

Indus River Basin of Pakistan

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World & Pakistan





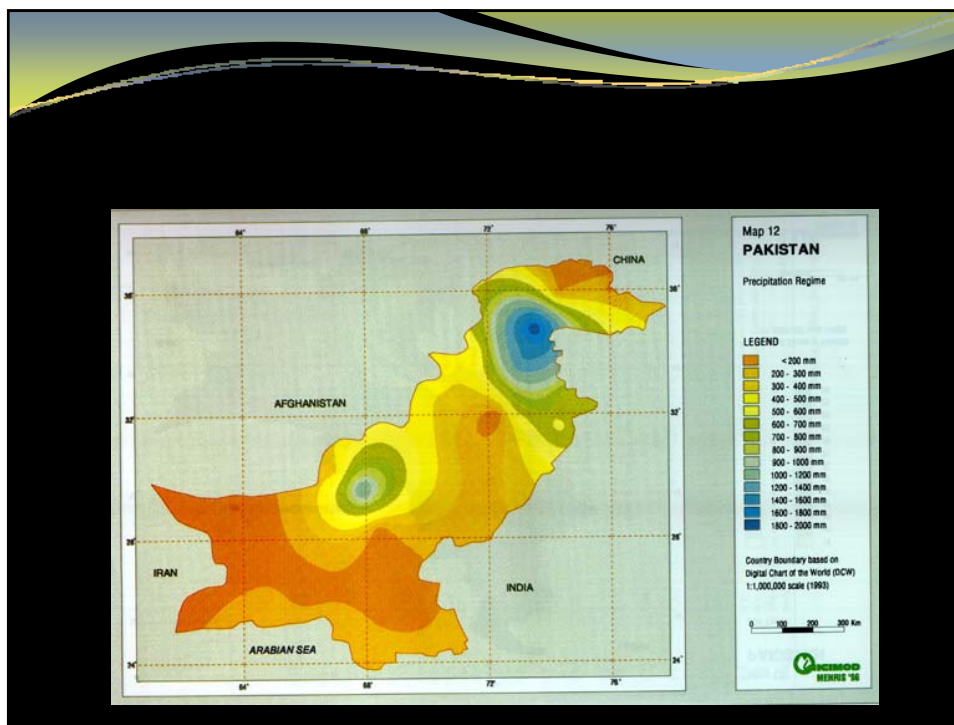
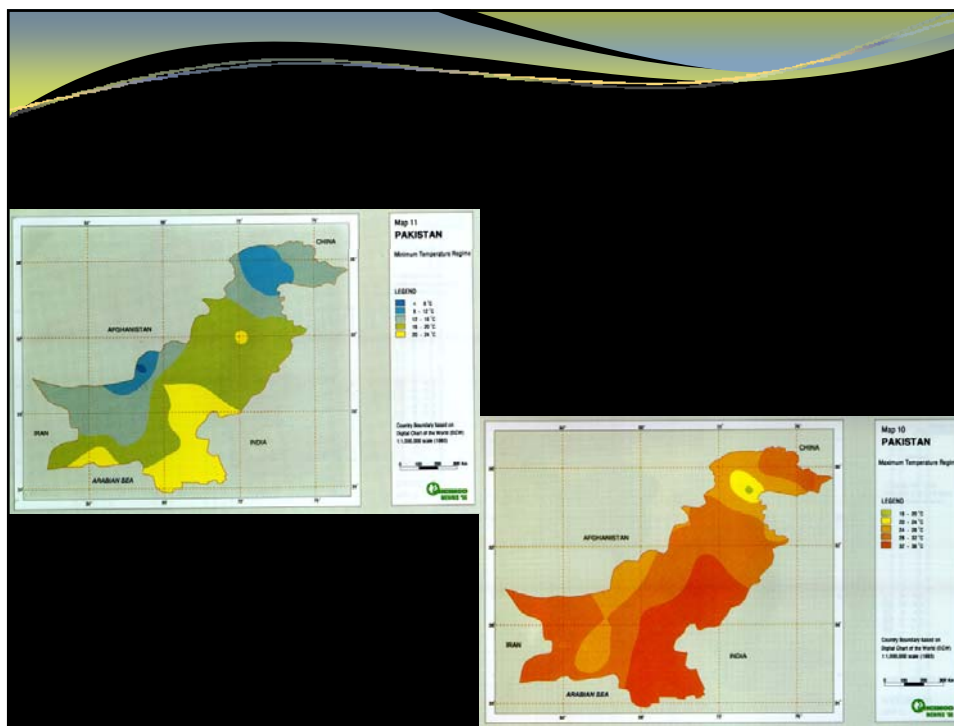
Pakistan

- Official Name: Islamic Republic of Pakistan
- Total Area: 796096 Km²
- Provinces: 5 (Punjab, Sindh, Balochistan, NWFP, Baltistan & Northern Areas)
- Population: 168.9 million
- Growth Rate: 2.2%
- Literacy Rate: 51% (53% Male & 29% Female)
- Below Poverty line: 32% (Urban 22% & Rural 39%)
- Health Expenditure: 0.7% of GDP
- GDP (per capita): \$492

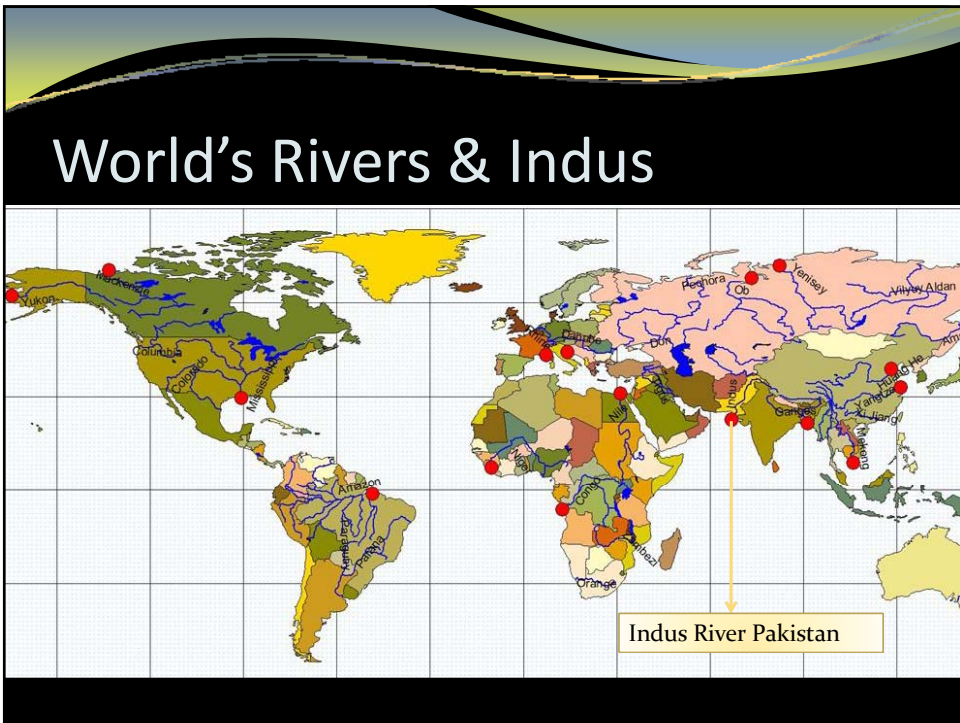
Source: Presentation of *Dr. Amir Muhammed* Chairman, Pakistan National IGBP Committee

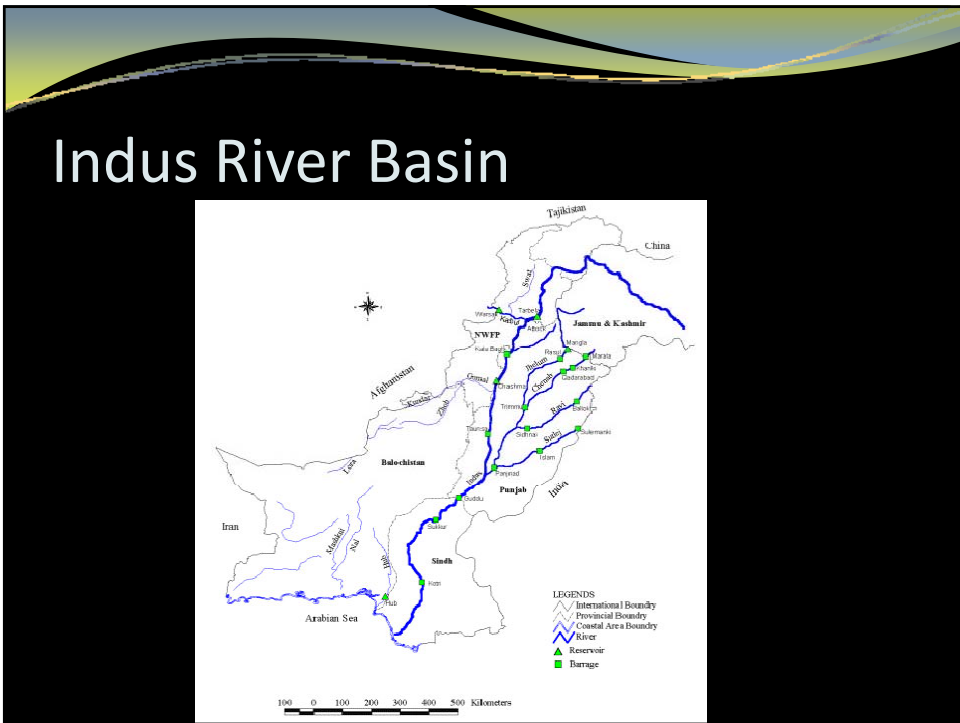
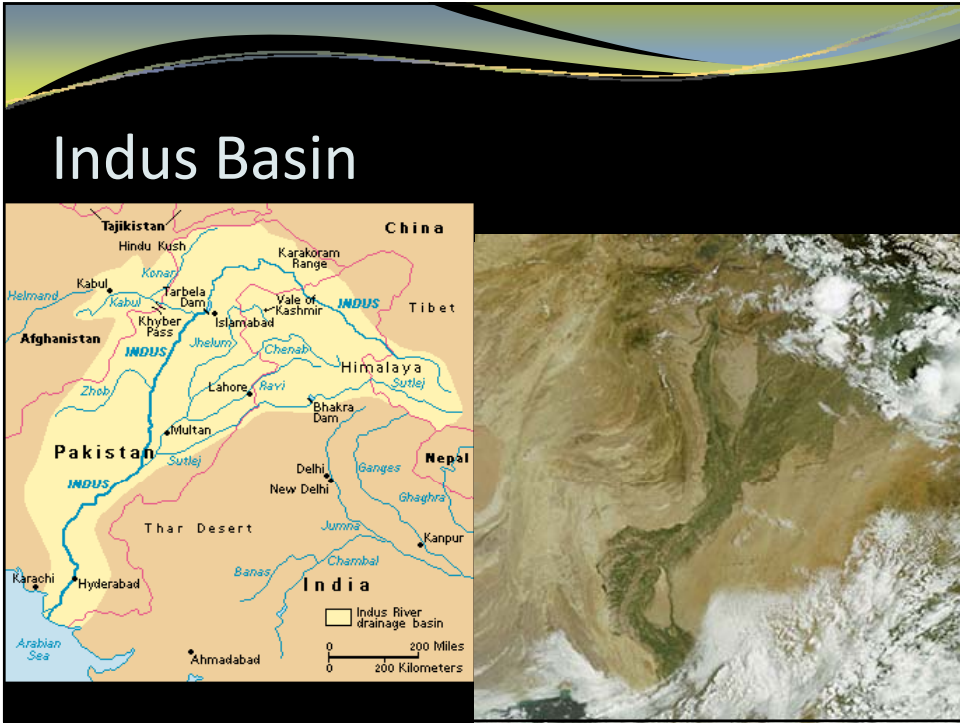
Climate

- Mostly Arid and Semi-arid
- Maximum temperature: 48°C to 53°C
- Minimum temperature: -8°C to 10°C
- Average rainfall: 278mm (weighted)
South 80-200 mm
North 250-1600 mm
- Monsoon Share: 49%



INDUS RIVER BASIN





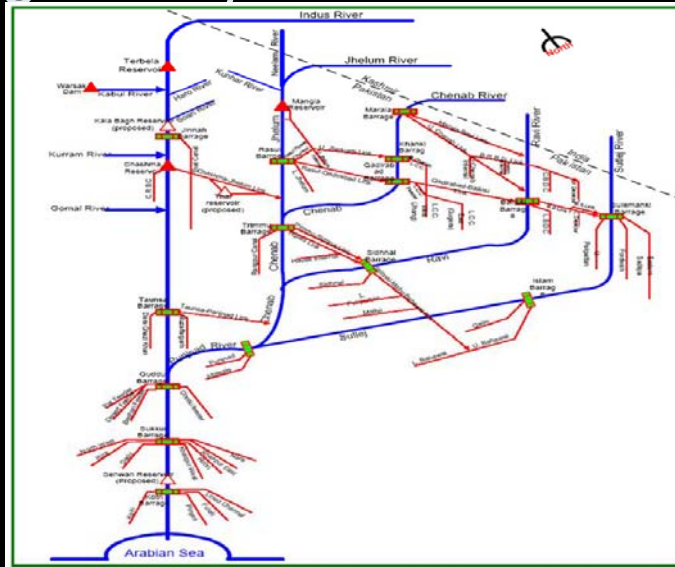
Average Annual River Flows

River	Average Annual Flow (1922-61) MAF	Average Annual Flow (1985-95) MAF	Average Annual Flow (2001-02) MAF
Indus	93	62.7	48
Jhelum	23	26.6	11.85
Chenab	26	27.5	12.38
Ravi	07	05	01.47
Sutlej	14	23.6	0.02
Kabul	26	23.4	18.9
Total	189	148.8	92.62

CANAL WATER DIVERSIONS & OUTFLOW TO SEA

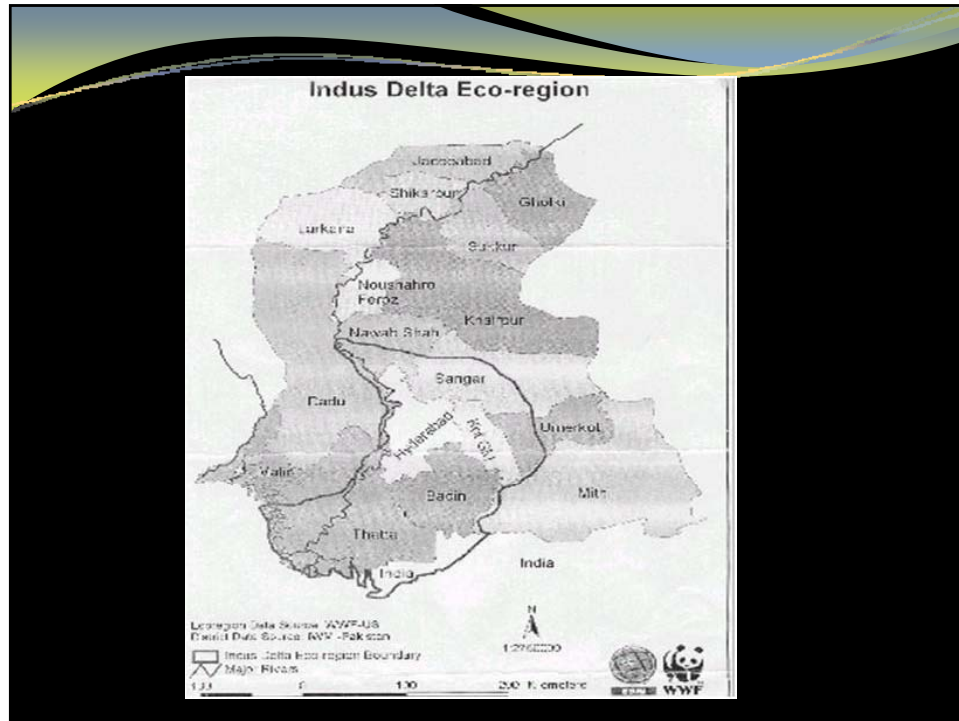
Canal Water Diversion			
1975 to 2000	Kharif	Rabi	Total
Average MAF	67.11	37.63	104.73
Out flow to sea below Kotri			
1975 to 2000	Kharif	Rabi	Total
Average MAF	37.01	02.49	39.50

Irrigation System



Indus Delta





Surface Water

- Water flow annually 187 Billion Cubic Meter (BCM) (173.63 from Western Rivers & 10.37 from Eastern rivers)
- Makran basin have an average flow 3.69BCM
- Kharan basin have an average flow 0.97BCM

Indus River at Sakrdu



Indus River at Ladakh



Indus River from Mountains



Indus River at Guddu Barrage



River water utilization

- Pre Independence – To date MAF
- Pre independence 64
- Pre Indus water treaty 78.6
- Pre Mangla (1966-67) 87.7
- Pre Tarbela 98.9
- Present 105

- Water accord allocation 117.35

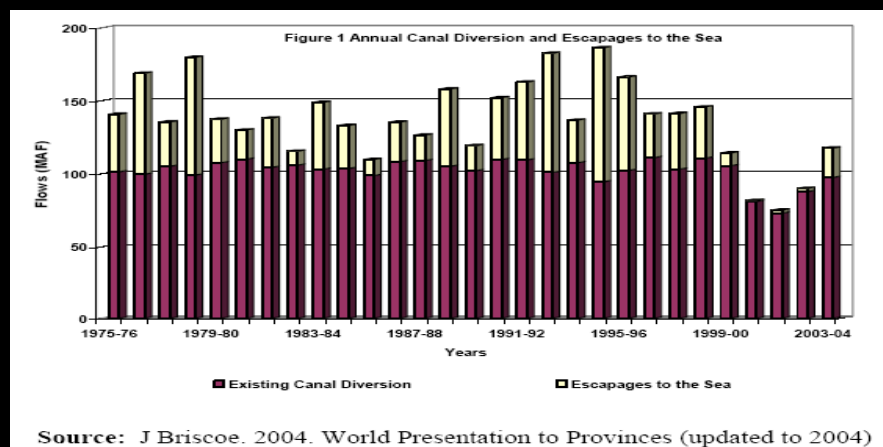
Ground Water

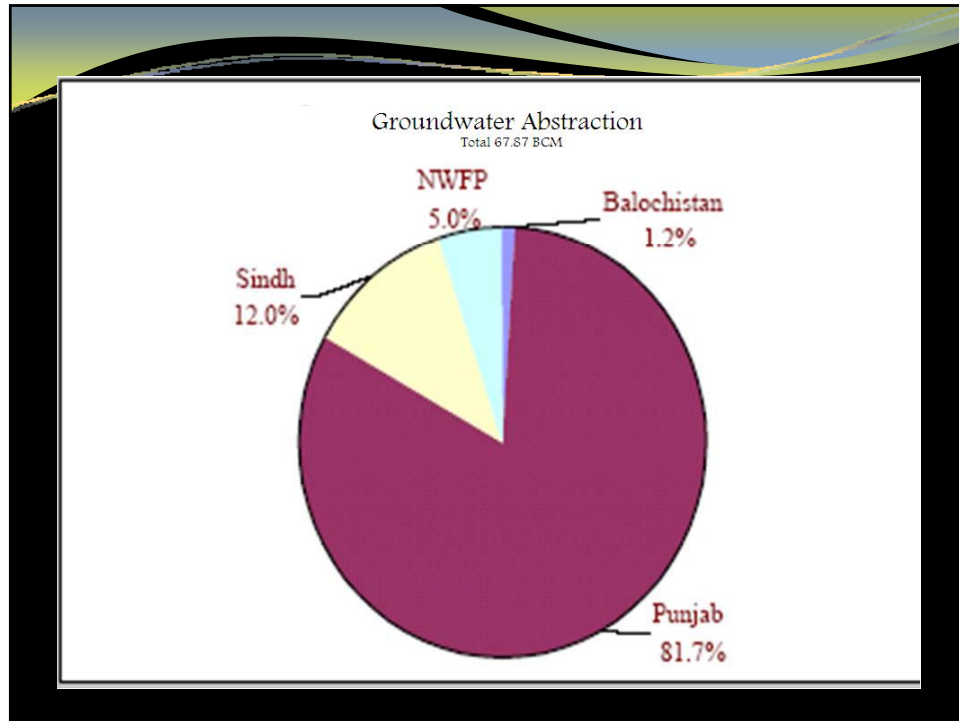
- Water abstraction 51.3 BCM
- Punjab 41.9 BCM
- Sindh 4.3 BCM
- NWFP 2.5 BCM
- &
- Balochistan 0.6 BCM

Ground Water

- The ground water resources are also fast depleting.
- Ground water pumping is estimated to reach 67.87 BCM by 2009.
- 70% of Pakistan's half-a-million tube wells produce hard or brackish water.
- If the network of canals and tubewells continue to provide gradually reducing quantities of fresh water,
- country faces a shortfall in food grain availability of about 4 million tonnes per year.
- Most important, the unity of the country will be undermined.

Canal Withdrawal & Flow to Sea





- The main source of water in Pakistan is Indus Basin Irrigation System (IBSI)
- Indus River originates from lake Mansarovar in Tibet- 2900 km total length.
- Total drainage area of 1,165,000 sq km, 712,000 sq km in Pakistan, rest in Himalayan ranges
- The Indus Basin has five major tributaries (Sutlej, Beas, Ravi, Chenab and Jhelum)
- Irrigates 45 million acres of land, 80% of total arable land- 170 Million population solely dependent on it

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- IBIS is the largest contiguous irrigation system in the world and is the mainstay of the irrigated agriculture in Pakistan.
- The Indus Basin System has
 - 3 dams,
 - 19 river barrages,
 - 12 inter-river link canals,
 - 45 huge canal commands, and
 - 900,000 tubewells.

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- The average annual flow of Indus River System is approximately 187 BCM
- of which presently
 - 117.37 BCM is being diverted for irrigation and
 - the remaining balance outflows into the sea.
- About 80% of the cropped area, approximately 18.09 million ha (Mha), is irrigated and
- 90% of the agricultural output comes from irrigated land.
- The net irrigated area is providing about 90 percent of food and fiber requirements of the nation.

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- Water is and will remain a critical resource for continued economic development.
- Overall irrigation system efficiency is about 45 %
- Outflow to the sea about 43 BCM
- However, about 13BCM is required

WATER STORAGE

Existing Storage Reservoirs in Pakistan

Dam	(Year)	River	Live Storage (MAF)
Tarbela	(1976)	Indus	9.69
Mangla	(1966)	Jhelum	5.34
Chashma	(1971)	Indus	0.61
Warsak	(1960)	Kabul	0.04
Baran	(1962)	Kurram	0.09
Hub	(1983)	Hub	0.76
Khanpur	(1984)	Haro	0.09
Tanda	(1965)	Kohat Toi	0.06
Rawal	(1962)	Kurang	0.04
Simly	(1972)	Soan	0.02
BKD Khan	(1900)	Pishin	0.04
Hamal	Lake		0.08
Manchar	Lake	Indus	0.75
Kinjhar	Lake	Indus	0.32
Chotiari	Lake	Indus	0.78

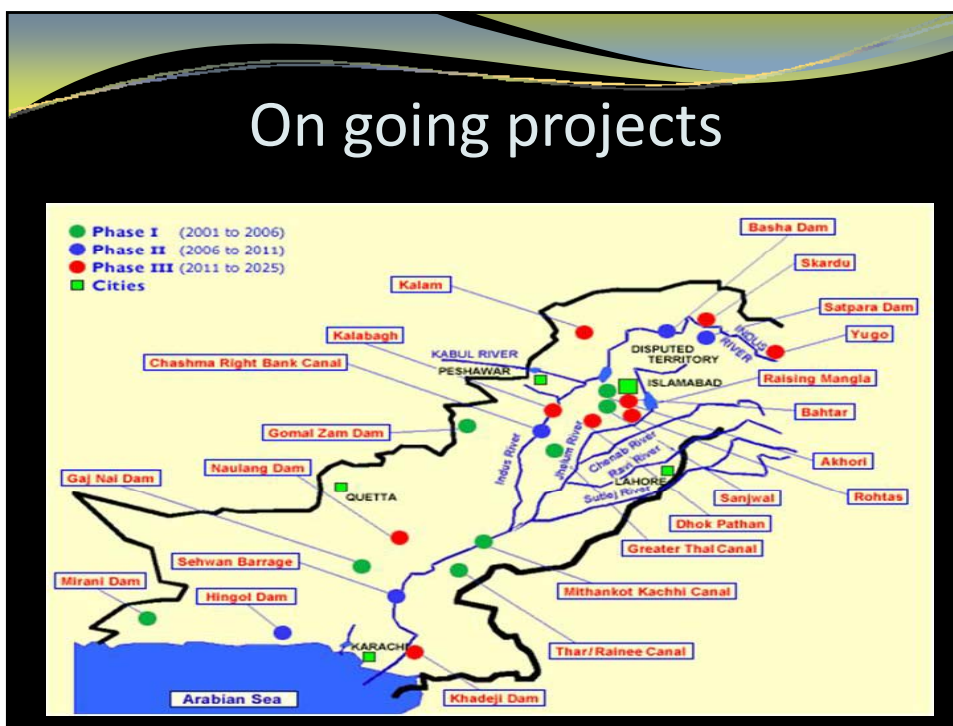
Total Storage: 18.71 MAF

On-going Water Storage and Canal Projects in Pakistan

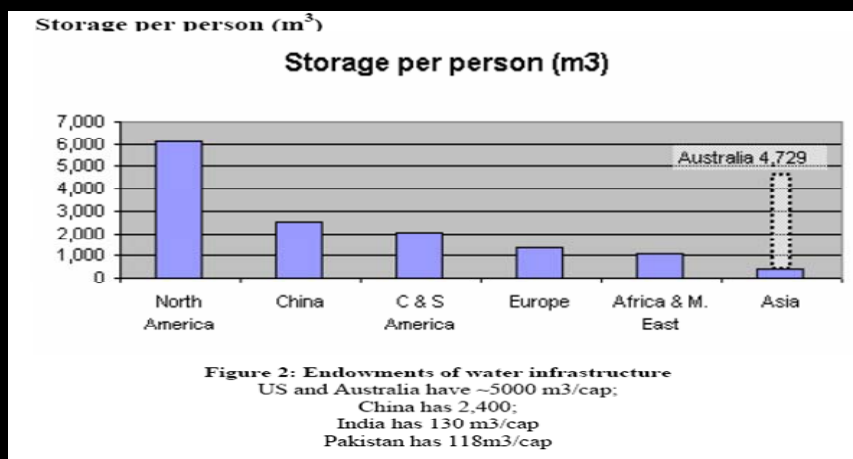
Name of Project	Storage (MAF)
Mangla Dam Raising	2.90
Gomal Zam Dam	1.14
Mirani Dam	0.30
Kurram Tangi Dam	1.20
Sabakzai Dam	0.02
Satpara Dam	0.08
Greater Thal Canal	
Kachhi Canal	
Rainee Canal	
Total increment in next 5 years	5.64
Basha Dam	7.10
Kalabagh Dam	6.10
Skardu Dam	15.52
Akhori Dam	3.60
Katzarah Dam	35.00
Total increment in future	32.32*

*excluding Katzarah Dam

On going projects



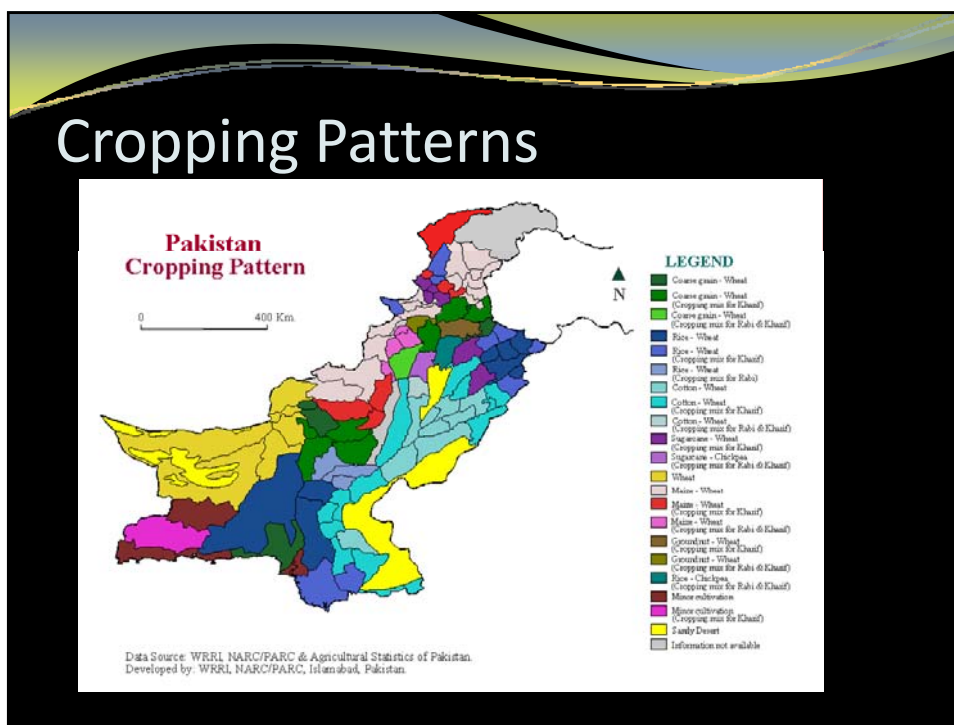
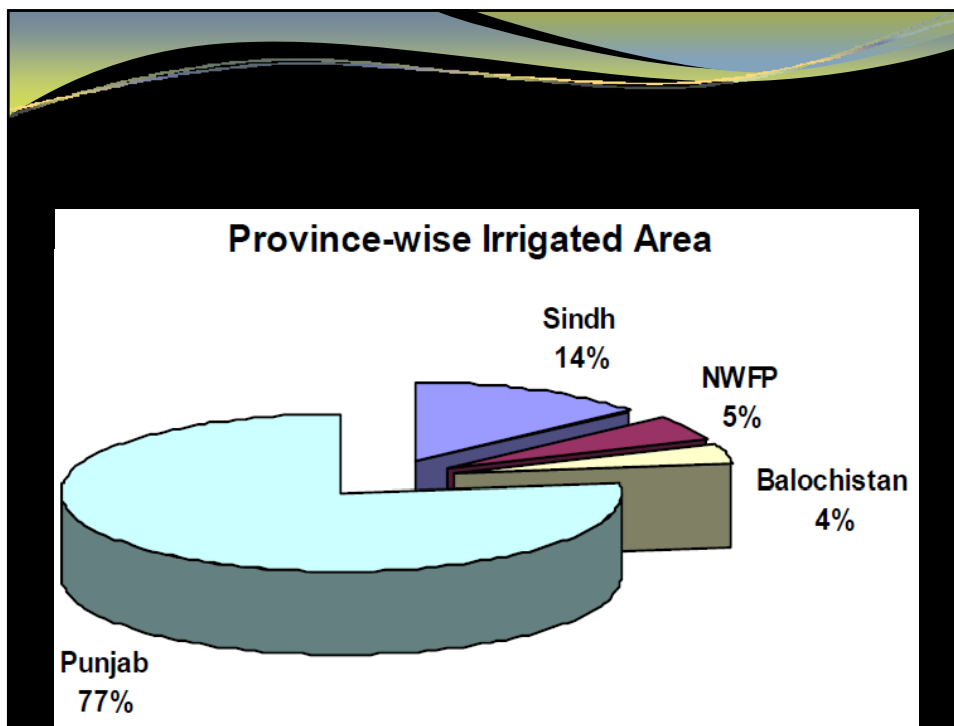
Storage per Person



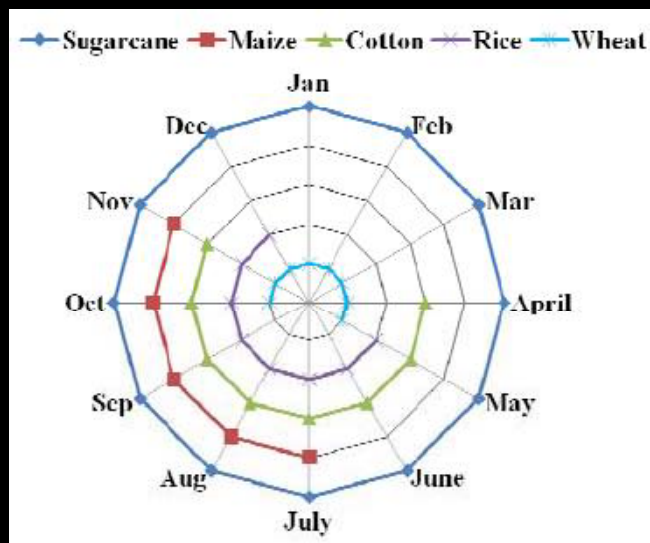
AGRICULTURE

Agriculture

- Agriculture Share: 24% of GDP
- Population involved in Agriculture: 68% (direct or Indirect)
- Major Crops: Wheat, Cotton, Rice, Maize, Sugarcane, etc.
- Water for agriculture: 97%
- Domestic: 02%
- Industry: 01%
- Irrigation System: Gravity flow
(Predominantly depends on irrigation)
- Mechanization: Initial Stages
- Export: >80% Agro. based



Cropping calendar of major crops



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- The cultivated area of Pakistan has increased from
- 14.70 Mha in 1947 to
- 23.5 Mha in Year 2008.
- *Kharif* (June–October) and *Rabi* (November– April) are the two principal agricultural seasons
- Total available water for irrigation, about 84 percent flows during kharif season and only
- 16 percent flows during rabi season.
- Nearly 81 % of river flows and
- 65% of precipitation occurs during the June to September monsoon.

Contd...

- In the Indus Basin, water is delivered to farms by watercourses based on “warabandi”. Warabandi is a continuous rotational of water generally lasts 7 days.
- The duration of supply to each farmer is proportional to the size of the farmers’ land holding.

Present Status of Water

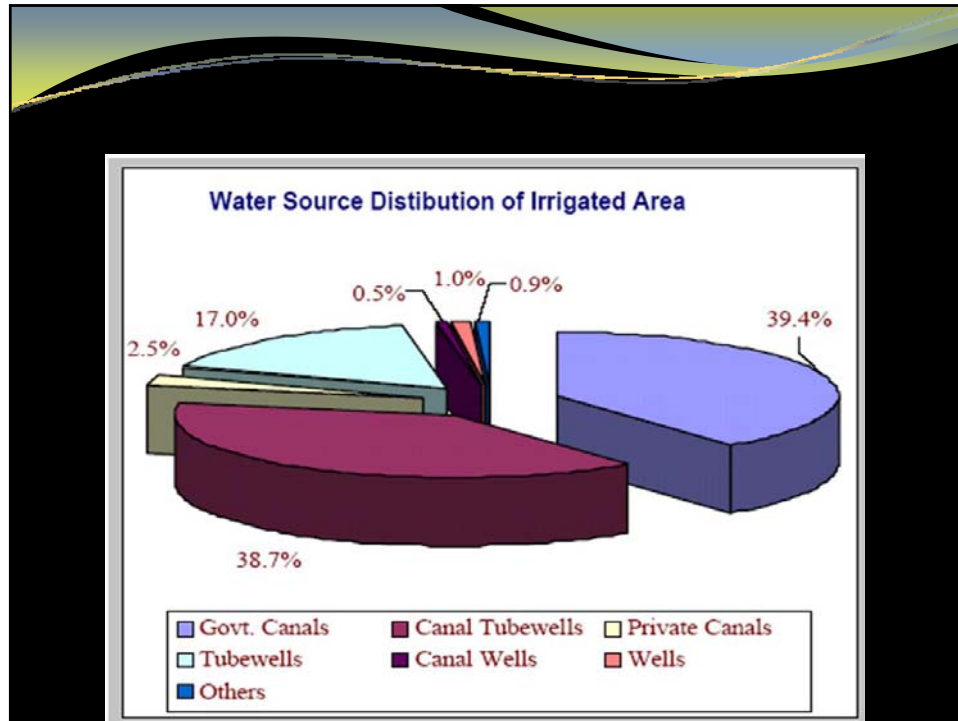
- Pakistan’s irrigated agriculture suffers from water logging and salinity,
- Over-exploitation of fresh groundwater,
- Low efficiency in delivery and use of irrigation water,
- Inequitable distribution ,
- Unreliable delivery of water,
- Insufficient cost recovery of irrigation and drainage charges.

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- 38% of the Gross Commanded Area (GCA) is waterlogged, of which
- 15% is severely waterlogged.
- 14% of the surface is saline, of which
- 6% is severely saline.
- Salinity is estimated to rob farmers of about 25% of the potential production of major crops
- Efficiency of delivery of the canal system is low, ranging from 35 to 40% from canal head to tail. Water does not reach many users toward the tail-end of the system

Contd...

- Inequity in the distribution of surface water due to deliveries less than designed levels,
- poor operation & maintenance , and
- even illegal diversion is a major concern in Pakistan.
- Operation and maintenance is inadequately financed.
- Many users and polluters of drains do not even pay for the use of drainage infrastructure.
- For example, urban centers and industries dispose of municipal waste and toxic effluents in canals and drains without payment or regulation



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- The poor state of drainage O&M is reflected in the periodic need for rehabilitation at roughly five year intervals.
- These problems have been identified to result from several underlying factors,
 - including public sector inefficiencies,
 - structure of the agrarian society,
 - the land tenure system,
 - the irrigation system design, and
 - the political economy resulting from the interplay of all these factors.

River Basin Management (RBM)

- To enhance the knowledge base to adopt sound technical solutions to drainage; and to reduce fiscal dependency especially for on-farm drainage
- The strategy consists of the following inter-linked parts:
 1. Restructuring the Provincial Irrigation Departments (PIDs) to form Public Utilities (PUs) around canal commands;
 2. Actively promoting the formation and development of Farmer Organizations (FOs);
 3. Strengthening federal agencies, notably the Water and Power Development Authority's (WAPDA's) Water Wing, to better implement their federal responsibilities; and
 4. Initiating the process of formalizing water rights and eventually of water markets, too.

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- The strategy is clearly dependent on the country's strong political commitment to implement genuine reform in the sector under a properly defined division of roles among public sector, community groups, and the private sector, and within the public sector among the Federal, Provincial, and local governments
- The reform program is also dependent upon a decentralized, efficient and participatory institutional apparatus for coordination planning, regulation, construction, financing, management and O&M.

THE REFORMS

- The role of WAPDA's Water Wing would be re-oriented away from intra-provincial construction to a wider spectrum of inter-provincial functions (including custodial stewardship of the Indus Basin/River aquifer);
- PIDs would be converted into autonomous Provincial Irrigation and Drainage Authorities (PIDAs), with responsibility for the intra-provincial aspects of the system from barrages to canal headworks, and from main drains that cross canal commands and major drainage basins to inter-Provincial drains operated and maintained by WAPDA;
- Self-accounting Area Water Boards (AWBs), initially set up as public utility pilot organizations, would eventually be established around all canal commands to take over and manage the irrigation and drainage system from canal headworks to distributaries/minors operated by Farmer Organizations (FOs), and from the branch drains operated by FOs to main drains operated by PIDAs; and
- FOs owned and controlled by farmers would also be encouraged, through a series of pilots, to take over and manage the irrigation and drainage system below the distributaries/minors and sub drains feeding into branch drains operated by AWBs.
- The FO pilots would be expanded gradually and modified to incorporate the lessons of experience or research.

SEDIMENTATION

- The Indus River System carries about 43,500 hectare metres of silt every year.
- About 40 per cent of the silt load settles before reaching the Indus mouth and erodes the storage capacity of the three main dams Tarbela, Mangla and Chashma.
- Tarbela dam is losing storage capacity of 100,000 cusecs each year.

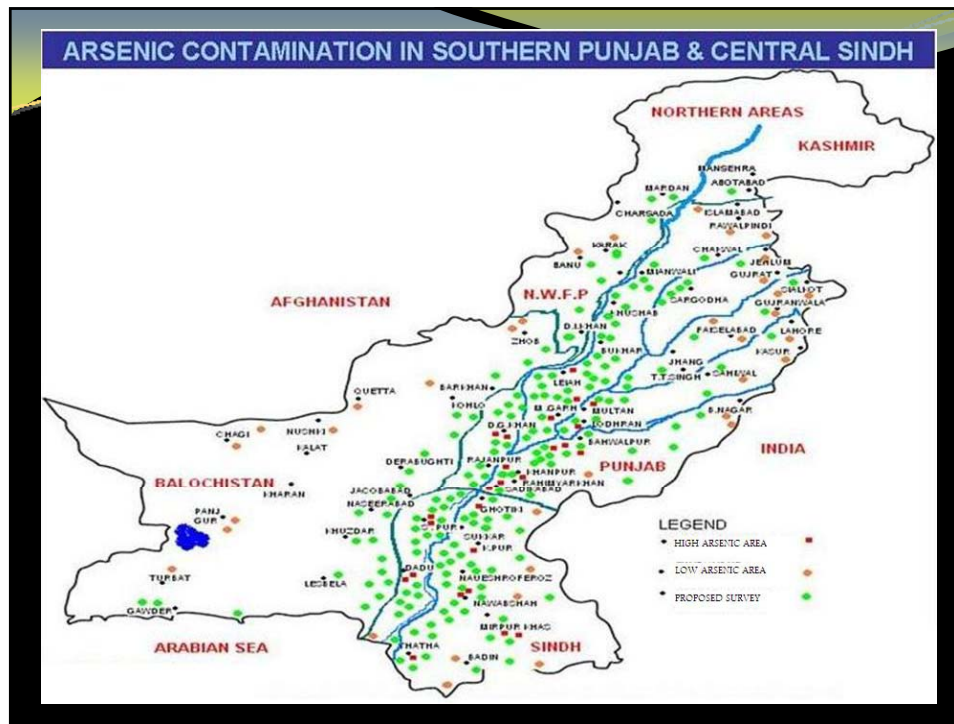
Reservoir Sedimentation in Pakistan (MAF)

• Reservoir Original Storage	Capacity Storage	Loss by 2001 Storage	Loss by 2010
• Tarbela	11.616	2.834 (24%)	3.951 (34%)
• Mangla	5.882	1.059 (18%)	1.510 (26%)
• Chashma	0.870	0.373 (43%)	0.481 (55%)
• <i>Total</i>	18.368	4.266 (23%)	5.942 (32%)

WATER QUALITY

Water Quality

Source	pH	Turbidity (NTU)	TDS (mg/l)	Coliform (MPN/100ml)	E.Coli (MPN/100ml)
Simly Dam	8.2	6	192	> 16	> 16
Rawal Dam	7.9	24	208	> 16	> 16
Sutlej River	7.5	694	580	> 16	> 16
Mangla Dam	8.2	4	93	> 16	> 16
Ravi River	7.5	670	127	> 16	> 16
Lahore Canal	7.6	647	126	> 16	> 16
Swat River	7.3	36	46	> 16	> 16
Indus River	7.6	76	84	> 16	> 16
Kabul River	6.1	774	120	> 16	> 16
Khanpur Dam	8.1	2	222	> 16	> 16
Tarbela Dam	7.9	52	94	> 16	> 16
Hanna Lake	7.5	11	385	> 16	> 16
Hub River	7.2	6	756	> 16	> 16
Hub Dam	7.2	5	743	> 16	> 16
Hamal Lake	7.3	12	4652	> 16	> 16
Manchar Lake	7.6	134	5318	> 16	5
Torkhezai Dam	7.7	400	150	> 16	> 16
Jhelum River	7.8	419	132	> 16	> 16
Chenab River	7.6	580	115	> 16	> 16
Chashma Lake	7.8	183	132	> 16	> 16



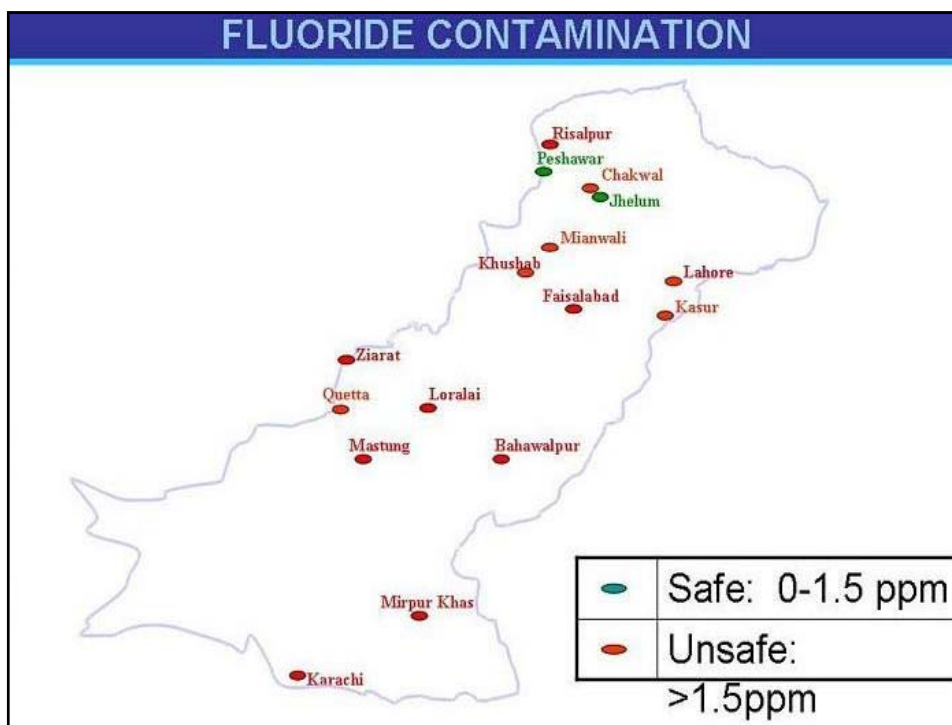
MAJOR WATER QUALITY ISSUES

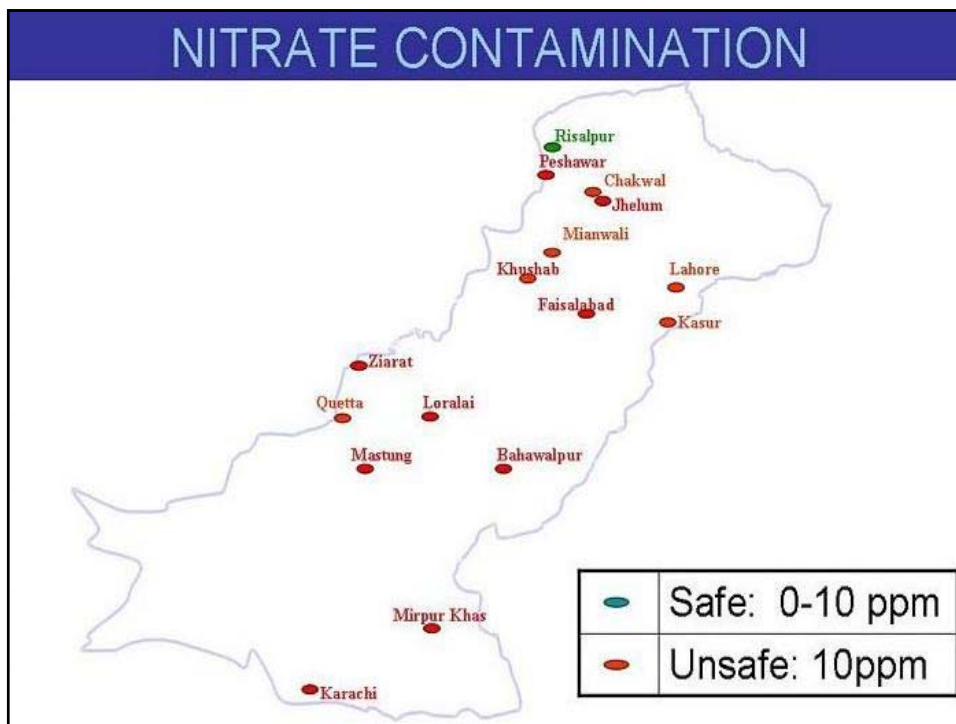
- 63% of water supplied to consumers is contaminated (UN Commission on Sustainable Development 30th April, 2004)
- Over use of groundwater in urban centers
- Unsafe disposal of sewage, industrial effluents and hospital waste
- Excessive use of fertilizers, pesticides & weedicides
- Improper disposal of solid waste
- Inadequate surveillance/monitoring arrangement
- Lack of awareness on quality issues
- Unskilled technicians responsible for treatment

WATER AVAILABILITY

Year	Population (million)	Availability (m ³ /Capita)
1951	34	5,300
1961	46	3,950
1971	65	2,700
1981	84	2,100
1991	115	1,600
2000	148	1,200
2005	150	1,000
2013	207	850
2025	267	659

FLUORIDE CONTAMINATION





Indus Water Treaty 1960

Indus Water Treaty 1960

Plan	India	Pakistan
Initial Indian	29 MAF/Year	90 MAF/Year
Initial Pakistani	15.5	102.5
Revised Indian	All water from the E. Rivers & 7% of W. Rivers	Some water from E. rivers & 93% W. rivers
Revised Pakistani	30% E. rivers & nothing from W. rivers	70% E. rivers and all of W. rivers
World Bank Proposal	Entire flow from eastern rivers	All flow from the western rivers

WATER MANAGEMENT

Water Apportionment as per Clause 2 of Water Accord 1991

Province	Allocation in MAF		
	Kharif	Rabi	Total
Punjab	37.07 (46.84%)	18.87 (49.38%)	55.94 (47.67%)
Sindh	33.94 (42.88%)	14.82 (38.78%)	48.71 (41.55%)
NWFP	05.82 (06.67%)	03.50 (09.16%)	08.78 (07.84%)
Balochistan	02.85 (03.60%)	01.02 (02.67%)	03.78 (03.29%)
Total	71.14 (99.99%)	38.21 (99.99%)	117.35 (99.99%)

Original Assumptions Farm Level Water Management

- Cropping intensity was designed around 50-75%;
- Agriculture was conceived as subsistent instead of commercial enterprise;
- Salinity and drainage concerns were not addressed;
- Water management was based on water rationing rather water demanded or required;
- Groundwater was not part of this equation, etc.

Facts about On-farm Water Management

- Cropping intensity has jumped to 125-200%;
- Agriculture is becoming like a commercial enterprise;
- Groundwater extraction is quite common;
- Population explosion, increases in irrigated areas, increase in high delta crops with too little additional water storages are facts on ground;
- Marketing system favors middle-man rather for producer and consumer, etc.

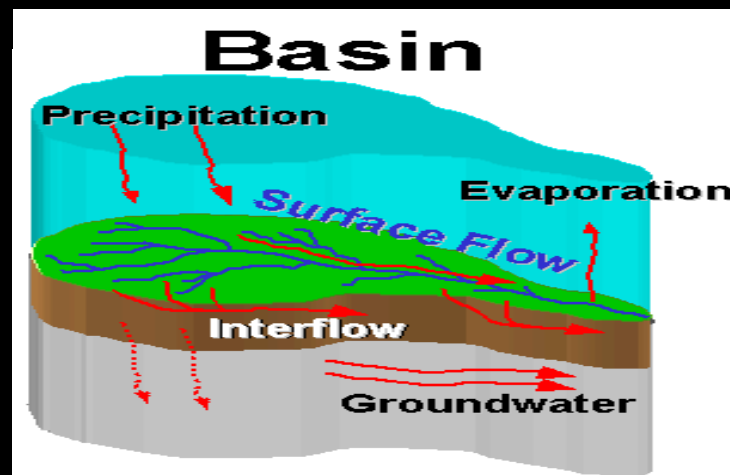
Issues associated with On-farm Water Acquisition & Management

- Groundwater quality & use concerns;
- No planned adjustments for intensive and commercial agriculture;
- Questionable profitability from agriculture as compared to other sectors;
- Too cheap canal water;
- Switching difficulties from supply-based to demand base water availability;
- Questionable conditions for efficient water application means; and
- Not enough forward thinking and creation of conditions for growing different crops in different zones based of water requirements, etc.

Options for On-farm Water Acquisition and Management

- Creation of conditions favorable for water efficient application systems to switch profitable commercial crops adjacent to a market like the Middle East;
- Facilitated use of acceptable quality ground-water (either as such or by treatment);
- Opting ways to convert supply-based to demand -based system;
- After making agriculture profitable enterprise, charge full price of canal water for encouraging efficient use of water; and
- Proactive water management from now to face water crises later.

Basin-wide Recommendations



Indus Basin related Recommendations

- Priority should be given to the Indus water projects NOT to loose Pakistan's due share under the Treaty 1960.
- Think-tanks on trans-boundary water management.
- IWT & Water Apportionment Accord of 1991 must be made part of curriculum of all concerned education centers.
- CBMs should be agreed and implemented for a smooth functioning of the Treaty.
- Most Important: Keep creating conditions that will be there to face off worst case scenario if not, enjoy the fruits of efficient water management as such.

Recommendations for Water Distribution within Pakistan

- Accord of 1991 must be followed in its true letter and spirit – going back must not be an option;
- New dams must be built without any further delay to implement 1991 Water Accord;
- Focus must shift to CBMs to ensure water distribution as per the Accord instead of promoting distrust among stakeholders;
- Agree to a plan of water sharing shortages; &
- Reorganize IRSA to make a neutral body.

Recommendations about Water Management within each Province

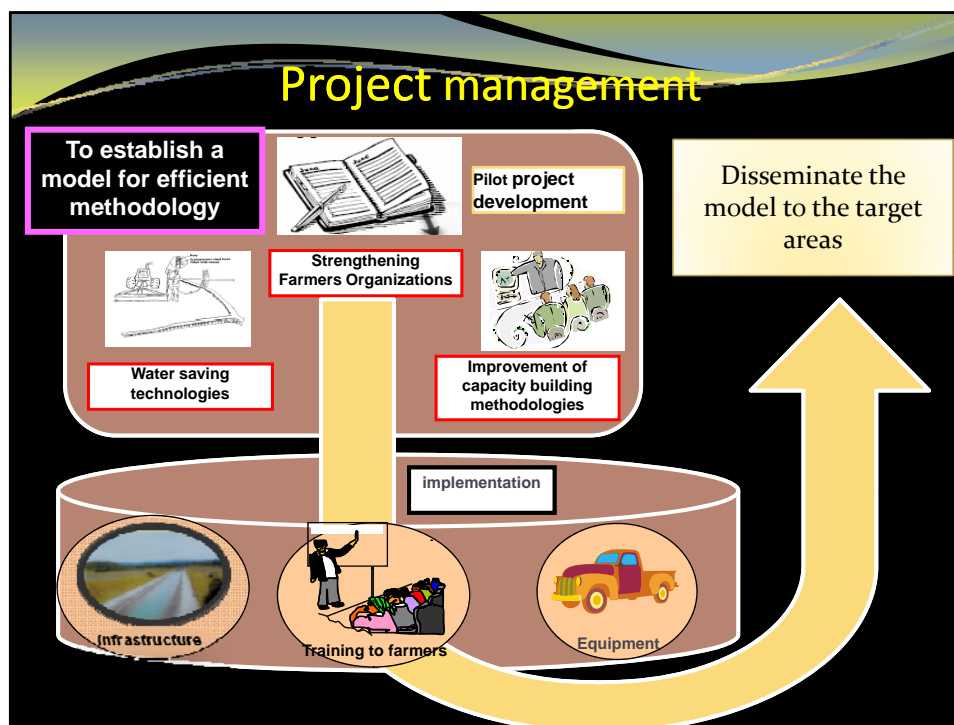
- Institutional reforms in irrigation departments must be followed in its true letter and spirit and should not be treated like a routine formality;
- To encourage client orientation, management and regulatory departments should be detached;
- Each province should either hold on to its share or sell its surplus water to encourage water efficiency and additional revenues;
- To avoid discrimination, each province should devise new water allowance measures for equitable distribution; and
- Each tail of secondary canal must have data loggers installed to ensure permitted supplies.

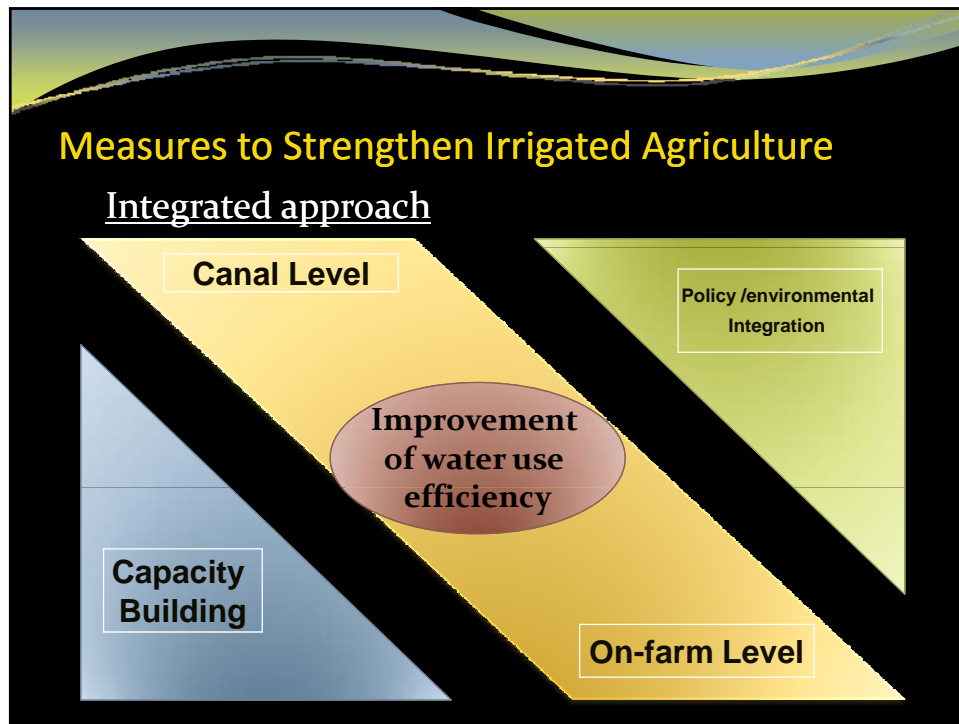
Recommendations for On-Farm Water Acquisition and Management

- Studies are required to convert a supply-based system into demand-based system for making use of modern efficient water application;
- Conditions should be created for horticulture as well as floriculture to save water as well as to turn subsistent source to commercial & profitable agriculture;
- Proper groundwater extraction and use should be facilitated;
- Studies should be initiated for rain-water harvesting and use modern systems to apply water efficiently.

Our Vision for the Future

- Pakistan must manage its water resources most efficiently by initiating and creating necessary conditions now that favor crops of high value with low water requirements that are delivered by high efficiency application modalities aimed at addressing expected water flows and facilitating switch from subsistent to profitable agriculture within a time frame of say 10 years.
- Alternative vision could be to make Pakistan an industrialized country within a specified period like Malaysia did under Mahatir Muhammad.





Purpose of the Project

- To Strengthen Irrigated Agriculture

Immediate objective

- To establish a model irrigation management

In the view of,

- Accepted canal water supply
- Water requirement control
- Capacity building methodologies

Accepted canal water supply

1. Infrastructure Improvement
 - Distributaries-Canal Rehabilitation
 - Watercourses Improvement
2. Institutional Reforms
 - To support Irrigation Management transfer for better water delivery and canal maintenance
 - Establishment and enhancement of Farmers Organizations

Project activity

On-site verification of the guidelines/manuals for AWBs/FOs and feedback for improvement

Water requirement control

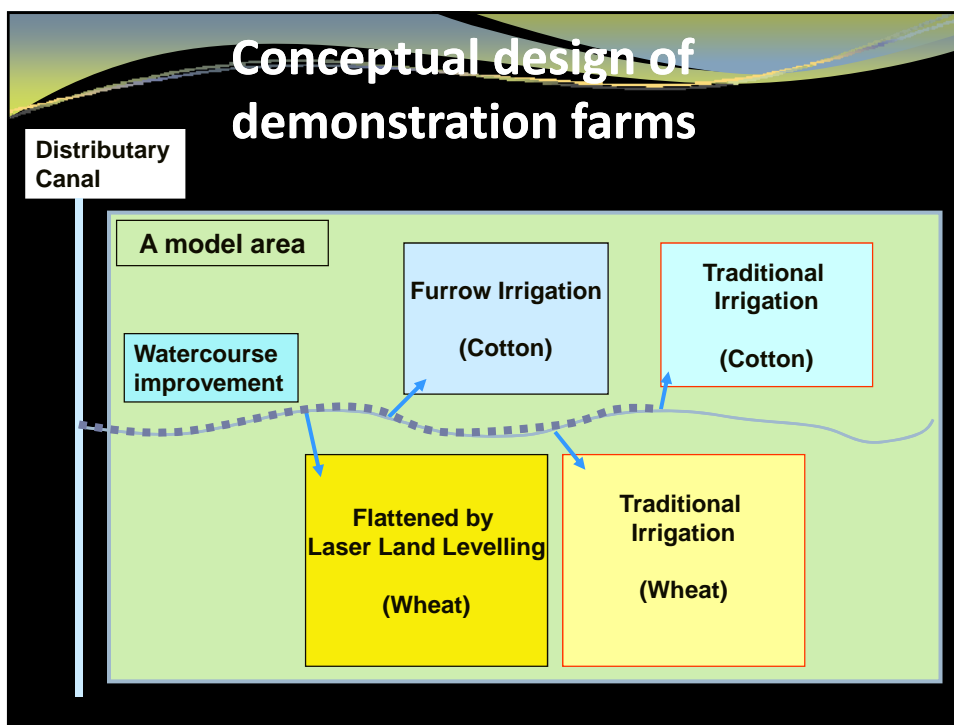
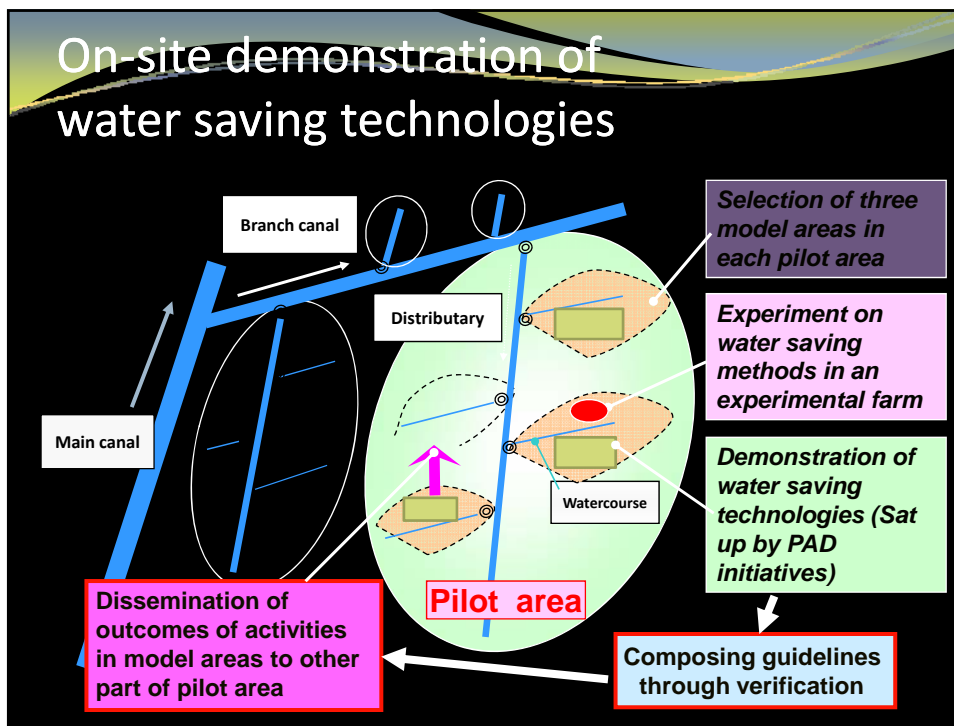
- Financial and technical support for water saving technologies
- To reduce water requirement and increase water productivity



Project activity

Demonstration and verification of the water saving techniques and feedback for further extension





Capacity building methodologies

To improve capacity building methodologies in farmers-friendly manner

Project activity

- Improve the methods of agricultural extension
- Improve the Training of Trainers (TOT) methods
- Disseminate and share the outcomes and experiences

Structure of two-step training

