)
Chasma	0.72 (1971)	0.37 (51%)	0.35 (49%)	0.29 (40%)	0.38 (52%)
Total	15.74	11.61 (74%)	4.13 (26%)	4.37 (28%)	5.82 (37%)

Source: WRM Directorate, WAPDA

4. AVERAGE ESCAPAGES BELOW KOTRI

Over the past thirty five years, upto September 2010, 1094.88 MAF of water had gone into the sea unutilized, equivalent to 10 years of canal withdrawals. Excluding the water required for protecting the ecosystem below Kotri, rest represents a direct economic loss. In monetary terms, after deducting 300 MAF required for environmental purposes, the value of unutilized water is US$ 149 billion. For better water management, storage capacity should be equivalent to at least 40% of annual water availability but Pakistan’s live storage capacity of about 12 MAF is just about 8 % of average annual river flows.

The average escapage below Kotri is 31.35 MAF (1976-2011) and Fig. 1 represents the downstream Kotri escapage, study on Water Escapage Downstream of the Kotri Barrage to Address Environmental Concerns (Study–II) in November 2005 by Kotri Barrage Study-II Consultants Group, financed by MoW&P through Federal Flood Commission, suggests that the downstream Kotri requirements are approximately 8.6 MAF considering the raising of Mangla dam and future usage by India (Treaty 1960), there is still 18 MAF water available for future development as depicted in Table-3.



Source: WRM Directorate based on data provided by Govt. of Sindh

Fig 1: Escapage downstream Kotri (MAF)

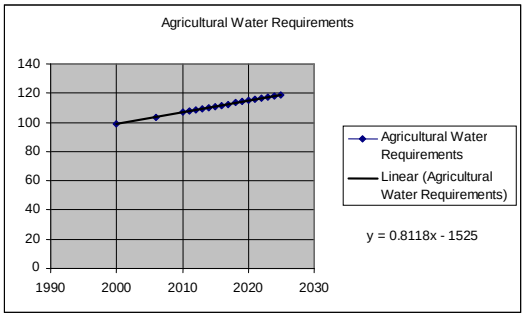
Table – 3: River Flows and Storage Potential

(MAF)

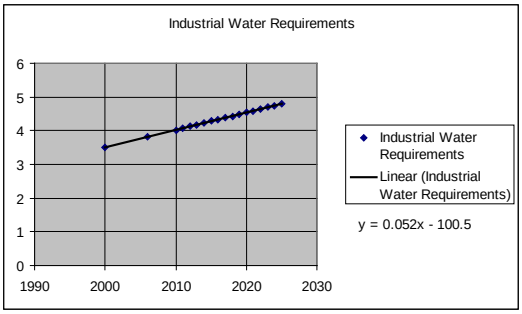
Down Stream Kotri Average Annual Flows (1976 – 2011)	31.35
Anticipated Uses	
Down Stream Kotri Requirement @ 5000 Cusecs round the year	8.6
Mangla Dam Raising Project	2.88
Indian Future Uses on Western Rivers (As per Indus Water Treaty)	2.0
Net Water Available	17.87
Diamer – Bhasha Dam Project	6.4
After Diamer – Bhasha Dam Project	11.47

5. WATER AVAILABILITY AND DEMAND GAP

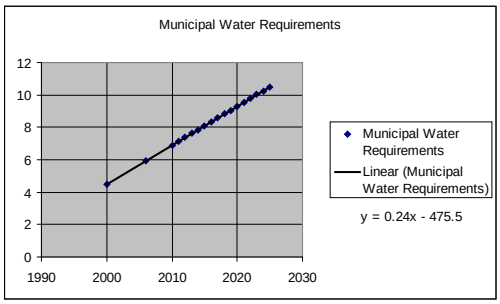
The average annual river flow is approximately 138 MAF, out of which almost 82% (113.16 MAF) occurs during summer seasons and 18 % (24.84 MAF) in winter, out of which 104 MAF is available at the canal heads for irrigation purposes, whereas, only 58.3 MAF reaches at the farm gate and 45.7 MAF is lost in conveyance system. The projected demand for agricultural usage is 119.0 MAF by the year 2025. The current industrial demand is about 4.02 MAF, which will increase to 4.8 MAF by the year 2025. The anticipated use for municipal and environmental use is 6.90 MAF and 1.46 MAF respectively which will be increased to 10.50 MAF and 1.70 MAF respectively by year 2025 as depicted in Figure-2 & Table-4.



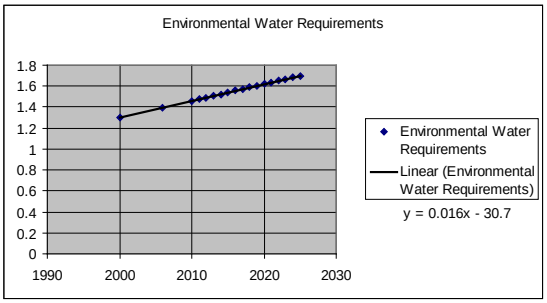
a) Agricultural Water Requirements



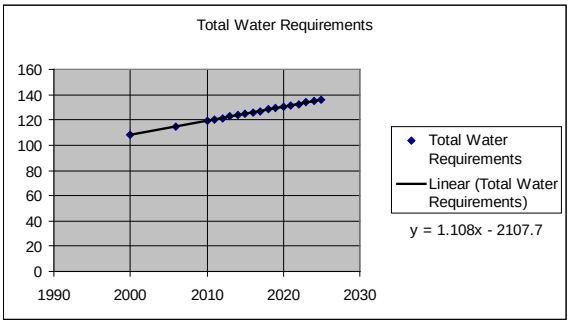
b) Industrial Water Requirements



c) Municipal Water Requirements



d) Environmental Water Requirements



e) Total Water Requirements

Fig 2: Current & Future Water Requirements (2000 – 2025)

Table–4: Current & Future Water Requirements of Pakistan (2010 – 2025)

(MAF)

Sr.No.	Usage	Present & Future Water Requirements				Additional Requirements in 2025
		2010	2015	2020	2025	
1	Agricultural	107	111	115	119	12
2	Industrial	4.02	4.28	4.54	4.8	0.78
3	Municipal	6.90	8.10	9.30	10.50	3.60
4	Environmental	1.46	1.54	1.62	1.70	0.24
5	Total	119.38	124.92	130.46	136	16.62

Source: National Water Policy 2003 (Draft) and updation upto 2010

Moreover, as per global standards, 1000 m^3 per capita is the threshold value for water scarcity. Pakistan at present is striving with water scarcity and only 1038 m^3 of water is available per capita, which will further be reduced to 751 m^3 per capita till year 2030.

The Table – 5 & Figure 3 show the anticipated growth in the population and the decline in per capita water availability.

Table–5: Water Availability Per Capita/Year (m^3)

Year	Population (million)	Water Availability (Cubic Meter)	Global Criteria
1951	34	5260	1000 m^3 per capita is the threshold value (Falkenmark & Wedstrand 1992)
2010	172	1038	
2020	204	877	
2025	221	809	
2030	238	751	

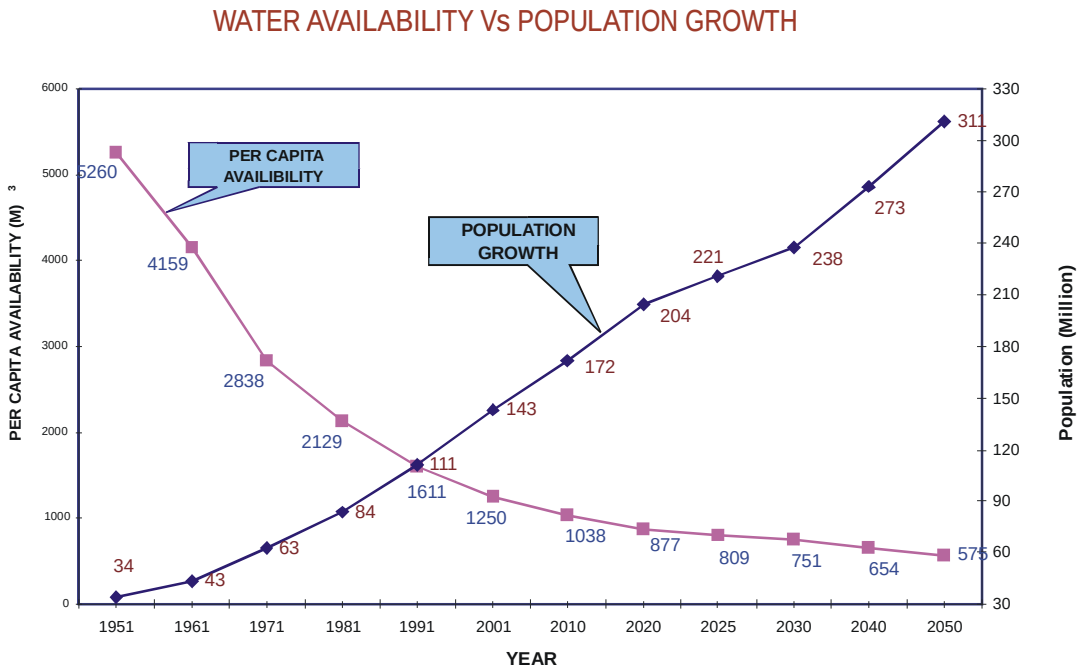


Fig 3: Per Capita Water Availability per year (m^3)

6. NEED FOR CONSTRUCTION OF STORAGE FACILITIES & CONSERVATION OF WATER

According to global criteria, Pakistan is already water stressed semi-arid country with annual per capita availability of just over 1000 m^3 in meeting the future water requirements, it must also be recognized that water flows in Pakistan are highly uneven across the seasons and years. The year round agricultural requirements can only be met if sufficient additional storage is made available. There are nearly 16.62 MAF shortfalls to the future water requirements. This additional water has to come necessarily from flood flows, for which the need for creation of storages on Indus and other rivers has been recognized. From analyzing the situation, it is clear that the balance of total additional water resources ground water exploitation and conservation measures are only sufficient to meet the requirements of water for nearly two decades or so, afterwards increasing reliance shall have to be placed on other measures such as adoption of conservation techniques to save water at all levels, adoption of demand based high efficiency irrigation system, harnessing hill torrents, and employing modern water management technologies. As these change over can not be brought about in a short period of time, it is necessary that the path to conservation and modernization be developed gradually to sustain future water demands.

To meet future water requirements, to an appreciable measure, it would be necessary to create large storages on Indus River. It is well known that storage projects take considerable time and effort for completion and need mobilization of heavy capital investment. Considering the acute shortage of water in coming years, the need for starting work on a major storage project is eminent.

In view of above situation, Government of Pakistan through WAPDA has launched a comprehensive integrated water resource and hydropower development plan, for development of water resources and hydropower generation. Table – 6 summarizes the project at different stages of implementation:

Table–6: Water Sector Projects

S. No.	Name of Project	Province	River	Storage Capacity (MAF)	Generation Capacity (MW)
1	**2**	**3**	**4**	**5**	**6**
i.	**COMPLETED PROJECTS (after the year 2000)**				
1	Mirani Dam	Balochistan	Dasht	0.152	-
2	Sabakzai Dam	Balochistan	Zhob	0.015	-
3	Mangla Dam Raising	AJK	Jhelum	2.88 (additional)	644 GWh
4	Satpara Dam	GB	Satpara Nullah	0.053	17.3
ii.	**Under Construction**				
1	Diamer Basha Dam	GB/KPK	Indus	6.40	4500
2	Gomal Zam Dam	KPK	Gomal	0.82	-
3	Darawat Dam	Sindh	Nai Baran	0.122	0.45
iii.	**Ready for Construction**				
1	Nai Gaj Dam	Sindh	Gaj	0.16	4.4
2	Ghabbir Dam	Punjab	Ghabbir Nullah	0.026	0.15
3	Winder Dam	Balochistan	Winder	0.0362	0.3
4	Kurram Tangi	KPK	Kurram	0.90	83.4
5	Noulong Dam	Balochistan	Mula	0.20	4.4
6	Garuk Dam	Balochistan	Garuk	0.0669	0.3
7	Pelar Dam	Balochistan	-	0.0992	0.3
8	Tank Zam Dam	KPK	Tank Zam	0.345	25.5
9	Papin Dam	Punjab	Tributary of Soan River	0.0896	0.3
10	Kalabagh Dam*	Punjab	Indus	7.9	3600
iv.	**Feasibility Study Completed**				
1	Hingol Dam	Balochistan	Hingol	1.206	1.0
2	Munda Dam	KPK	Swat	0.676	740
3	Akhori Dam	Punjab	Off Channel	7.6	600
v.	**Detailed Engineering Design Under Finalization**				
4	Bara Dam	KPK	Bara	0.085	5.8

S. No.	Name of Project	Province	River	Storage Capacity (MAF)	Generation Capacity (MW)
5	Daraban Dam	KPK	Khora	0.0697	0.75
vi.	**Projects Under Study**				
1	Khaplu Dam	GB	Shyok	7.10	690
2	Bhimber Dam	AJK	Bhimber Nullah	0.04	2
3	Chiniot Dam	Punjab	Chenab	1.0	-
4	Sangarh Dam	Punjab	-	1.1	-
5	Dotara Carryover Dam	Punjab	Karral & Dhund Haro	Drinking water for Islamabad	-

***** The project will be executed after the consensus of provinces.

At the same time there is a need to reduce the water losses from water supply system. Conservation measures will include following areas of activities at National, Regional and Farm levels as:

- Lining of main and branch canals.
- Lining of distributaries and minor canals.
- Irrigation system rehabilitation program.

The active flood plains of Indus River and its major tributaries comprise some five million acres, within this area; about 1.7 million acres are under crops, about 350,000 acres are woodland. Agriculture is dependant primarily on residual soil moisture and high water table after flooding, although, in some more elevated area pumps and tubewells are utilized. The flood flows of all rivers and hill torrents of Balochistan has been assessed as 10 MAF which almost go waster rather causing damage to land and population. To utilize the flood water for agriculture development and other purposes the flood water could be stored diverted to lands after preparing proper feasible projects.

Remodeling and modernization should take care of inequitable distribution of water. At present 60 percent of irrigation areas at the tail commands are either getting no water or the supplies are far below the authorized supplies. The irrigation system should now begin moving towards a demand based supply system. This may involve huge expenses and may not be economical as a large scale measure. Pilot schemes can be implemented at strategic locations in all provinces. There is a great potential for reducing water use through introduction of Sprinkler and Drip Irrigation for many crops, while it is true that capital investment can be intensive for modern mechanized irrigation such as these, consideration should be given to their introduction and means of financing them, given the increasing scarcity of water in Pakistan.

7. CONCLUSION AND RECOMMENDATIONS

Pakistan water resources are diminishing at an alarming rate, as can be concluded from the stated facts in this paper. The quality of water is also deteriorating with time. To improve the situation it is dire need of time to construct storage facilities and improve the irrigation system and techniques. It is concluded and recommended that:

- Surplus water of at least 18 MAF is available for immediate development.
- Sedimentation of existing reservoirs is enhancing with time thereby reducing the water availability.
- It is strongly recommended that construction of storage of ready projects of reservoir and hydropower should be started immediately.
- The high efficiency irrigation systems like drip and sprinkler need to be developed at appropriate sites for popularizing such technologies among farmers. The ultimate solution of water scarcity lies in adoption of such technologies depending upon economic feasibilities and in attaining more production per drop of water.

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