# PAKISTAN
# WATER & POWER DEVELOPMENT AUTHORITY

# WAPDA'S DEVELOPMENTAL PLAN

18.9.09

**September 2009**

# WATER AND POWER SECTOR DEVELOPMENT

- Irrigated agriculture is the backbone of Pakistan's economy. The agriculture sector is the major user of water and its consumption will continue to dominate the water requirements. Direct rainfall contributes less than 15 percent of the water supplied to the crops. The major user of water for irrigation is the Indus Basin Irrigation System. About 105 Million Acres Feet (MAF) out of 155 MAF of surface water is being diverted annually for irrigation while around 48 MAF is pumped from groundwater.
- Pakistan has a total 196.72 MA area out of that 72.70 is cultivable. The cultivated area (Irrigated & Barani) has come to 52.31 MA, whereas 47.62 MA is area under all sort of irrigation sources. (27 MA is the area under canal irrigation).
- With large cultivable land base of 77 Million Acres (MA) of which only 27 MA are canal commanded, Pakistan still has the additional potential of bringing about 20.39 MA of virgin land under irrigation.
- With increased population, Pakistan is fast heading towards a situation of water shortage Per capita surface water availability was 5260 cubic meters in 1951when population was 34 million, which reduced to 1038 cubic meter in 2010 when the estimated population is 172 million. The minimum water requirement to being a "water short country" is 1,000 cubic meters. In the year 2012, Pakistan will have reached the stage of" acute water shortage"

# WATER AND POWER SECTOR DEVELOPMENT

- According to the 1960 Indus Water Treaty, signed between India and Pakistan with the good offices of World / Bank, India was allowed exclusive rights to use waters of Ravi, Sutlej and Beas rivers, whereas the waters of Western Rivers, Indus, Jhelum and Chenab were assigned to Pakistan. Under the 1960 Treaty, the Indus Basin Replacement Works comprising two major dams, 5 barrages and 8 link canals were constructed to alleviate the problems. However, due to excessive sediment inflows in the river water, all the three storages (Tarbela, Mangla, Chashma) are rapidly loosing their capacities. By the year 2025, these storages would loose 37% (6.27 MAF) of their capacity, which virtually means loss of one mega storage project.
- An annual average of over 35.2 MAF escapes below Kotri varying from 9 MAF to 92 MAF. However this surplus water in the river system is available in about 70-100 days of summer only. To save and utilize available water, construction of additional storage facilities is essential for sustainable irrigated agriculture, which supports about 70% of the population of Pakistan.
- National demand of electricity has been and would keep on growing rapidly. Based on the present generation capacity, the hydel:thermal mix in the country is 34:66, which is almost the reverse of an ideal hydel - thermal mix, which should be 70:30 for overall economic development of the Pakistan. Though induction of thermal generation initially helped in overcoming load shedding, it resulted in substantial increase in power tariff. Therefore, a sizeable injection of cheap hydropower through multipurpose storages is a viable option to keep the cost of electricity within affordable limits.

# WATER AND POWER SECTOR DEVELOPMENT

- To facilitate the process of economic development and to ensure greater social stabilization in Pakistan, it is imperative that employment creation and poverty reduction issues are addressed on priority. Additional water storages and power generation would form the basis of this strategy during the next decade.
- At present the rated electric power generating capacity in Pakistan is only 18000 MW with the demand growing at 10% annually. The average per capita consumption is only 482 units. Power shortage in the industrial, agricultural and domestic sectors has been evident for the past few years with the shortage assuming critical proportions last year. The water shortage is even more acute. To feed a population of nearly 172 million people, existing water storage capacity of 15 Million Acre Feet (MAF) needs to be tripled in the years ahead so that the remaining 20 million acres of cultivable land can be brought under plough. Water conservation and increased water productivity must also be encouraged.

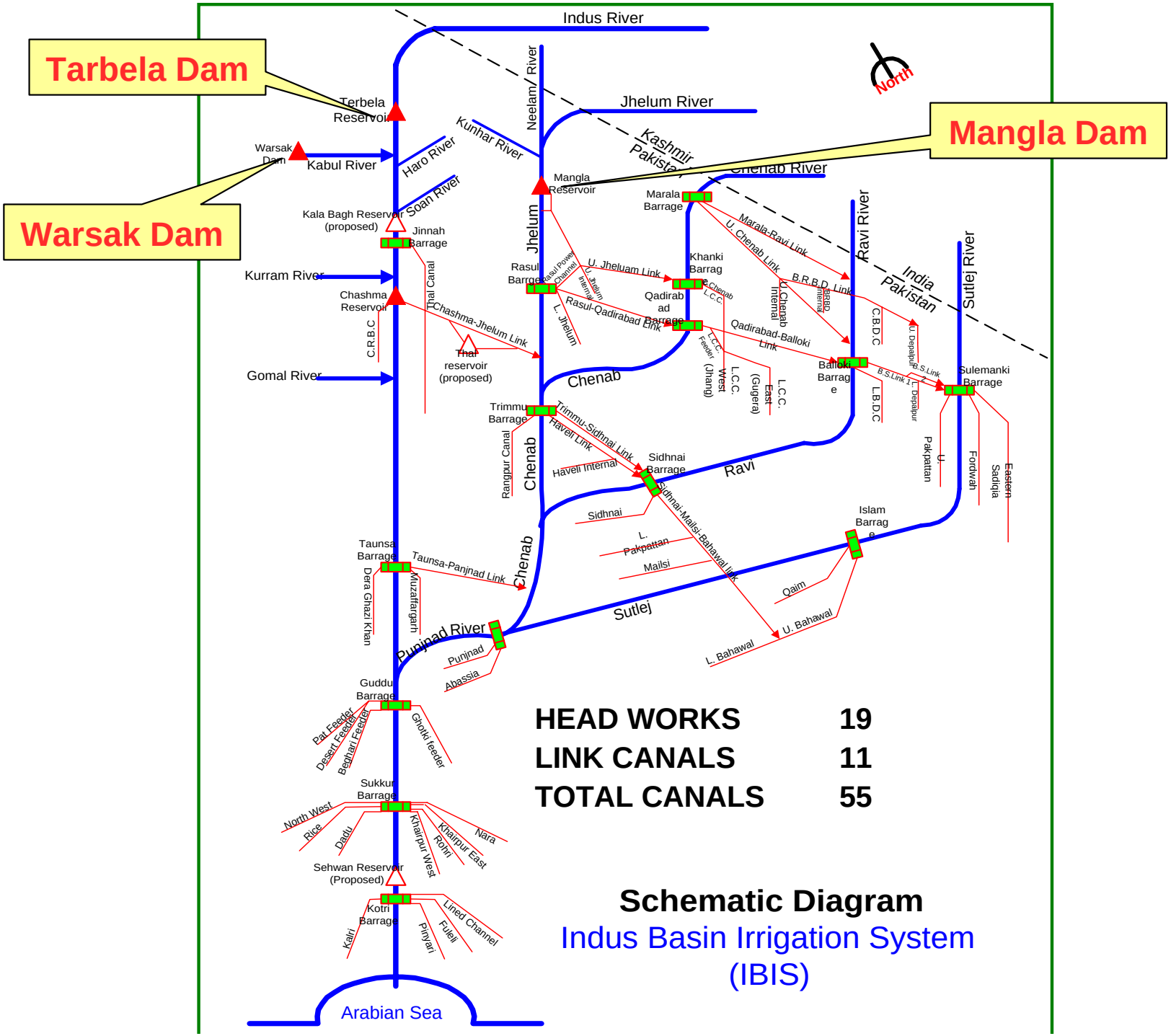
# WATER AND POWER SECTOR DEVELOPMENT

- It is an economically unsustainable fact that the total water storages capacity in the country is only 15 MAF representing 13% of the total annual flows of 136 MAF. Countries in Asia, Africa and the Americas have a storage capacity many times greater. To address this problem the Government of Pakistan (GoP) is developing feasibility and detailed engineering studies for nearly 20 MAF of water storage and 25,000 MW of hydel power. This is apart from thermal power being developed by the private sector, Independent Power Producers (IPPs) and the Government.
- To achieve the above objectives the GoP through WAPDA and the private sector plans to concentrate on the following water and power projects in the next few years: (i) Construction of large dams including Diamer-Basha Dam for Public/Private Partnership (ii) Construction of Medium/ Small Water Storage Dams (iii) Construction of Hydropower Projects (iv) Construction of Canals (v) Protection of Irrigation Infrastructure (vi) Water Conservation Strategies. These projects would create additional water storages, generate cheap indigenously developed electricity and prevent flood damages. All these measures would also ensure food security, employment generation and above all poverty alleviation.

# WAPDA's Fifty Years (1958 – 2008)

- **Construction of major Water infrastructure:**
  - **Completion of Indus Basin Replacement Projects**
    - **5-Barrages (Sidhnai, Mailsi Siphon, Qadirabad, Rasul & Chashma), 8 inter-river Link Canals (Trimmu-Sidhnai, Sidhnai-Mailsi, Mailsi-Bahawal, Rasul-Qaidrabad, Qadirabad-Balloki, LCC Feeder, Balloki-Sulemanki, Chashma-Jhelum, Taunsa-Panjnad), Mangla and Tarbela Dams**
  - **SCARPS Program (over 70 SCARPS)**
  - **Ghazi Barotha Hydropower Project**
  - **Development of Water Resources under WAPDA Vision 2025**
    - **5-Dams (Mangla Dam Raisin, Mirani, Sabakzai, Gomal Zam & Satpara), 3-Mega Canals (Rainee, Kachhi & Greater Thal), 5-Hydropower Projects (Allai Khwar, Khan Khwar, Duber Khwar, Jinnah, Neelum-Jhelum), 2-Drainage Projects - RBOD I & III (under implementation), 25000 MW Electricity (Under study)**
- **Expertise development in water & power engineering**

# INDUS BASIN IRRIGATION SYSTEM




| | |
|---|---|
| **HEAD WORKS** | **19** |
| **LINK CANALS** | **11** |
| **TOTAL CANALS** | **55** |

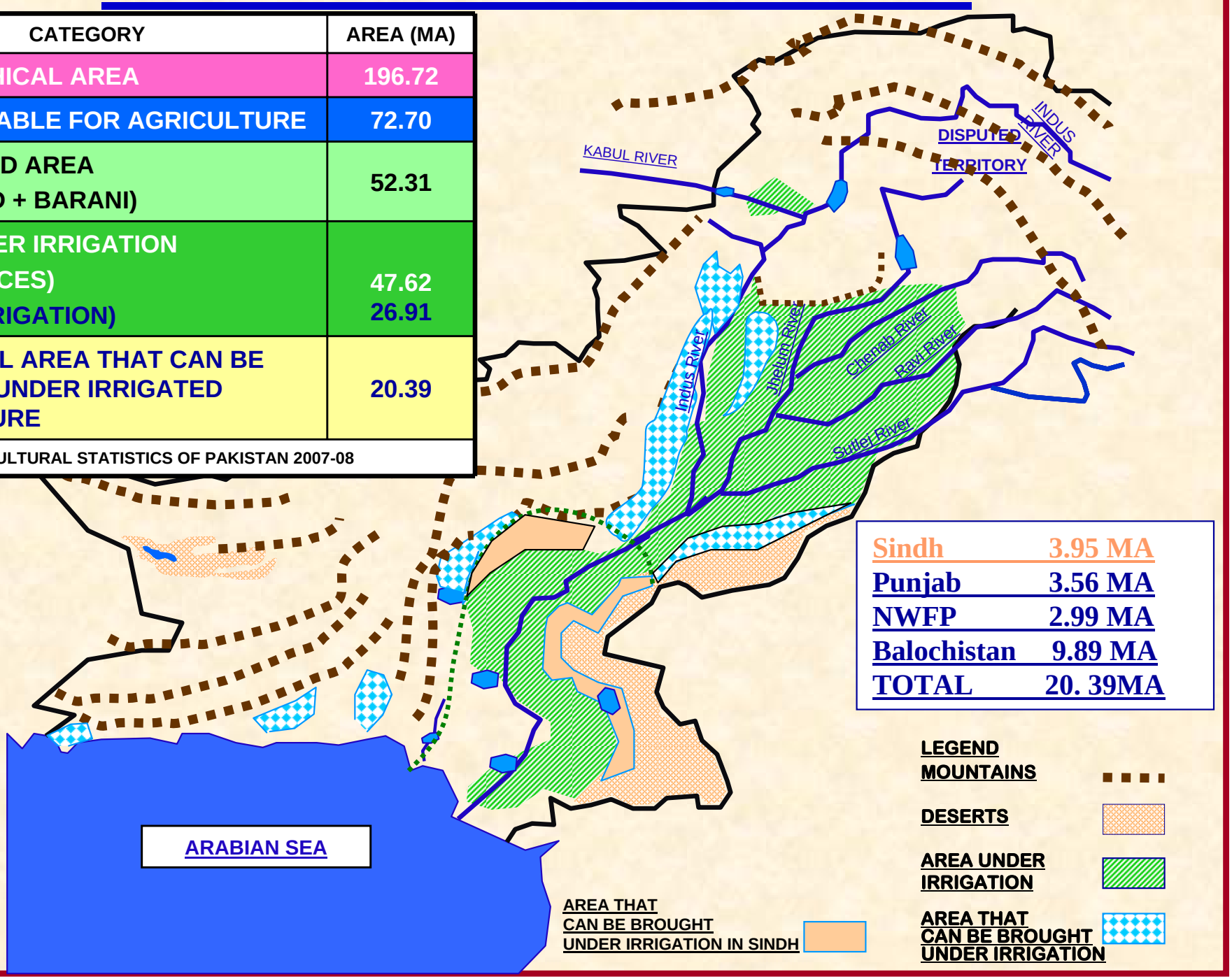
**Schematic Diagram**

Indus Basin Irrigation System (IBIS)

# LAND USE IN PAKISTAN

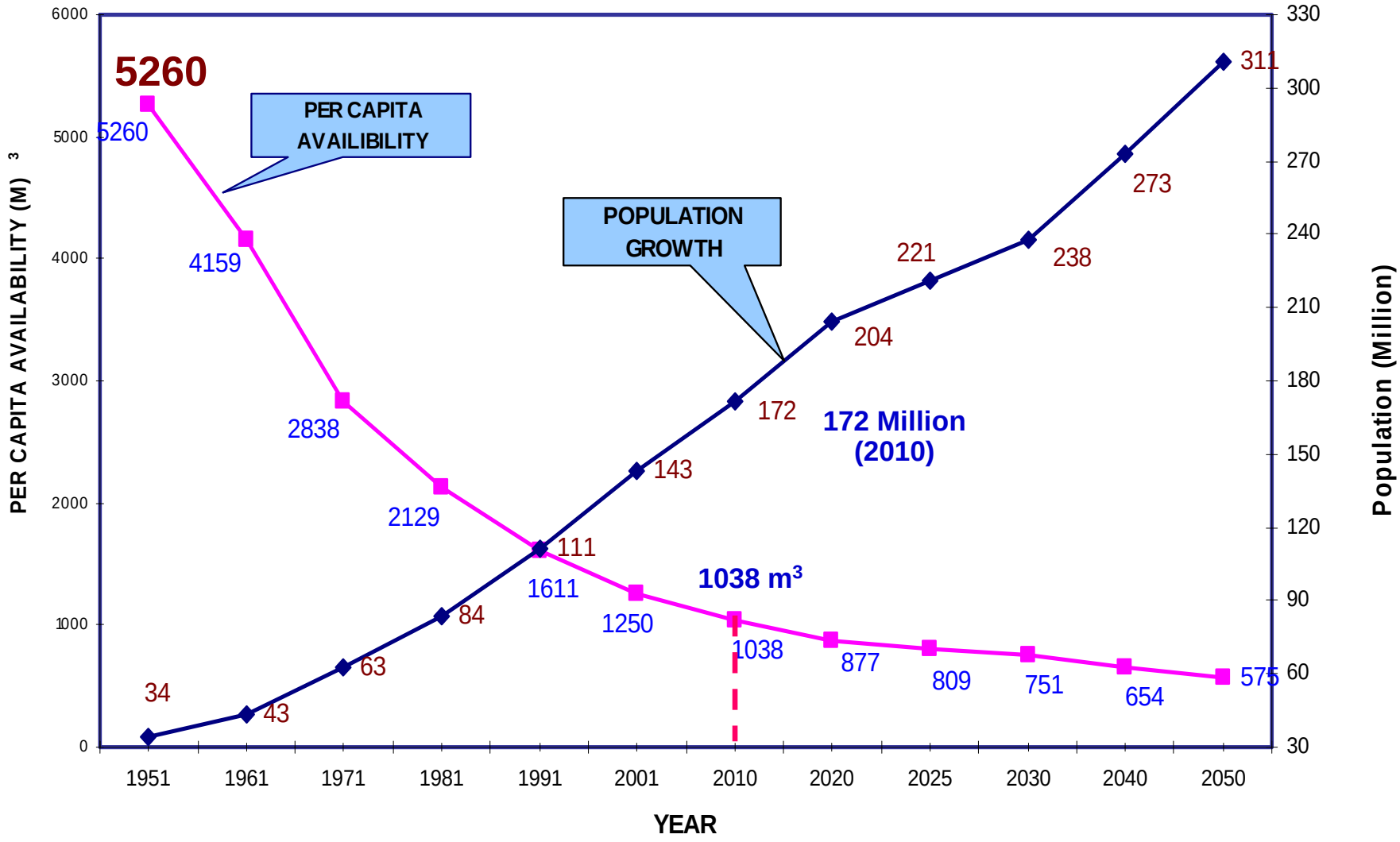
| CATEGORY | AREA (MA) |
|---|---|
| GEOGRAPHICAL AREA | 196.72 |
| AREA SUITABLE FOR AGRICULTURE | 72.70 |
| CULTIVATED AREA (IRRIGATED + BARANI) | 52.31 |
| AREA UNDER IRRIGATION (ALL SOURCES) (CANAL IRRIGATION) | 47.62 26.91 |
| ADDITIONAL AREA THAT CAN BE BROUGHT UNDER IRRIGATED AGRICULTURE | 20.39 |

SOURCE: AGRICULTURAL STATISTICS OF PAKISTAN 2007-08



# WHERE DOES PAKISTAN STAND IN WATER AVAILABILITY vis-a-vis POPULATION

## 2010 – 1038 $m^3$ per capita




As per global criteria, 1000 $m^3$ per capita is the threshold value

# RESERVOIR SEDIMENTATION (MAF)

| RESERVOIR | LIVE STORAGE CAPACITY | | LIVE STORAGE LOSS | | |
|---|---|---|---|---|---|
| | ORIGINAL | YEAR 2009 | YEAR 2009 | YEAR 2012 | YEAR 2025 |
| 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%) |
| CHASHMA | 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%)** |

## NEW STORAGES CURRENTLY BEING DEVELOPED/EXAMINED

| UNDER IMPLEMENTATION | |
|---|---|
| MANGLA DAM RAISING – AJK | 2.88 MAF |
| DIAMER-BHASHA – NA/NWFP | 6.40 MAF |
| GOMAL ZAM - FATA | 0.89 MAF |
| KURRAM TANGI - FATA | 0.90 MAF |
| | **11.07 MAF** |

| IN PLANNING STAGE | |
|---|---|
| DASU – NWFP | 0.8 MAF |
| MUNDA – FATA | 0.8 MAF |
| AKHORI – PUNJAB | 6.0 MAF |
| SHYOK – N / Areas | 5.0 MAF |
| Total: | 12.6 MAF |

# WATER DEVELOPMENT POTENTIAL

**DOWN STREAM KOTRI AVERAGE ANNUAL FLOWS**

| | |
|---|---|
| 1976-2000 | 32.3 MAF |
| 2001-2008 | 12.3 MAF |

| | |
|---|---|
| **DOWN STREAM KOTRI AVERAGE ANNUAL FLOWS (1976-2008)** | **32.3 MAF** |

**ANTICIPATED USES**

- **Down stream Kotri requirement** — **8.6 MAF**
  **(3.6 MAF + 5 MAF)**
  **@ 5000 cusecs round the year**
- **Mangla Dam Raising Project** — **2.9 MAF**
- **Afghanistan uses on River Kabul** — **-**
- **Indian future uses on Western rivers** — **2.0 MAF**
  **(Based on area indicated in Indus Water Treaty)**

| | |
|---|---|
| **NET AVAILABLE FOR DEVELOPMENT** | **18.8 MAF** |
| **After Diamer Basha Dam Project** | **12.4 MAF** |

# MAJOR WAPDA PROJECTS COMPLETED 2000-2009

- **Ghazi Barotha Hydropower Project** **US$ 2250 Million**
- **Mirani Dam Project** **Rs. 5811 Million**
- **Sabakzai Dam Project** **Rs. 2005 Million**

# MAJOR WAPDA PROJECTS UNDER EXECUTION

## DAMS

- Mangla Dam Raising
- Gomal Zam Dam
- Satpara Dam
- Kurram Tangi Dam

## CANALS

- Rainee Canal
- Kachhi Canal
- Greater Thal Canal

## DRAINAGE PROJECTS

- RBOD-I
- RBOD-III

## HYDROPOWER PROJECTS

- Allai Khwar
- Khan Khwar
- Duber Khwar
- Jinnah
- Neelum-Jhelum

# WATER SECTOR PROJECTS UNDER STUDY

## STORAGES

| | |
|---|---|
| • Diamer Basha Dam | Ready for Construction |
| • Kurram Tangi Dam | -do- |
| • Akhori Dam | Under Study |
| • Sukleji Dam | -do- |
| • Sehwan Barrage Complex | -do- |
| • Munda Dam Project | -do- |
| • Shyok Dam Project | -do- |
| • Yulbo Dam Project | -do- |

## CANALS

| | |
|---|---|
| • Chashma Right Bank Canal (Lift-cum-Gravity) | -do- |
| Irrigation of Skardu / Bunji Plains | -do- |
| Training & Capacity Building | -do- |

# HYDROPOWER PROJECTS UNDER STUDY

| Project | River |
|---|---|
| Diamer-Basha | Indus |
| Golen Gol | Golen Gol-Mastuj |
| Kohala | Jhelum |
| Tarbela 4th Ext. | Indus |
| Dasu | Indus |
| Bunji | Indus |
| Phandar | Ghizar |
| Palas Valley | Chor Nullah |
| Spat Gah | Spat Gah |
| Basho | Basho |
| Keyal Khwar | Keyal Khwar |
| Lawi | Shishi |
| Harpo | Harpo Lungma |
| Thakot HPP | Indus |
| Pattan | Indus |
| Yulbo | Indus |
| Shyok | Shyok |
| Refurbishment/Rehabilitation of Mangla Power House | Jhelum |

# HYDROPOWER PROJECTS WHICH CAN BE UNDERTAKEN FOR EXECUTION DURING NEXT FIVE YEARS

| PROJECT | RIVER |
|---|---|
| Diamer Basha Dam | Indus |
| Kohala | Jhelum |
| Bunji | Indus |
| Munda | Swat |
| Dasu | Indus |
| Patan | Indus |
| Others<br>(Matiltan, Palas Valley etc.) | |

# 32 SMALL/MEDIUM DAMS IN PAKISTAN

## PHASE-I – (2009-2012)

| BALOCHISTAN | | NWFP | |
|---|---|---|---|
| •Hingol Dam - (3 MW) | US$ 263 M | •Bara Dam – (5.8MW) | US$ 178 M |
| •Naulong Dam - (4.4 MW) | US$ 146 M | •Daraban Zam Dam – (0.75 MW) | US$ 34 M |
| •Winder Dam – (0.3 MW) | US$ 21 M | | |
| •Pelar Dam – (0.72 MW) | US$ 21 M | | |
| •Garuk Dam – (0.72 MW) | US$ 22 M | | |
| **SINDH** | | **PUNJAB** | |
| •Nai Gaj Dam - (4.2 MW) | US$ 212 M | •Ghabir Dam – (0.15 MW) | US$ 14 M |
| •Darawat Dam – (0.45 MW) | US$ 40 M | •Papin Dam – (0.2 MW) | US$ 27 M |
| •Sita Dam Project – (0.15 MW) | US$ 49 M | | |
| *Phase-I – Estimated Cost = US$ 1026 Million* | | | |

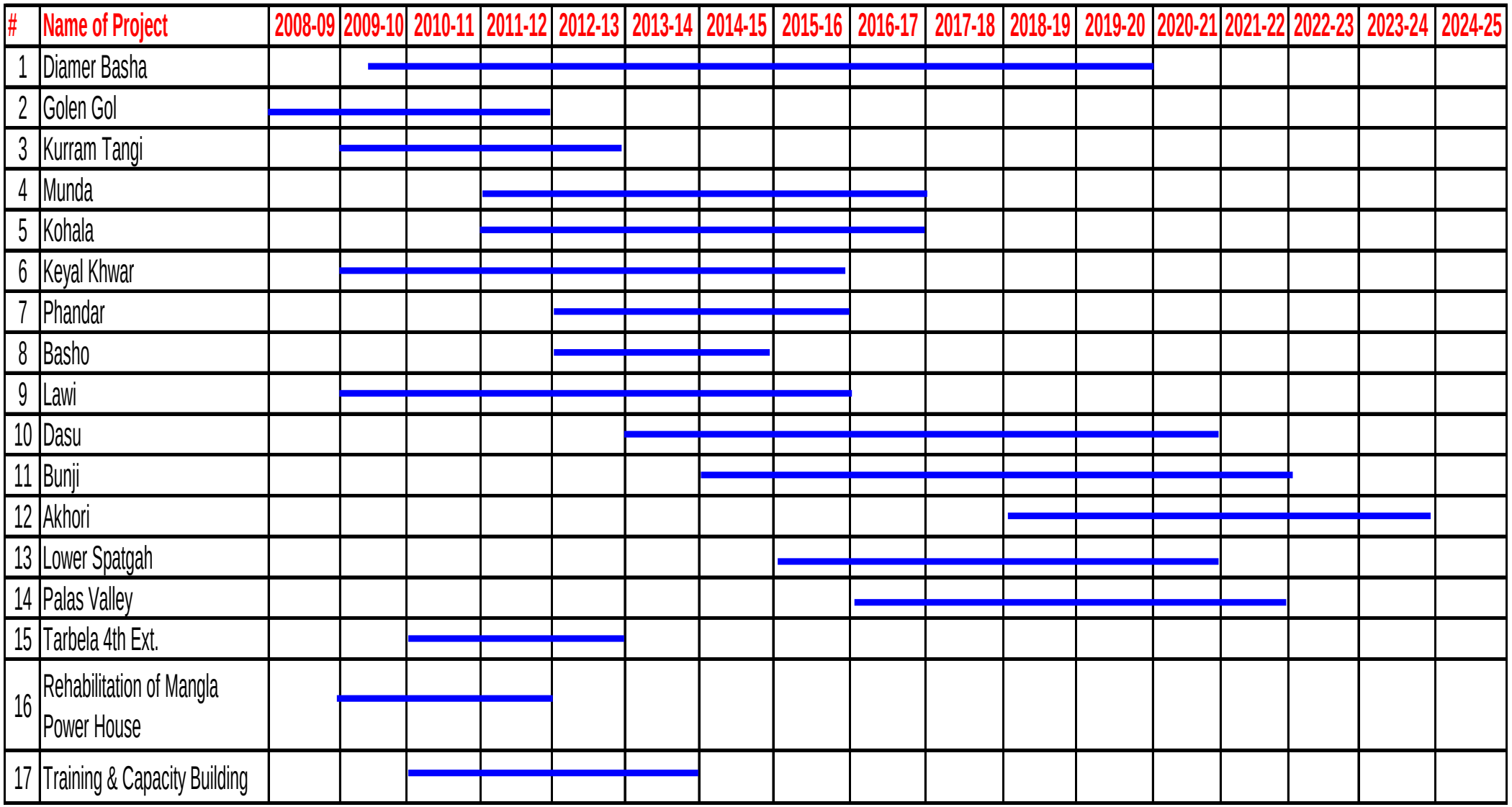
## PHASE-II – (2010-2013)

| BALOCHISTAN | NWFP |
|---|---|
| •Sukleji Dam | •Chaudwan Zam Dam |
| •Basol Dam | •Tank Zam Dam |
| •Badinzai Dam | •Sheikh Haider Dam |
| •Purali Dam | •Chashmai Akor Dam |
| | •Chowkas Dam |
| | •Totakan Dam |
| | •Kuhai Dam |
| | •Siran Dam |
| **SINDH** | **PUNJAB** |
| •Salari Dam | •Kot Fateh Dam |
| •Nali Dam | •Mujahid Dam |
| •Khenji Dam | •Lawa Dam |
| •Naing Dam | •Mohra Shera Dam |
| | •Jamalwal Dam |
| *Feasibility study, detailed design under process* | |

# PAKISTAN'S HYDROPOWER POTENTIAL
## (RIVERWISE SUMMARY)

| Sr. No. | River/ Tributary | Power (MW) |
|---|---|---|
| 1. | Indus River | 37780 |
| 2. | Tributaries of Indus (Northern Areas) & NWFP | 6006 |
| | Sub Total (1+2) | 44746 |
| 3. | Jhelum River | 3143 |
| 4, | Kunhar River | 1435 |
| 5. | Neelum River & its Tributaries | 1844 |
| 6. | Poonch River | 397 |
| | Sub Total (3+4+5+6) | 6819 |
| 7. | Swat River & its Tributaries | 2371 |
| 8. | Chitral River & its Tributaries | 2282 |
| | Sub Total (7+8) | 4653 |
| 9. | Schemes below 50 MW on Tributaries | 1055 |
| 10. | Schemes below 50 MW on Canals | 408 |
| | Sub Total (9+10) | 1463 |
| TOTAL | | 57681 |

# CONSTRUCTION SCHEDULE FOR 20000 MW HYDROPOWER GENERATION



| # | Name of Project | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022-23 | 2023-24 | 2024-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Diamer Basha | | | | | | | | | | | | | | | | | |
| 2 | Golen Gol | | | | | | | | | | | | | | | | | |
| 3 | Kurram Tangi | | | | | | | | | | | | | | | | | |
| 4 | Munda | | | | | | | | | | | | | | | | | |
| 5 | Kohala | | | | | | | | | | | | | | | | | |
| 6 | Keyal Khwar | | | | | | | | | | | | | | | | | |
| 7 | Phandar | | | | | | | | | | | | | | | | | |
| 8 | Basho | | | | | | | | | | | | | | | | | |
| 9 | Lawi | | | | | | | | | | | | | | | | | |
| 10 | Dasu | | | | | | | | | | | | | | | | | |
| 11 | Bunji | | | | | | | | | | | | | | | | | |
| 12 | Akhori | | | | | | | | | | | | | | | | | |
| 13 | Lower Spatgah | | | | | | | | | | | | | | | | | |
| 14 | Palas Valley | | | | | | | | | | | | | | | | | |
| 15 | Tarbela 4th Ext. | | | | | | | | | | | | | | | | | |
| 16 | Rehabilitation of Mangla Power House | | | | | | | | | | | | | | | | | |
| 17 | Training & Capacity Building | | | | | | | | | | | | | | | | | |

# PROJECTS UNDER EXECUTION

| Sr # | Project | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Allai Khwar | | | | | | | | | | | | | | | |
| 2 | Duber Khwar | | | | | | | | | | | | | | | |
| 3 | Khan Khwar | | | | | | | | | | | | | | | |
| 4 | Jinnah | | | | | | | | | | | | | | | |
| 5 | Neelum-Jhelum | | | | | | | | | | | | | | | |
| 6 | Gomal Zam Dam | | | | | | | | | | | | | | | |
| 7 | Satpara Dam | | | | | | | | | | | | | | | |

# SMALL/MEDIUM DAMS
## PHASE–I (2009–2012)

| Sr # | Project | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|
| 1 | Hingol Dam | | | | | |
| 2 | Naulong Dam | | | | | |
| 3 | Winder Dam | | | | | |
| 4 | Pelar Dam | | | | | |
| 5 | Garuk Dam | | | | | |
| 6 | Nai Gaj Dam | | | | | |
| 7 | Darawat Dam | | | | | |
| 8 | Sita Dam | | | | | |
| 9 | Bara Dam | | | | | |
| 10 | Daraban Zam Dam | | | | | |
| 11 | Ghabir Dam | | | | | |
| 12 | Papin Dam | | | | | |

# SMALL/MEDIUM DAMS
## PHASE–II (2010–2013)

| Sr # | Project | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| 1 | Sukleji Dam | | | | | | |
| 2 | Basol Dam | | | | | | |
| 3 | Badanzai Dam | | | | | | |
| 4 | Salari Dam | | | | | | |
| 5 | Nali Dam | | | | | | |
| 6 | Khenji Dam | | | | | | |
| 7 | Naing Dam | | | | | | |
| 8 | Chaudwan Zam Dam | | | | | | |
| 9 | Tank Zam Dam | | | | | | |
| 10 | Sheikh Haider Dam | | | | | | |
| 11 | Chashmai Akor Dam | | | | | | |
| 12 | Chowkas Dam | | | | | | |
| 13 | Totakan Dam | | | | | | |
| 14 | Kuhai Dam | | | | | | |
| 15 | Siran Dam | | | | | | |
| 16 | Kot Fateh Dam | | | | | | |
| 17 | Mujahid Dam | | | | | | |
| 18 | Lawa Dam | | | | | | |
| 19 | Mohra Shera Dam | | | | | | |
| 20 | Jamalwal Dam | | | | | | |