Chapter 20

WATER

Pakistan has one of the largest contiguous irrigation systems in the world, known as the Indus Basin Irrigation System (IBIS). The System comprises six major rivers, that is, the Indus, Jhelum, Chenab, Ravi, Sutlej and Kabul, and their catchments. It has three major storage reservoirs, 19 barrages, 12 inter-river link canals, 40 major canal commands and over 120,000 watercourses. The Indus River has a total average annual flow of 146 Million Acre Feet (MAF), of which only 106 MAF of water is diverted to canals. Pakistan receives about 50-80 per cent of the total average river flows from snow or glacial melt, while the remaining from the monsoon rains.

Having a very large contiguous irrigation system, Pakistan is also highly vulnerable to the adverse impacts of climate change due to its geo-climatic situation. Climate change has posed serious threats associated with increased frequency and intensity of floods, prolonged droughts and growing water stress and the frightening possibility of the melting of the Himalayan icecap.

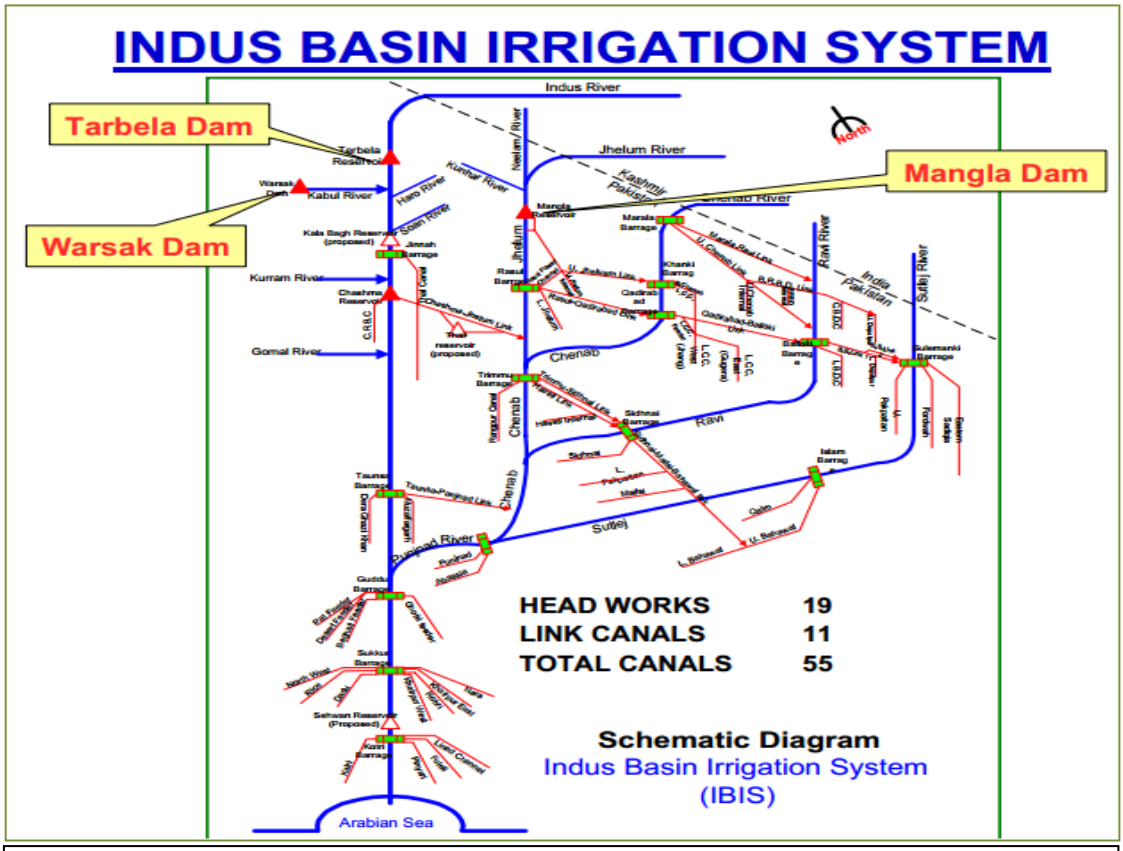


Figure-1: Schematic Diagram of the Indus River Basin (Source WAPDA)

Pakistan's economy is facing daunting challenges in the water sector. Besides demands of an ever-growing industrialising economy and rapidly urbanising society, the potential for augmenting supply is limited, water table is falling and water quality issues have increasingly become serious. Pakistan is in the group of countries, which are now moving from water stressed to water scarce. Keeping in view the emerging issues related to climate change, water resource management is also a serious challenge.

Moreover, access to an adequate supply of water for all sectors (agriculture, industry and domestic) is one of the top priorities of the present government. Since water availability is continuously diminishing in all contexts, formulation and effective implementation of a comprehensive set of measures for the development and sustainable management of the water resources are key challenges. The government vision for the welfare of the people, and poverty alleviation has been given top priority in the development programmes and projects being implemented under the water sector. The strategies adopted so far provide a benchmark for moving forward in the next five years.

The broad goal of development of water resources sector is to uplift the agro-based economy on the national level by maximising crop production, through progressively increasing surface water supplies and conserving them using the latest technologies available and protecting land and infrastructure from water-logging, salinity, floods and soil erosion in an integrated manner. The goal also includes electricity generation to achieve the better energy mix, catering to the ever-increasing demand of water for industrial and commercial activities in a cost effective manner as well as for drinking purposes. The Plan emphasises the importance of institutional infrastructure in the water sector, that is, policies, governance, institutional strengthening, capacity-building, and knowledge-based management to make the investment in physical infrastructure more efficient and sustainable.

Situational analysis

Water availability

Pakistan receives snowfall mostly in the Northern Areas during the winters, whereas the rainfall is markedly erratic in magnitude, time of occurrence and aerial distribution. The average rainfall ranges from less than 100 mm in parts of the Lower Indus Plain to more than 750 mm near the foothills in the Upper Indus Plain.

At present, Pakistan is totally depending on three western rivers of the Indus, that is, Kabul, Jhelum and Chenab, while three eastern tributaries of the Indus – Ravi, Sutlej and Beas – were given to India for its exclusive use after an agreement. Currently about 4.60 MAF of water flows from India to Pakistan through these eastern rivers, with an additional 3.33 MAF of run-off generated in their catchments within Pakistan. Contribution of the Kabul River to surface water is 21 MAF.

According to the IRSA figures (2013), the Indus River System receives an average annual water inflow of about 146 MAF, which is mostly derived from snow and glacial melting. Pakistan's current water availability at various canal head works is about 97.71 MAF with estimated annual losses of 48.29 MAF. As per the WAPDA, Pakistan extracts about 50 MAF from groundwater aquifers, and has already crossed the sustainable limit of safe yield. This over-mining and pollution of aquifers has resulted in salinisation, and increased concentration of fluorides and arsenic in water, which in turn is degrading the quality of agricultural lands.

Table-1: Canal head works withdrawals (below Rim Station (MAF) 2013

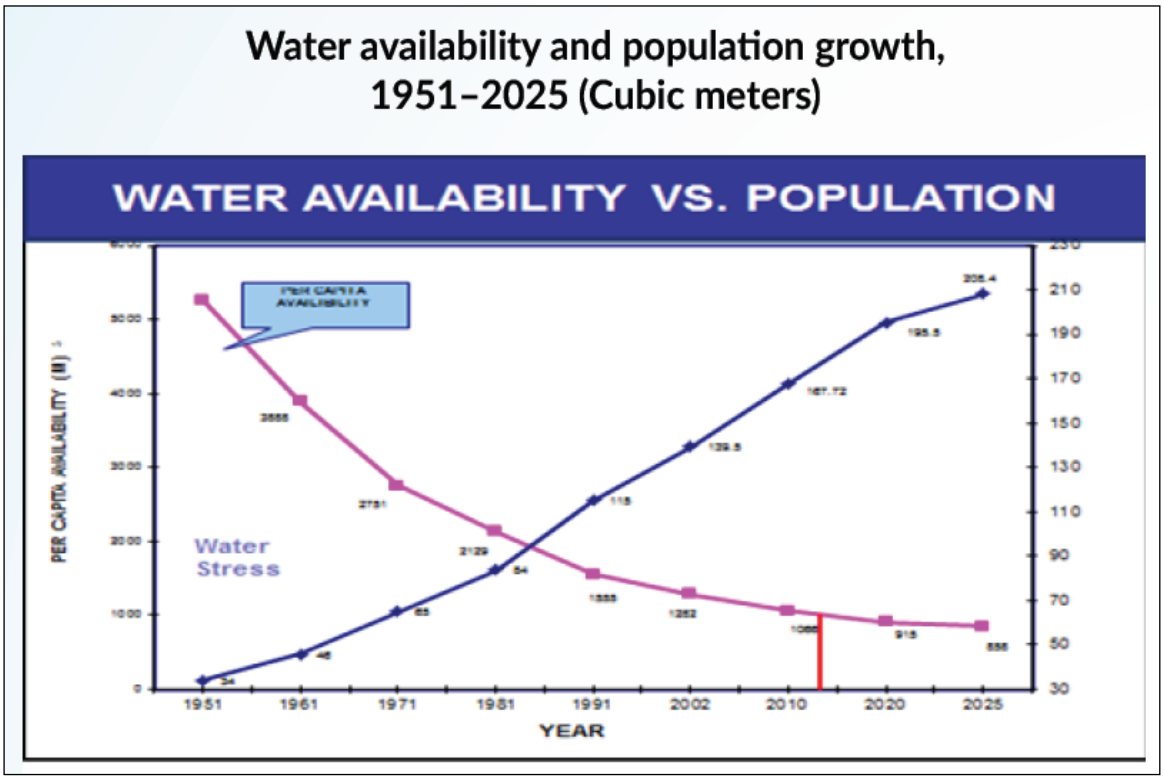
Province	Kharif (April-September)	Rabi (October-March)	Total
Punjab	33.83	17.44	51.27
Sindh	29.16	13.6	42.76
Khyber Pakhtunkhwa	0.94	0.49	1.43
Balochistan	1.61	0.64	2.25
Total	65.54	32.17	97.71

Source: *Indus River System Authority*

Water requirements

According the Economic Survey of Pakistan 2013-14, population of the country is projected to reach 220 to 230 million by 2025. Population rise, rapid urbanisation and poor socio-economic conditions will increase pressure on water resources. The corresponding requirement at the canal heads would be nearly 62.3 MAF. This represents a shortfall of about 27.3 MAF of water in 2025. Unless improvements are made, this will limit the development potential in various sectors.

Figure-2: Declining water availability in Pakistan



Source: *WWF-Pakistan, 2007*

Agriculture

To meet the food need of the ever-growing population, an efficient use of water is a must for sustainable agricultural growth and agriculture-oriented activities to gain more benefits from this sector. Increases in agricultural production will require additional water. Based on the population growth projections, an estimated additional 10 MAF of water will be needed at the farm gate by 2025.

Municipal use

The current urban and rural water usage for the domestic and municipal purposes is estimated to be 4.5 MAF, but by 2025 it is expected to increase by 10.5 MAF, having a shortfall of six MAF.

Industry

Out of over half a million large and small industrial units, around 120,000 are textile, chemical, fertilizer, tanneries and other manufacturing and processing activities. Presently, these industries and mines are estimated to be using 3.5 MAF, which is expected to rise to 4.8 MAF by 2025, that is, an additional requirement of 1.3 MAF.

Environment

In order to ensure adequate water for wetlands, environmental protection (to curb sea water intrusion and meet requirements of mangrove forests) and increased irrigated forestry, substantial quantity of water will be required.

Strategies

Conflicts across competing water uses and users are growing every day. Access to an adequate supply of water for the agriculture, industry and domestic sectors is one of the priorities of the Vision 2025. The Plan provides a roadmap to provide clean and judicious amount of water to all sectors and stakeholders. In this regard, the federal and provincial governments will leave no stone unturned to enhance water storages and conservation, including construction of small, medium and large dams. A comprehensive set of strategies encompasses the following:

Water storage

In order to meet future water requirements, it is necessary to construct large storage dams on the Indus River. The federal government has launched a comprehensive integrated programme of water resource and hydropower development. For storage, the WAPDA has identified water reservoir sites of about 65 MAF capacities, and other locations with a power potential of 35,000 MW. The implementation of this programme on various projects has already commenced. The Diamer-Bhasha is a flagship multipurpose mega dam on which work has already been initiated, and it will provide an additional storage capacity of 6.4 MAF and generate 4500 MW of hydroelectric power.

Water conservation

Water conservation and its rational management is the central theme of water strategy of the Plan. This is to be achieved through on-farm water management, canal lining, rehabilitation of the irrigation infrastructure, rainwater harvesting and hill torrents management, wastewater treatment and adoption of high-efficiency irrigation system techniques.

Flood management

Pakistan is facing serious threats of floods due to climate change and global warming. It has witnessed frequent disastrous floods for the last several years, which are generally caused by heavy concentrated rainfall in the catchment areas of the main rivers during the monsoon season, and are often augmented by snowmelt. Some of the floods were most devastative in nature and caused huge losses to property, agricultural crops and a large number of human lives. According to the Federal Flood Commission estimates, Pakistan has suffered a cumulative financial loss of more than $37.554 billion during the past 66 years. From 1950 to 2013, around 11,572 people lost their lives, some 188,531 villages damaged or destroyed and a total area of 603,942 square kilometres was affected due to 21 major floods. To address the future flood management and increasing flood protection works, the Planning Commission has extended its full support to the Federal Flood Commission for formulating the 'National Flood Protection Plan IV' to protect infrastructure, flood embankments, spurs and flood forecasting and warning system. Yearly details of flood damages are:

Year	Direct losses ($ Million)	Number of lost lives	Number of affected villages	Flood affected area (square km)
1950	488	2,190	10,000	17,920
1955	378	679	6,945	20,480
1956	318	160	11,609	74,406
1957	301	83	4,498	16,003
1959	234	88	3,902	10,424
1973	5,134	474	9,719	41,472
1975	684	126	8,628	34,931
1976	3,485	425	18,390	81,920
1977	338	848	2,185	4,657
1978	2,227	393	9,199	30,597
1981	299	82	2,071	4,191
1983	135	39	643	1,882
1984	75	42	251	1,093
1988	858	508	100	6,144
1992	3,010	1,008	13,208	38,758
1994	843	431	1,622	5,568
1995	376	591	6,852	16,686
2010	10,000	1,985	17,553	160,000
2011	3730	516	38,700	27,581
2012	2640	571	14,159	4,746
2013	2000	333	8,297	4,483
2014	188	346	3,610	9,510
Total:	37,741	11,918	192,141	613,452

Source: *Federal Flood Commission*

Integrated water resources management

The IWRM approach helps manage and develop water resources in a sustainable and balanced way, taking account of social, economic and environmental interests. It recognises many different and competing uses and users. The integrated approach coordinates water resources management across all sectors and interest groups, and at different scales from local to international. It emphasises involvement in national policy and law making processes, establishing good governance and creating effective institutional and regulatory arrangements as routes to more equitable and sustainable decisions. A range of tools, such as social and environmental assessments, economic instruments, and information and monitoring systems support this process. Water resources management calls for high-level consensus and political resolve, because the basin management is a politically sensitive issue.

Water governance

In many ways, the water crisis is because of the lack of governance, resulting from the failure of the public institutions to manage resources for the well-being of humans and ecosystems. Institutional reforms and effective coordination linkages among all water-related sub-sectors will be strengthened. An organisational framework in consistent with international best practices will be further improved to undertake developmental and regulatory functions in an effective manner.

Water pollution

It is a serious concern having adverse impact on the health of people and ecosystems. One of the most dangerous consequences of industrial and agricultural pollution is an ever-increasing groundwater contamination. Environmental degradation, along within safe drinking water and lack of basic sanitation facilities, has a huge impact on health of the people, particularly children under the age of five years. Diarrhoea and typhoid, two most common illnesses related to poor water and sanitation, account for about 30 per cent of the environmental costs or 1.8 per cent of the GDP. The WHO has reported that about 25-30 per cent of the hospital admissions are related to water-borne bacterial and parasitical conditions, whereas half of the infant deaths are caused by water-related infections. The Plan will promote an enabling environment to achieve goals for an efficient use of water for protection and conservation of environment.

Knowledge-based interventions

The following steps will be taken.

- An operational mathematical model of the Indus Basin will be prepared for an efficient management of the water resources, taking into account the factor of climate change.
- Efficient and effective hydro-meteorological data dissemination systems will be put in place.
- Nationwide surveys will be undertaken for assessment of the groundwater, including its quality, quantity, withdrawal and recharge potential.
- Conflict resolution mechanism will be strengthened to manage disputes and ensure equitable and fair sharing of water.
- Economic instruments will be designed using value and prices for efficiency and equity. It will improve allocative and technical efficiency for sustainable social and economic development.

- Information management and exchange to improve knowledge for better water management will be done.
- Participatory assets management will be extended.
- Steps will be taken for reducing the unaccounted and non-revenue water.

Trans-boundary water issues

The following steps will be taken during the Plan period.

- Necessary measures will be intensified for resolving the trans-boundary water issues with India and for implementation of the Indus Waters Treaty (1960) in letter and spirit, including capacity-building of institutions.
- Consultations on other trans-boundary issues will be initiated, such as pollution, untreated effluent being passed down to Pakistan from India.
- Since signing of the Indus Waters Treaty, India has developed numerous storage projects on three Eastern Rivers of Ravi, Sutlej and Beas, and consequently, during the dry season, there is almost zero flow in these rivers. Minimal environmental flows are required to protect the river biodiversity.
- India is over-mining the aquifer with the result that groundwater in Western Punjab is also being affected. This concern will also be pursued and more authentic data will be collected on this account.
- The Kabul River brings water into the Indus Basin. Construction of projects on the River and its tributaries can have a negative impact on Pakistan's already scarce water resources, and violate its historic and lower riparian water rights. Deliberation will be made to pre-empt and protect these inflows.
- Capacity-building process of the related institutions will be undertaken to effectively address the trans-boundary waters.

Water infrastructure and financing

Both traditional and innovative modes of financing are required to meet the large deficit of deferred maintenance and capital investment, while higher investments are also necessary for the future programmes. The allocation in the PSDP for dealing with this has increased considerably over the years. Since water-related infrastructure is one of the primary responsibilities of the federal government, the total allocations for this will be increased to Rs247.37 billion in the Plan. The year-wise federal and provincial details of the investment plan are given in Table 2, 3 and 4. Suitable projects will be prepared and offered to private investment through mechanisms, such as the Build Operate Transfer (BOT), Build Own Operate (BOO), Build Own Operate and Transfer (BOOT). Direct investment in the form of loans as well as equity will be promoted and establishment of the Special Purpose Vehicles will be encouraged to attract financing through bonds and debentures. Since water is an important sector, it is also hoped that additional funds will be made available by the multilateral banks, international development agencies and bilateral donors. Levying of additional charges on consumers to repay capital investment – on the pattern of the Neelum-Jehlum Hydropower project – will be replicated in other projects. Innovative financing options will be explored for the Diamer-Bhasha Dam and other similar projects. The Public-Private Partnerships will be pursued as the preferred mode of financing.

Federal programme

The water sector investments have following dimensions.

- Investment to keep the system operative
- Investment to keep the system sustainable
- Investment to keep providing basic human needs, that is, Food, Fibre and Energy

However, the water sector investment has to take into account future needs as the system can neither be built in pieces nor in a given short time, for example, the Bash Dam Project gestation period is over ten years including six to seven years of construction period. It is estimated that the financing requirement is to the tune of Rs208 billion in the next five years.

Table-2: Year-wise Federal Investment Plan

(Rs billion)

S#	Sub-sector	2013-14	2014-15	2015-16	2016-17	2017-18	Total
On-going programmes							
1	Medium and small dams	18	11	7	7	9	52
2	Canals	9	11	6	5	6	36
3	Drainage	6	5	5	4	5	25
5.	Provincial Irrigation Scheme	22	15	8	7	9	61
6.	Flood Protection Programme	1	1	1	1	1	5
7.	New initiatives and research	1	1	3	6	6	17
8.	Miscellaneous scheme	2	1	0	4	5	11
	Total	**58.5**	**43.9**	**30.6**	**35**	**40**	**208.1**

The Proposed Provincial Programme, amounting to Rs384 billion, mainly focussed on rehabilitation and improvement of the existing irrigation system, construction of medium and small dams, and water conservation through on-farm water management and micro-irrigation practices, introducing high efficiency irrigation system (sprinkler and drip irrigation).

Yearly financial projection and sub-sector wise details are given in Table 3:

Table-3: Year-wise provincial investment Plan

(Rs billion)

S. #	Name of province	Five Year Plan					
		2013-14	2014-15	2015-16	2016-17	2017-18	Total
1.	**Punjab**						
	Irrigation and drainage	10.8	12.1	15.9	15.9	16.2	91
	Flood schemes	0.7	1.1	1.8	2	2.9	11
	Small dams	7.2	8.3	10.6	10.7	11	61.5
	Research	0.7	1.1	2.2	2.4	2.6	11.5
	New schemes	3.6	4.2	5.7	5.6	5.7	31.8
	Total	**23.0**	**26.9**	**36.1**	**36.5**	**38.4**	**206.8**
2.	**Balochistan**						
	Irrigation, drainage and Flood	2.2	3	4.4	4.8	5.9	26
	Small dams and delay action dams	1.4	1.9	3.1	4	4	18.5
	New schemes	1.4	1.9	4	4	4.8	20.5
	Total	**5.0**	**6.8**	**11.4**	**12.7**	**14.7**	**65**
3.	**KPK**						
	Irrigation, drainage and flood	1.4	2.3	4.4	5.6	5.9	25
	Small dams andresearch	0.9	1.9	2.6	3.2	4.4	16.7
	New schemes	1.4	1.9	2.2	3.5	3.7	16.4
	Total	**3.7**	**6.1**	**9.2**	**12.3**	**13.9**	**58.1**
4.	**Sindh**						
	Irrigation, drainage and flood schemes	8.6	10.6	14.1	14.3	15.4	81
	Small and delay action dams	3.6	5.3	7	7.9	9.9	43.5
	New schemes	3.6	4.5	6.2	7.1	8.4	38.5
	Total	**15.8**	**20.5**	**27.3**	**29.4**	**33.8**	**163**
	Grand total (Provincial)	**47.6**	**60.3**	**84.1**	**90.9**	**100.8**	**383.7**
	Grand total (National)	106	104	115	126	141	592

Innovative approach

In order to meet challenges of the growing water demands of the nation, a number of innovative initiatives will be undertaken. A detailed overview of these new initiatives has been provided below in Table 5. However, a systematic analysis is needed to be made to ensure the success of these innovative schemes.

Table-5: Major interventions for water resources development

S.#	Description	On-going interventions	Future interventions
1	Large and medium dams	Gomal Zam Dam Satpara Dam KurramTangi Dam (Kaitu Weir) Darawat Dam NaiGaj Dam Naulong Dam Ghabir Dam	Diamer-Basha Dam Mohmand or Munda Dam Dasu HPP* Bunji HPP Thakot HPP
2	Small and delay action, and recharge dams	All provinces	All provinces
3	Raising and extension of dams	Mangla Dam raising	Tarbella 4th Extension HPP
4	Intra-basin water transfer	Greater Thal Canal Project (Phase-I) Rainee Canal Project (Phase-I) Kachhi Canal (Phase-I)	Greater Thal Canal Project (Phase-II) Rainee Canal Project (Phase-II) Kachhi Canal (Phase-II)
5	Water conservation	Canal lining in all provinces Rehabilitation of irrigation systems in all provinces High efficiency irrigation system in all provinces	The programmes will be continued in the future.
6	Flood management	Normal emergent flood programme in all over Pakistan Other flood management programmes are also being implemented in all provinces	Master planning for future flood management is underway.
7	Drainage	Lower Indus Right Bank Irrigation and Drainage (RBOD-I) RBOD-II Balochistan Effluent Disposal into RBOD (RBOD-III) Remedial measures to control water logging due to Muzaffargarh and TP Link Canals	The programmes will be continued in the future.
8	Rainwater harvesting and hill torrents management	A feasibility study on rain water harvesting and hill torrents management is in process. Survey and study design for construction of rain water dams (reservoir along river Indus in Sindh)	Future projects on the basis of feasibility study will be taken up for implementation.
9	Master planning of water and hydropower projects	Review and evaluation of master planning and hydropower resources of western rivers.	Future projects on the basis of master planning will be taken up for implementation.
	Wastewater recycle and reuse	Installation of Effluent Treatment Plant (RBOD-III) pilot project	The major programmes of effluent treatment plants in all over Pakistan will be initiated after successful implementation of pilot project.

* HPP – Hydro Power Project

Table-4: Major on-going projects

S#	Name of projects	PC-I cost (Rs Million)	Storage live (MAF)	Power (MW)	Updated status
1.	Gomal Zam Dam	20,626	0.892	17.4	Substantially completed
2.	Satpara Dam	4,480	0.053	17.36	Completed
3.	KurramTangi Dam (KeituWier)	12,662.6	0.90	83.4	Review of design completed. Tendering and bidding of Stage-I (Kaitu Weir) in process.
4.	Darawat Dam	9,300	0.09	0.45	97% completed
5.	Nai Gaj Dam	26.236	0.16	4 .2	41% completed
6.	Naulong Dam	18,027	0.242	4.4	Contractor being mobilised
	Total	**65,121.836**	**2.337**	**127.21**	