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2012

Development of Integrated River Basin Management (IRBM) for Indus Basin



CHALLENGES AND OPPORTUNITIES



Why we are here:

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Development of Integrated River Basin Management (IRBM) for Indus Basin

CHALLENGES AND OPPORTUNITIES

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Preface

WWF – UK and WWF – Pakistan have worked together to implement a project on Indus Basin Water Security. This involved an advocacy driven approach to make sure that environment flows in the Indus Water Basin are protected. In the present water crisis in Pakistan, we urgently need to analyze water management in the country for technical and policy implications. 'Development of Integrated River Basin Management (IRBM) for the Indus Basin: Challenges and Opportunities' has been launched by WWF.

In the current climate change scenario, and the prevailing water crisis there is an urgent need for a critical analysis of water management in Pakistan with a focus on both technical and policy implications. WWF – Pakistan strongly believes that there is a need to scientifically assess the causes that have exacerbated the current crisis, along with determining the loopholes in the overall administrative and response mechanisms that has contributed to the present situation besides the natural calamity. The analysis shall further give pragmatic solutions that will help counter any such future eventualities with greater preparedness. In the absence of a water policy, it was deemed pertinent to have a document that reflects the major water issues, covers the concerns of major stakeholders in water use and presents a way forward.

This study also reviews the present policy, institutional and legal framework for water resources, allocation and management, presents a critical analysis of management of 2010 floods, and covers water economics and zoning focusing on irrigated eco zones of the River Indus. Finally, the study looks at international best practices, provides recommendations for an improved river basin management framework for the Indus Basin and identifies the elements of a proposed National Water Policy for Pakistan.

The study is the collaborative effort of three water sector specialists: Mr Khalid Mohtadullah, Dr Pervaiz Amir and Ms Simi Kamal.

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Designed by Nadia Aine

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Abbreviations and Acronyms

ADB	Asian Development Bank
AJK	Azad Jammu and Kashmir
AKRSP	Aga Khan Rural Support Programme
AWBs	Area Water Boards
CAS	County Water Resources Assistance Strategy
CCI	Council of Common Interests
CEO	Chief Executive Officer
DRC	Domestic Resource Cost use
ECAFE	Economic Commission for Asia and Far East
EPA	Environmental Protection Agency
ERC	Emergency Relief Cell
EU	European Union
FAO	Food and Agriculture Organisation
FATA	Federal Administrated Tribal Area
FEWS	Flood Early Warning System
FFA	Framework for Action
FFC	Federal Flood Commission
FFD	Flood Forecasting Division
FOs	Farmer Organisations
GB	Gilgit-Baltistan
GCM's	Global Climate Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographical Information System
GLOF	Glacial Lake Outburst Flood
GM	Gross Margin
GOP	Government of Pakistan
GVP	Gross Variable Profit
GW	Giga Watt
GWP	Global Water Partnership
HDR	Human Development Report
HYV's	High Yield Variety seeds
IBWT	Indus Basin Water Treaty
ICOLD	International Commission on Large Dams
ICT	Islamabad Capital Territory
IFPRI	Institutional Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IPOE	International Panel of Experts
IRBM	Integrated River Basin Management
IRSA	Indus River System Authority
ISEA	Integrated Social and Environmental Assessment
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
IWT	Indus Waters Treaty
JC	Joint Committee
JICA	Japan International Cooperation Agency
KPK	Khyber Pakhtunkhwa
KRIL	Kinki Improvement Law
KW	Kilo Watt

LBCDP	Lake Biwa Comprehensive Development Project
LBOD	Left Bank Outfall Drain
LGs	Local Governments
LLBCD	Law for Lake Biwa Comprehensive Development
MAF	Million Acre Feet
MDB	Murray Darling Basin
MDBI	Murray Darling Basin Initiative
MDGs	Millennium Development Goals
MNAs	Members of National Assemblies
MoWP	Ministry of Water and Power
MPAs	Member of Provincial Assemblies
MTDF	Medium Term Development Framework
MW	Mega Watt
NDMA	National Drainage Mangemnet Authority
NDP	National Drainage Programme
NDRM	National Disaster Risk Management
NDWP	National Drinking Water Policy
NGO	Non Government Organisation
NMCs	National Mekong Committees
NECP	National Energy Conservation Policy
NSP	National Sanitation Policy
NWFP	North West Frontier Province
O&M	Operation and Maintenance
PADs	Provincial Agriculture Departments
PEPCO	Pakistan Electric Power Company
PARC	Pakistan Agriculture Research Council
PCR	Project Completion Report
PCWR	Parliamentary Committee on Water Resources
PEPA	Pakistan Environmental Protection Act
PIDA	Provincial Irrigation and Drainage Authority
PIDs	Provincial Irrigation Departments
PMD	Pakistan Meteorological Department
PIIB	Private Power and Infrastructure Board
PWP	Pakistan Water Partnership
RBMPs	River Basin Management Plans
RBOD	Right Bank Outfall Drainage
SUPARCO	Space and Upper Atmosphere Research Commission
SWMO	Sindh Water Management Ordinance
TDF	Tarbela Development Fund
TDS	Total Dissolved Solids
TVC	Total Variable Cost
UNHCR	United Nations High Commissioner for Refugees
VATs	Value Added Taxes
WAPDA	Water and Power Development Authority
WCAs	Water Course Associations
WCD	World Commission on Dams
WFD	Water Framework Directive
WUAs	Water User Associations
WWF	World Wide Fund for Nature
ZTBL	Zarai Taraqiati Bank Lintied

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Ms Meher Marker Noshirwani, a gender and environment specialist, who documented the in-depth discussions among the three authors of the report and IRBM framework. She provided facilitation for the stakeholder workshop, documented the workshop proceedings, prepared the workshop report, and assisted in finalization of the report.

Ms Sanaa Baxamoosa, assisted in review of research materials, analysis and report writing, formatting, consolidation of chapters with feedback, note taking of consultants meeting during the development of the IRBM framework.

Ms Kausar Hashmi of Raasta Development Consultants coordinated the project between WWF - Pakistan, the authors and team members. She also managed the logistics of the stakeholder workshop, and assisted in finalization of the report.

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Executive Summary

In collaboration with WWF – UK, WWF – Pakistan has worked on a project on Indus River Basin security. This being an advocacy based approach stresses on management that ensures environmental flows in the Indus River Basin. This led to an analysis of water management in Pakistan, which was urgently needed in the face of the prevailing water crisis in the country, for technical and policy implications. Hence the launch of 'Development of Integrated River Basin Management (IRBM) for the Indus Basin: Challenges and Opportunities'.

The study objectives were:

- Review of the present institutional and legal framework for water resources, allocation and management;
- Critical analysis of management of 2010 floods;
- Water economics and re-zoning of areas on basis of cropping patterns with special focus on irrigated eco zones of River Indus;
- Recommendations for an improved framework as an alternate National Water Policy.

More than 100 documents (reports, policies, papers, presentations, articles) were reviewed and about 50 websites searched in support of the study. The outputs of the study include the following:

- A. Main report entitled “Development of Integrated River Basin Management (IRBM) for Indus Basin: Challenges and Opportunities”. Frameworks incorporating stakeholder inputs in:
 - IRBM Framework for Indus Basin (chapter – 10)
 - Elements of Water Policy (chapter – 9)
 - Next Steps Forwards for WWF (chapter – 11)
- B. Policy Briefs:
 - IRBM for Indus River
 - Proposed Elements of a National Water Policy
 - Institutional Framework Analysis for Indus Basin
 - 2010 Floods and Lessons learnt
 - Water Scarcity and impacts on Cropping Patterns in the Indus Basin

Policy and Legal Framework for Water Resources Allocation and Management

This report reiterates that the Indus Basin irrigation system is vulnerable, that greater flexibility is required in the way water systems are envisaged and used and identifies building trust among water users and the institutions that control water as priority issues.

According to the Constitution of Pakistan, water is a provincial subject, but the Federal Government has to perform regulatory functions to ensure access and equity amongst the provinces. The Parliamentary Committee on Water Resources (PCWR) is the main parliamentary body of elected representatives that oversees all water-related affairs in Pakistan. The legal cover for carrying out regulatory functions is provided by the WAPDA Act (1958), IRSA Act (1992), and Environmental Protection Act (1997). The main legal frameworks for water resources management at the provincial level is provided by the Punjab Canal and Drainage Act (1873), the Sindh Irrigation Act (1879) and NWFP Canal and Drainage Act (1873).

The existing legal framework for water resources allocation and management lacks a consolidated policy on water that integrates both the development and management of this precious and scarce resource. To date, there has been no comprehensive water policy implemented that deals with water resources management in a holistic manner, cutting across federal and provincial boundaries and competing water uses in Pakistan.

Pakistan's National Water Policy is yet to be finalized, even though a comprehensive exercise was carried out in 2002 to develop water-related strategies. The National Drinking Water Policy and the National Sanitation Policy are still in the preliminary stages and it is too early to ascertain their effectiveness.

The signing of the Indus Water Apportionment Accord (1991) is upheld in Pakistan as a testament of political will. Under this Agreement, water allocation is made on the average annual basis of 117.35 MAF that includes 114.35 MAF of main flow and 3 MAF of ungauged canal flow.

The new realities of climate change, the energy crisis, global economic recession, extreme weather patterns, security issues, social dynamics and population growth dictate that Pakistan's current legislative and policy framework for water resources planning, development and management be revisited and reformulated.

In terms of policy and legislation, the study recommends the following:

- **Make benefit sharing the corner-stone of all future water resources development initiatives including the conservation and management of ecosystems and their services that people depend on;**
- For those treaties and accords that are 'sacrosanct' (including the Indus Waters Treaty and Water Accord), draft new additions/amendments/conditions within the existing ambit to bring in benefit sharing;
- Bring in equity and fair distribution in the context of benefit sharing;
- Insist on equitable distribution within provinces (i.e. work on the basis of a balance of benefits to head, middle and tail farmers) rather than between provinces;
- Incorporate integrated approaches at Basin level for irrigated, rain-fed and arid areas;
- Use modern tools of verification including GIS and remote sensing for greater transparency.

Policy Recommendations for Water Sharing in Provinces

- Storages at different levels;
- Modes of sharing water shortages among provinces when they occur;
- Modes of sharing flood water;
- Modes of generating environmental flows;
- The issue of new canals and the repair of the degenerating infrastructure;
- Countering the siltation of dams and improved watershed management;
- Strengthening the barrages;
- Increasing the productivity of water use in agriculture;
- Tackling low productivity including groundwater in the water resources of each province and/or River Basin.

Water Management Institutions

Water resources management in Pakistan is divided into two tiers: Federal and Provincial. Several major institutions are involved in water resources management at both these levels. In general, the institutional framework for water management in Pakistan is mainly geared towards implementation of the Water Accord of 1991.

It was found that increasing non-merit based appointments, lack of budgets, an absence of clear definition of roles, responsibilities and targets, lack of coordination and communication between federal, provincial and local administrative departments, mistrust of government and lack of commitment hamper the effectiveness of water management systems and institutions. While there is a fair system of monitoring and compliance, water theft and unauthorized withdrawals are also quite common at the canal level and below.

In terms of the Sindh-Punjab debate, it can be concluded that not everyone in Punjab has excess, or even adequate, water nor is everyone in Sindh deprived of water. Both provinces face the same constraints in terms of equitable distribution among users. Integrated water resources management approaches, with their three Es of economic efficiency, environmental sustainability, and equity, may provide a useful framework to reorient water demand and improve water management; there are options for increasing water supply from within the system without investing huge amounts in new infrastructure. One such option would be to repair and upgrade the canal system where feasible, while allowing water to seep from canals in areas where ground water

needs to be critically recharged. Additionally, there is tremendous scope to increase water productivity by investing in agriculture.

Currently, there is no single organization responsible for the integrity of water resources in the Indus River Basin. It is recommended that Pakistan must move from a business-as-usual scenario to benefit sharing mechanisms between provinces so that the needs and priorities of all provinces are met by the new water management legislative and institutional frameworks.

It is commended that instead of establishing more institutions, the existing ones be rationalized, as indicated in the earlier part of this brief. In terms of the Sindh-Punjab debate there are options for increasing water supply from within the system without investing huge amounts in new infrastructure. One such option would be repairing and priming the canal system where feasible and using other methods for improved water management, as per the soil and rock conditions and cropping patterns.

It is recommended that the water discourse be redefined in terms of head, middle, and tail farmlands in irrigated areas and in terms of other ways of water resources management in non-irrigated rain-fed and arid areas.

Proposed Irrigation and Agricultural Reforms

- Socioeconomic homogeneity among farmers (i.e. all hold land titles rather than some owning land while others are landless and caught in a system of sharecropping);
- Incentives are in place for better managing service delivery and quality;
- Farmers pay for water based on satisfactory service delivery (i.e. service providers are made accountable);
- Irrigation schemes and programs specifically designed to benefit the poor by putting in specific conditions for investments, repairs, and rehabilitation of water infrastructure.

Managing the Indus Basin System and Its Infrastructure

Catchment areas within the Indus Basin System are rather haphazardly managed. Silting of Tarbela and Mangla dams and mitigating such siltation to prolong the life of these dams is an overriding concern of catchment management. Pakistan has implemented extensive watershed projects above the Tarbela Dam and Mangla Dam to reduce the sedimentation load in its river system.

Catchment management can directly contribute to salt load management in the Indus Basin. Addressing the salt balance problem can help improve groundwater quality and also impact agriculture productivity particularly in the Sindh province where river flows have become highly variable, possibly due to the impact of climate change, as evident in the 2010 and 2011 floods.

Pakistan's agriculture is dependent on both surface (canal) and groundwater. In recent decades irrigated agriculture in the Indus Basin has moved towards conjunctive use of surface and groundwater. The Indus Basin has fresh groundwater potential of about 55 MAF as groundwater with varying levels of recharge depending on canal operation and rainfall, which is mostly in Punjab.

Almost 50 MAF of water is abstracted from aquifers in both irrigated and *barani* areas. The Indus River system provides a variable flow but recharges groundwater. Outside the Indus Basin the problem is more acute. In Balochistan the critical hard rock deep water aquifers are already being tapped. Due to this over-exploitation of groundwater, the province has been in a water crisis situation for many years.

In Punjab the Vehari area and in districts along the Sutlej many farmers are abandoning agriculture, and land prices are declining because groundwater pumping and drilling costs are becoming prohibitive.

At present, Pakistan has over 68 listed small dams with an average capacity to irrigate 6800 acres. It also has extensive potential for construction of small dams on its tributaries that feed into the Indus Basin system. More recently small dams have received renewed interest with the government announcing over 50 small dam projects.

Needless to say, that any dam construction should adhere to international guidelines and ensure that social and environmental costs are calculated and reflected in the project appraisal documents. Special care should be taken to address environmental concerns at the Environmental Impact Assessment (EIA's) stage which should be broad based with extensive stakeholder consultation.

Stream flow to propel turbines to produce electricity has long been utilized to provide power to far flung areas. Pakistan has not fully exploited this potential.

The hydro potential of Pakistan is estimated to be about 41 GW, out of which 1,290 MW can be generated by micro-hydro systems. According to the Alternate Energy Board (AEB), the maximum potential of micro hydel is in the Gilgit-Baltistan region.

Besides formal barrages there are other wetlands that can be supported by creating artificial and temporary wetland sites. These water bodies serve temporary structures that can absorb flood waters for temporary storage and are often developed on unproductive and waste lands near river systems e.g. Lillah area off the motorway on the River Jhelum.

Given the protracted debate on Kalabagh dam and the entrenched positions of Sindh and Punjab, the real contribution of dams to Pakistan and their potential had become lost in too much rhetoric and politics. It is time to think of these dams as assets of Pakistan to bring greater propensity.

The financial dynamics of Tarbela highlight the untapped potential of the linkage between the public and private sectors in the context of water resources development in Pakistan. There is no tangible relationship between public and private entities in the water sector. Pakistan has the world's largest contiguous irrigation infrastructure but we do not leverage our investment in water, that has huge potential as collateral to raise funding for new projects.

Suggestions for Indus Basin System Management

- Regulation and licensing, for extracting groundwater;
- Inventory of groundwater resources and changes over time;
- Promoting solar operated pumps where feasible, that have initial large investments but the marginal cost of pumping more water is much less;
- Measures that provide incentive for water conservation and support alternate technologies that reduce the crop water requirements;
- Policing of irregularities and action on emergency basis to avert a crisis in Balochistan due to excessive over draft of groundwater;
- Developing groundwater storage as an alternative to surface storage;
- If the cost of pumping water can be reviewed in the light of *abiana* the two sources surface water and ground water can be balanced close to the true cost (pumping) and value of water (opportunity in next best use).
- Proper steps to address the issues of water quality;
- Development of smaller sustainable projects that take into account environment concerns and are cognizant of upper lower riparian issues;
- Greater attention to more micro investments in village ponding structures, micro hydel projects, small dams, water harvesting for enhancing water security;
- Exploiting Pakistan's vast small dam potential with greater attention to safe design and social engineering of the benefits of these schemes;
- Revive the traditional *karez* system in Balochistan;
- Focus on developing technology and equipment to dredge the silt out of check dams to increase their life.
- Pakistan has to increase water storage capacity for inter seasonal transfer of water. This is absolutely fundamental;
- Need to focus more on water savings in agriculture that is the largest user of water.

Environmental Flows for Sustainable Development

WWF's stance on environmental flows is reflected in its approach based on sound science that explicitly recognizes the tradeoffs between benefits provided by water infrastructure and detrimental effects on biodiversity, ecosystems services and riparian livelihoods. WWF advocates for integration of environmental water needs into national laws, policies and plans while allowing equitable water allocation.

Environmental flows refer to the amount of water needed in a watercourse to maintain healthy ecosystems and directly improve livelihoods and human welfare just as agriculture, industry, hydropower and domestic users all place demands on water resources, so does nature. At the time of signing the Indus Waters Treaty (1960) the concept of minimum environment flows or climate change impacts on water resources were not part of the discussions and therefore, not addressed this issue causes conflict in the water sector.

Sensitivity on environmental issues is exceptionally high in Sindh. The province as the lower riparian has always brought in the issues of Indus delta, lakes and riverine water uses into the dialogue. The interaction between local communities and natural water bodies have been stronger in Sindh because of unusable groundwater, high aridity and dependence of communities on the aquatic and ecological goods (fish, forest, other vegetation). Sindh's insistence on water needs down stream of Kotri has been finally successful in carrying out three environmental studies.

The complete reports of these studies are still not available in the public domain, while, the government has made public recommendations from a panel of experts as under:

- 5000 cusecs constant discharge is recommended downstream Kotri barrage in the River Indus to meet all water needs of the downstream delta;
- Below Kotri, releases will equitably share shortages of the system; these releases will be dealt like diversions to an irrigation canal. 5 MAF average flood flows should go over 5 years, i.e. 25 MAF water should go down over a period of 25 years.

The following conclusions can be drawn:

- Climate change is putting additional stress on ensuring environmental flows as greater demands are placed on water in other sectors. This situation is likely to become worse in the coming years and requires careful consideration from policy makers;
- There are spin-offs from ensured environmental flows in any live and dead river system. Whereas, some of the water recharges underground resources, water that flows through riverine belts benefits the local and bed agriculture often free of cost. Rationalizing this externality and putting a value on it for recovery from those benefitting needs should be further analyzed;
- Flora and fauna will be under further stress as temperatures rise and the rate of extinction of species are likely to increase, creating ecological imbalance with widespread social, economic and biophysical implications;
- Engaging policy makers in constructive dialogue on the importance of minimum environmental flows is no single province's domain. It should receive central place in any water policy and the costs and benefits of supporting environmental flows as a policy should be highlighted through the media for public awareness;
- Environmental flows can only be guaranteed during a lean period if there is a regulatory mechanism of storage upstream. Likewise emergency releases during drought periods will need analysis through advanced hydrology models taking advantage of current GIS and remote sensing technology to determine needs and impacts of critical reaches.

Given that IBRM calls for integration, an approach that balances development with conservation, this would be a good framework for the Indus Basin. In this context there is a need to revisit the current divide where government is seen to develop infrastructure and NGOs seen to favor conservation. This will require long-term work on developing a continuum of linked approaches, policies and interventions that will bring together infrastructure development and conservation, water use and environmental flows into a single integrated framework.

Management of 2010 Floods

In July 2010, Pakistan faced unprecedented floods affecting the entire country. According to estimates, over 20 million people were affected, nearly 2000 lives were lost, and more than 4.6 million people were left shelterless. Devastation spread to nearly 100,000 km², over 2.2 million hectares of crops were destroyed and approximately 450,000 livestock was lost. Further, the Flood Inquiry Commission Report appointed by the Supreme Court of Pakistan states that the gross loss from the 2010 floods amounted to 5.8 % of the Gross Domestic Product.

There is no particular policy specifically dealing with flood management. Instead, a number of provincial and federal Acts drive the flood policy in the country, namely: Punjab Irrigation Act 1873, Sindh Irrigation Act 1879, NWFP Act 1873, Balochistan Ordinance 1980, Punjab Soil Reclamation Act 1952, Water Users Association Ordinances 1981, Provincial Irrigation and Drainage Authority (PIDA) Acts 1997, WAPDA Act 1958, Indus River System Authority (IRSA) Act 1992 and Environment Protection Act 1997.

In the case of Pakistan's floods of 2010 it was seen that the mismanagement of dikes and lack of investment in flood protection exacerbated the damage. Even though Pakistan has had experiences with floods in 1954, 1973 and 1975, there appeared to be complete chaos in the response mechanism to these floods during the early stages. However, as flooding progressed the administrative units established temporary relief centers.

Downstream impacts were devastating even though downstream areas had 22 days of warning. In spite of this there was no systematic mobilization of the water management institutions to issue warnings and spread awareness amongst downstream communities to mitigate the amount of destruction caused.

The FFC played a passive role and was rather dormant. A review of its recent work has shown that this institution undertakes technical assistance assignments often unrelated to floods. With the induction of the National Disaster Relief Management the institution's role on flood management has become further diluted. The National Disaster Management Authority (NDMA) was much more active in terms of providing flood management and flood relief. The Pakistan Meteorological Department (while earlier predicting the 2010 monsoon to be normal) stepped into action once the event had started to unfold.

Above all, the absence of local government was acutely felt. The removal or abeyance of local government institutions meant that there was a vacuum in terms of local leadership and a chain of command that could have acted for warning and actions in a systematic manner.

The politics of floods management is not yet documented in any systematic way, and is largely anecdotal. Given the propensity of corruption and political discrepancies the floods provided another instance where pressure was applied on government employees and those struggling to deal with the problems, to act in ways that would reduce the damage of the politically connected, even if that meant exposing larger population to the effects of floods.

Perhaps the greatest indicator of eroding governance and transparency came in the form of foreign donor pledges. It is reported that Pakistan received less than 20 percent what was pledged and the population in general refrained from giving donations to the Prime Minister's Flood Relief fund due to a lack of trust on how the money would be spent, transparency and accountability.

Weaknesses in the irrigation infrastructure that enhanced flood damages include the following:

- Deferred maintenance of flood embankments;
- Insufficient reservoir/storage capacity to absorb flood peaks;
- Lack of response mechanisms to early warnings;
- Need to expand flood early warning system (FEWS);
- **Encroachment of the flood plains and riverine areas.**

The breaches in flood protection embankments along the Indus River caused the main damage, and none occurred due to overtopping. There is no comprehensive inspection protocol for critically reviewing important major river training works and embankments. The ageing infrastructure and deferred maintenance are also aspects that need immediate attention:

- The absorptive capacity of catchments is too low to prolong run-off concentration time;
- There are no additional reservoirs to absorb flood peaks;
- The discharge capacity of the existing barrages and river training works is too low to handle floods of this magnitude.

Government should take cognizance of possible ecological solutions such as dedicated areas for wetlands in the event of floods, inter-lake and inter-canal links to move surplus water to drylands e.g. Thal canal, Cholistan canal that would result in utilization of the excess water as opposed to wasting it into the sea in the absence of large scale storages. Furthermore, the impact of unprecedented torrential rains during the monsoon as witnessed in August-September of 2011 need to be incorporated in future analysis.

The Government of Sindh may consider the following recommendations:

- Immediate repairs and rehabilitation of embankments/bunds in all the affected districts;
- Immediate and concrete steps to strengthen all the flood protection embankments/bunds, on both the banks of the river;
- Removal of all privately raised bunds and illegal structures in natural course of the river, that obstruct free flow of water;
- Removal of encroachments from inside the bund walls on both the sides of the river to allow more quantity of water to flow, reducing the pressure on the old structure of barrages;
- Removal of illegal deltas that have been allowed to be built up through siltation;
- Dredging of river and canals on a regular basis;
- Flushing of drains on a regular basis in the command areas of all the three barrages;
- Feeding of lakes on a regular basis every year making them standby escape routes and/or reservoir with appropriate outlets;
- Repairs, maintenance and rehabilitation of all irrigation infrastructures by fixing achievable targets for physical works;
- Reduction of pressure on all the barrages through construction of escapes/spill ways.

Water Economics and Agro-Ecological Zoning of Indus Basin

Postulated changes in water availability in line with Global Climate Models (GCM's) suggest that Pakistan will face severe water shortages due to extended glacier melt, global warming, mismanagement of water and lack of water storage facilities that could help it to regulate water from high flow periods (summer-monsoon months) to low flow periods (*rabi*-winter months). Volatile price fluctuations in the international market also require that crop area allocations take macro and micro realities into consideration while giving guidelines for preferred cropping patterns. Aberrations in water availability are already showing up as predicted by IPCC (2007) that initially there will be widespread floods due to intense but short bouts of monsoon rains as seen in 2010 and 2011 floods.

The report provides extensive analysis of cropping intensities in all provinces and areas falling in the IRBS. Likewise, the performance of dominant cropping rotations e.g. rice-wheat, cotton-wheat and sugarcane-wheat are described in considerable detail providing a cost of production analysis for dominant crops. The analysis reveals that while the system rigidity follows the dominant cropping patterns there is ample opportunity to incorporate new crops like maize, oilseeds, fruits, vegetables, condiments.

Emerging Potential of Maize and other High Value Crops

Maize is the only crop showing significant dynamics and expansion. This is logical and two maize crops can be incorporated into the system annually. Maize has over 50 by products besides grain and valuable residues that serve as animal feed. The US has perhaps the largest collection of germ plasm and research on crops has been on maize. Pakistan could benefit from this research and hybrid technology thereby dramatically reducing the chronic malnutrition and feed resource deficiency. Genetically modified seeds triple yields in Pakistan.

Pakistan has a weak research base in maize but foreign multinationals like Monsanto and Cargil are doing substantial business in the seed sector. Rapid advances in productivity can be made at a relatively low cost by paying attention to this rather neglected crop. In addition to maize there are other crops especially oil seeds, pulses, condiments, fruits & summer vegetables, dates that can be planted separately or intercropped to raise the productivity of the farm system and other high value enterprises to enhance overall crop productivity.

Macro Performance and Cropping Pattern Adjustments

Pakistan is a major exporter of rice, cotton and fruits. It has widespread potential to enhance its exports particularly for high value products. Its fisheries sector has grown tremendously but still there remains great potential to increase productivity of inland fisheries and integrate this into fish-crop-livestock farming systems as has been successfully done in Far Eastern countries (China, Philippines, Indonesia, and Thailand). Likewise emphasis on high value enterprises in the areas of fruits, vegetables, and medicinal plants are seldom part of intensive cropping patterns but tend to take a peripheral place in the farming systems due to lack of knowledge and markets. Those venturing into these areas are rewarded provided the production, and processing systems are based on international standards and can compete in the international markets. Besides these formal exports, there is considerable cross border movement of livestock, wheat and other products to Afghanistan, Middle East and Central Asia that moves through informal sources. Similarly, fish products from coastal areas enter lucrative markets under “ghost businesses” depriving government of valuable revenue but fetching profit for those participating in such trade in connivance with international syndicates. In particular, Pakistan is facing severe stress with livestock exports that are taking a heavy toll on domestic livestock prices for beef and mutton.

Tea and edible oil are imports of volume that burden Pakistan's exchequer. Despite repeatedly demonstrated potential of oil seeds like (sunflower, safflower, palm-oil etc.) Pakistan has made negligible gains in introducing these crops into its cropping patterns. The main reasons are lack of markets, processing facilities and price support from the government. Edible oil crops are the most likely entrants into cropping patterns provided these constraints can be improved. Likewise changing the technology (e.g. integrated pest management) can reduce reliance on imports of pesticides that enter visibly into the imports bill. In the case of sugar Pakistan should look carefully at the comparative advantage of this crop as it increases the burden on water resources. If, imports are much cheaper it is better for the economy and population's welfare to import lower priced sugar (Brazil, Cuba) and utilize the water realized for higher value products like fruits, vegetables, condiments, organic farming etc.

Virtual Water

Modern water allocation correlates strongly with the amount of water it takes to produce a given unit of an agriculture output. Internationally, now countries view their outputs in terms of total water that went as an input. So what you export or import is enumerated in terms of water transfers as opposed to value of the import or export only. Unfortunately, such thinking has not entered the Pakistani policy domain or sensitivity to such accounting methods brought into a business model or promoted amongst entrepreneurs. As water becomes scarce a prime decision to produce will relate to how much output can be produced for a given amount of water. This rationale is valid since water gets allocated to the produce that will yield a highest return per unit of water. Moreover, when products are traded or moved within a country, and between districts, provinces or regions, besides arguing on the basis of value of produce, producing districts or provinces can state that this produce has consumed a certain amount of water so, a specific proportion of MAF of water can be implicitly imputed into the value of the tons of grain, or livestock. Climate change is likely to affect the crop enterprise sector. Present cropping patterns and intensities will face water challenges that will force some substitution and adjustment in rotations even though the system has shown remarkable rigidity and stability over centuries. Venturing into Corporate Farming and opening up the sector to foreign investment should take cognizance that investors are not interested in Pakistan's land but its fresh water resources. When true value of water is built into the analysis the so called attractive proposals become much less attractive and warrant careful consideration keeping the country's interest as supreme.

Implications of Cropping Patterns and Water Economics

Within the Indus Basin there is dynamics in use of inputs, choice crop varieties, timing of sowing and harvesting but yields have stagnated over the past decade, and growth rates show wide variance from 2-7 percent which is likely to be further widened as water and energy crisis is aggravated.

Cropping intensities in Punjab, KPK, and Balochistan are high and Sindh tends to display lowest cropping intensities (partly due to mismanaged water and growing high delta crops in abundance e.g. sugarcane). Wheat-rice, wheat-cotton, and sugarcane-fodder are dominant crop rotations in the Indus Basin. The support price for some of the major crops partially determines the rotation farmers are likely to follow. Although in recent years with support prices announced primarily for wheat, and other governments

para-statal like (rice export corporation) taking a back seat farmers have relied more heavily on marketing mechanism which have often been exploited. Thus farmers face hard choices in continuing with certain crops especially in zones where other more traditional or new crops remain untested on a large scale. Lack of marketing infrastructure the other crops like maize, *jowar*, pulses, oilseeds, etc. discourages their widespread commercial production.

Water in Pakistan is becoming scarce. While almost 90 percent water is utilized in agriculture, the cost of pumping water with rising diesel and electricity prices and persistent load-shedding is increasing the cost of water. Whereas, *abiana* rates (water charges) for canal water are dismally low (Rs. 200-400/annum) those with access to a canal have a clear production advantage. Cropping patterns will continue with rigidity as long as water is highly subsidized and high delta crops will remain attractive. However, when true water costs are factored in dynamics in cropping patterns is a highly probable outcome.

In the absence of storage and capacity to regulate there can be no option for water on demand. Thus, water pricing without water on demand is an unrealistic concept. For markets to work water has to be available when, where, in whatever quantities demanded and free from interruptions.

The study found yields to be in the range of countries at similar stages of development but rather stagnant over the last decade. There is marked difference between Pakistan's field crop yields and those obtained at the international level. Likewise a major difference was noted between yields of a progressive farmer and an average farmer pointing to the marked potential to improve yields within local circumstances by better system management.

Food security is a valid concern for Pakistan and it will continue to produce wheat in most of its cropping systems where water is available or even where not available (*barani* areas). However, by bridging yield gaps considerable areas can be released from *rabi* wheat production and put to higher value enterprises orchards, oilseeds, maize etc.

Pakistan needs to rationalize its crop water use based on crop physiology. Scientific advance in metrology and GIS can help guide where and when water is needed the most.

It seems that such information is not available to farmers despite the availability of technology to the meteorological and research departments e.g. SUPARCO. Even input fertilizer, and pesticide use could be tied to observations validated through GIS and remote sensing.

The high import bill of oilseeds and tea in Pakistan is largely due to a strong political economy that wishes to maintain status quo. Indus Basin can easily be geared to relieve this heavy burden on the national exchequer by substituting crops in the relevant agro ecological zones in favor of oilseeds (both winter and summer) and by taking out low value maize and planting tea in Manshera, Abbottabad and other upper reaches of the Indus in northern areas along the Indus.

Evaluation of water resources within changing climate circumstances was found deficient. The missing link between crop systems modeling and water resources at macro and micro level undermines innovation in cropping patterns that can lead to a major turnaround in the Indus Basin System.

For long term sustainable development for Pakistan, economic surpluses in the agricultural sector must be created. There is water, a hard working farmer, but no science and no management. We have to put the best minds into agriculture and ensure that maximum returns are realized for each and every acre water is utilized. There are ample opportunities for substituting high delta crops with crops that require less water and divert this water into more intensification and introduction of high value crops and enterprises like vegetables, flowers, fruit and livestock.

Actions Required for Integrated Approaches for the Indus Basin

- Given that Pakistan is an agricultural country, thinking in terms of agro-ecological zones (rather than eco-zones) is more appropriate for the Indus Basin;
- Carry out modeling and analytical studies at agro-ecological zone level to understand productivity, substitution potential, constraints and opportunities;
- Advocate potential of maize to transform agricultural economy;
- Advocate crop-livestock integrated agriculture that makes best use of land-water-labor-technology and market opportunities;
- Advocate processing, transportation, refrigeration, marketing and allied functions of the agribusiness sector for handling high value products;
- Establish an effective Prices Commission or institution at Federal and Provincial levels which generate and share data on production, farm systems, cropping patterns etc;
- Use emerging technology tools in media, telephony, and the internet to provide daily information to farmers to make decisions on what to plant, when and how, and in what quantities to produce and where to market the crops.

Best Practices in Integrated River Basin Management (IRBM)

IRBM provides a set of guiding principles for water managers, and there is a need to translate those principles to practical improvements in water management that help deliver tangible outcomes. There are several successful examples of IRBM approaches around the world that highlight some or many of these elements even if the term IRBM is not used. A study of Murray-Darling Basin Initiative, Mekong River Basin, Lake Biwa, Yodo River Basin and Water Framework Directive, European Union has yielded conclusions and lessons that would be very useful in Pakistan.

Key Aspects of IRBM Crucial to a Successful IRBM Approach

- Political will on the part of the federal and provincial government is crucial. The relevant government authorities need to commit themselves to IRBM philosophies in a clear, transparent and tangible manner;
- IRBM practices rely on local knowledge as a foundation for sustainable water management and consumption practices. Local knowledge should be encouraged and applied within the process of IWRM and combined with new knowledge for the sustainable development of the river Basin in question;
- Community involvement is the foundation for all management practices of natural resources;
- Effective partnership of all stakeholders is the single most important aspect of a successful IRBM initiative; Active dialogue between stakeholders with confidence and willingness to cooperate with one another is a crucial element of IRBM;
- Effective partnership is based on the following criteria:
 - A common vision for the River Basin and its long term development shared and agreed to by all stakeholders;
 - IWRM agreed to and adopted as the approach for water resources management by all stakeholders;
 - Commitments of all stakeholders including participation and provision of inputs and decision-making;
 - Agreed modality for building a strong participatory approach for decision making;
 - Basin development goals should include healthy river Basin, improved water security, economic development, livelihoods and welfare of communities.
- Shared benefits should be the cornerstone of the approach;
- Good governance and effective water systems take time and patience;
- There needs to be a limit to what can be withdrawn from river systems, so that environmental flows can be maintained and rivers remain healthy;
- Participation from within 'the system' (academic, research and political groups) and from outside (citizens'

movements, protests and litigation) make a crucial contribution to achieving a balance between the various uses of water and the needs of the resource itself. The rights and entitlements of all populations relying on or benefiting from a water source have to be addressed and protected with equal interest and vigour, if not with equal and similar measures.

Elements of Water Policy

Given that such a water policy is still not in place in Pakistan, the proposed elements of a National Water Policy for Pakistan are succinctly stated below:

1. Climate Change and Water Adaptation

All water and development projects approved for funding are carefully screened for their resilience to climate change and appropriate measures are included to enable both mitigation and adaptation perspectives as appropriate.

2. Environmental Flows

This policy should ensure a regular, controlled environmental flow each year, to be guaranteed through strict regulation and implementation and a GIS based monitoring system.

3. Groundwater, Quality and Salt Balance

Regulation of groundwater should receive high priority and practical steps that are environmentally sound, socially acceptable and which can be legally enforced and economically feasible will be put in place to rapidly reduce over exploitation of groundwater resources.

Monitoring of water quality should be carried out for both surface and groundwater. Environmentally sound emergency measures should be designed and undertaken to ensure that large and small urban centers facing acute underground water shortages are checked and populations are protected from acute water shortages forecasted in the long run.

Measures should be taken to achieve salt balance in the Indus Basin through a phased programme to introduce appropriate conservation methods (which may be different for different areas), improve water quality, improve drainage and monitor and manage salt balance. Gains already made by addressing water logging and salinity contribute directly to improving the environment and conserving water and land resources, and should be continued.

4. Conservation of Water

Steps should be taken at all levels through widespread media campaigns by encouraging public private sector partnerships to raise awareness about conserving water at all levels and places through appropriate incentives and penalties by influencing demand and supply of water on a need basis.

5. Integrated Flood Control and Drought Management

Flood and drought management should be a high priority, with a national body coordinating assessments, responses and planning. An Integrated Flood and Drought Control Management system at appropriate levels, that includes clear actions and steps for mitigating the effects of these events on water and land resources, should also be considered.

6. Inter-Seasonal Transfer Facility to Regulate Flows

Create and expand water storage facilities at all levels from local ponds to multi-purpose dams and embark on a sustained path of building a cascade of infrastructure on its Indus River Basin system to meet its irrigation and power needs and also to mitigate the negative impacts of floods and droughts. However these must be undertaken after extensive environmental assessment to mitigate the impact on biodiversity and the environment.

The tradeoffs between the benefits provided by dams water and their detrimental effects on biodiversity, ecosystem services, and riparian livelihoods should be assessed. A comprehensive assessment of institutions, and their capacities should be undertaken to

reorient all institutions to participate in addressing Pakistan's water infrastructure and water conservation needs with clear recognition of sharing both productive and environmental benefits with upper and lower riparian in a fair and just manner.

7. Drinking Water and Sanitation Needs

The access to clean and sufficient drinking water is recognized as a human right that will be ensured through investments focusing on both urban and rural areas to remove disparities in price and availability.

8. Irrigation water

Irrigation water efficiency is enhanced by improving delivery systems, establishing benchmarks for minimum crop water requirements, promoting efficient irrigation practices (bed and furrows, trench plantation, land-leveling, etc) and adopting new conservation technologies (e.g. rainwater harvesting, drip irrigation etc.) that help save water.

9. Water Zoning

The existing cropping pattern reviewed. Zoning land according to water productivity and water conservation potential should be undertaken at macro and micro level through widespread technical, environmental, social and economic consultations with relevant stakeholders. This way a framework can be developed that will identify the yield gaps to be bridged in each zone, to ensure that optimal annual productivity of the systems bring marked improvements in the farming sector, while also conserving the basis of these improved yields.

10. Institutional and Legislative Framework

Institutional and legislative framework for water management revisited to rationalize roles of all stakeholders and improve laws.

A comprehensive set of water laws will be developed that are relevant to Pakistan's circumstances and define rights, uses, value, principles of pricing, subsidies, licenses, polluter penalties and incentives.

11. Water Rates

Water rates evaluated in line with economic and social realities to bring it close to the “true” value of water. All explicit and implicit subsidies on water to be recognized and rationalized with sufficient attention to service delivery and accountability.

12. Water and Energy Nexus

Development and conservation of water and power resources on rivers, canals, on channel and off channel will be ensured in an integrated manner.

13. Participation of Farmers

A paradigm shift is recognized as fundamental in the irrigation and agricultural production process. This change in perspective will be encouraged across the board by developing suitable linkages between agriculture and irrigation at all levels and support systems. It needs to take place in such a manner that ensures engaging farmers in the decision making process of water use at all levels but more so at the farm level.

14. Research, Science and Technology

Linkages should be developed between research and practice. Research universities and facilities must engage effectively with water users, and farmers. Research institutions need to be linked to actual applications in the field. Funding and support for linking research with practice should be encouraged, covering water and land resources, their use and conservation.

Research efforts should focus on emerging needs and will include but not be limited to following areas:

- Telemetry and hydrometeorology;
- Assessment of water resources and measurements;
- High altitude glacier, snow and ice hydrology;
- Groundwater hydrology and recharge;
- Management of waterlogging and salinity;
- Water – harvesting;
- Multiple cropping systems under water scarcity regimes;

- Sedimentation of reservoirs and the safety of water related structures;
- Soil and materials research;
- Recycling and re-use;
- Use of sea/marine water resources;
- Social and economic engineering aspects;
- Capturing advances in allocative and technical efficiency in water;
- Utilization of indigenous water knowledge and systems.

Other areas may emerge according to threats, opportunities, basin-wide changes, local needs and conservation requirements.

15. Institutional Strengthening and Capacity Building

Gaps and weaknesses should be addressed through appropriate long-term and short-term training and capacity building programmes.

16. Comprehensive Water Law

Pakistan should put into place a comprehensive set of water laws that define water rights, uses, value, conservation and principles of pricing, subsidies, licenses and polluter penalties.

IRBM Framework for Indus Basin

First, it is important to understand and incorporate the policy determinants that would drive the IRBM approach. In the case of Pakistan, these would be climate change impending emergencies, population and poverty, energy crisis, the financial crunch and the security situation in the country. Basin development then, would place equal emphasis on healthy and alive rivers, ecological conservation and improved water security, as well as economic development, livelihoods, creation of assets and quality of life. A theoretical basis of IRBM with particular reference to IRBM possibilities for Pakistan is presented below.

1. Manage Water Flow within Basin

- Manage both rural and urban water flows within Basins, and subdivide the Basin into smaller units in pragmatic ways;
- Any flood management plans in a Basin should include drought management, and take measures to maximize the positive aspects of floods such as retaining part of flood flows for use in crop production;
- Develop linkages among relevant institutions.

2. Integrate Land and Water Management

- Land-use planning and water management should be combined and synthesized to enable the sharing of information between land-use planning and water management authorities;
- Flood management needs to recognize, understand and account for linkages between upstream and downstream in order to realize synergies in improving river basin performance.

3. Manage Risk and Uncertainty

- Water-related risks are related to hydrological uncertainties that are subordinate to social, economic and political uncertainties: the biggest and most unpredictable changes are expected to result from population growth and economic activity;
- Management of flood and drought risks consists of systematic actions in a cycle of preparedness, response and recovery, and should form a part of IRBM;
- Risk management calls for identification, assessment, and minimization of risk, or elimination of unacceptable risks through appropriate policies and practices.

4. Adopt a Mix of Strategies

- IRBM strategies must not propose single solutions – different parts of the Basin warrant different approaches. Agro-ecological or hydrology-based strategies are more likely to succeed;
- While the Basin must be approached holistically, the strategies need to be grounded in reality – comparison of the available options and selecting a strategy or a combination of strategies that is most appropriate to a particular situation are required;

Both long-term and short-term interventions need to be designed.

5. Ensure a Participatory Approach

- IRBM should encourage the participation of users, planners and policy-makers at all levels and should be open, transparent, inclusive and communicative; this requires the decentralization of decision-making, and includes public consultation and the involvement of stakeholders in planning and implementation;
- IRBM must keep gender perspectives in mind and should include all marginalized groups of people
- It is important to make use of the strengths of both a "bottom-up" approach and "top-down" approach in determining the appropriate mix;
- River Basin committees or organizations, at Basin or sub-basin levels, can provide appropriate forums for such coordination and cooperation across functional and administrative boundaries.

Policy Determinants

Based on the analysis of this study five main policy determinants have emerged for Pakistan.

1. Climate Change Crisis

Climate change has a direct impact on the hydrological cycle and it appears to be having serious consequences on surface and groundwater resources in the Indus Basin. With rising population water uses are projected to shift dramatically, including water requirements for crops, livestock and municipal uses.

2. Financial Crisis

Pakistan is facing severe financial stress which is likely to continue and progressively reduce its ability to undertake vital investments in the water sector. The international financial crisis has meant reductions in development assistance flows. With rising inflation, agriculture is facing a difficult time. Negative impacts on agricultural productivity are likely.

3. Energy Crisis

The demand for energy in the future is likely to rise steeply. Present peak load demand deficit exceeds 5000 MW and is undermining economic growth. While hydropower is the cheapest source of power in the country its development has been stunted while alternative sources like solar, wind, thermal and biogas are in an infancy stage. Pakistan relies heavily on oil and gas which is linked to a circular debt. Pakistan, therefore, needs investments upto almost US \$ 50 billion to partially realize its hydropower potential of 60,000 MW in the next two decades.

4. Security Outlook

The last decade has seen deteriorating security in the country due to terrorism, extremism and the War on Terror. Rural to urban migration is likely to result in culmination of large mega cities that would require further investments in water infrastructure.

5. The Crisis of Population Growth and Poverty

Pakistan's population is predicted to be 265 million by the year 2030 (Planning Commission of Pakistan, 2010). Economic growth rates in Pakistan are tied to the performance of the agriculture sector, where land ownership and access to land, water and environmental resources directly impact equity, distribution of wealth and welfare. Water is the most crucial input here and its management means direct impact on economic growth and stabilization of growth rates.

Larger national objectives that IRBM of Indus Basin would address

In addition to the policy determinants it must be understood that an appropriate IRBM initiative for the Indus basin must respond to larger national objectives relating to a balance between water conservation and water resources development:

- Creation of wealth and well being through generation of economic surpluses from land and water resources;
- Distribution of wealth and well being in equitable manner;
- Correction of historical 'kinks' in land ownership, water rights and entitlements keeping in view water quality and availability;
- Rationalizing the historical resource allocation of water and revisiting the basis of the allocation;
- [Protection and securing of the water resources of the Indus Basin;](#)

[Protection of environmental rights, access to water and ecological zones.](#)

The analysis of Indus Waters Treaty 1961, Water Accord 1991, IRSA document, PIDA documents, Water Vision 2025, draft Water Policy and Pakistan CAS 2005, Benefit Sharing in Hydropower 2011 have shown that water reforms for IRBM of Indus Basin imply change in policy, governance, institutions, laws, regulations and processes in the way water is used, shared, conserved and valued.

While there are laws to govern water distribution, Pakistan needs the following measures to strengthen the Indus River Basin System:

- Shift from management of water supply to management of water demand;
- Effective regulations for abstracting, using and disposing water, must be a check on groundwater. Like India, groundwater is a public good and belongs to the state;
- Effective water pricing and recovery: Whatever are the charges for *abiana* or water prices, they must be collected. This covers other prices as well. Even if we recover all *abiana* charges at such dismally low rates we cannot maintain our irrigation system. Water charges have to be reviewed in the light of alternate sources of pumping water e.g. diesel and electricity. To this must be added the value of water;
- Penalties for non-compliance: It covers implementation of collecting water charges as well. This would require identification of groups who do not pay. But what are the incentives in terms of rebate to those who pay on time;
- Conservation guidelines;
- National regulatory framework for water use;
- Rationalization of *abiana* and other water rates to near cost of what developing, abstracting, storing and distributing water;
- Information services for farmers;
- Focus on water quality.

There is no need to create new institutions, but rationalization of their roles is needed to define clear roles and functions, remove overlapping and provide human, technical and financial resources to allow these institutions to deliver their mandate. Perhaps consolidation of water institutions to bring them under a single banner would result in greater efficiency and focused outputs that can help turn around the water scenario in Pakistan.

Investments and systems must be planned now for future floods and the upgrading of capacity of Meteorological Department and other infrastructure to address flood prediction management and monitoring should be undertaken as a priority. The role of the Federal Flood Commission and its functions should be redefined. With the implementation of 18th amendment interprovincial and intra provincial issues related to environmental impacts of floods should receive high priority in future action plans and policies. Review management of existing flood management organisations and infrastructure along with their up-gradation.

The whole inter departmental coordination needs a review at all levels with strong capability for modeling and scenario building. This capacity should be enhanced with strong research backing and linkages with civil society, academia and media. Flood cost and impact assessment is only focusing on the loss to life and property. The social costs, environmental costs and indirect costs to economy also need to be measured.

Water Economics and Agro-Ecological Zones in Indus Basin

[Thinking in terms of agro-ecological zones \(rather than eco-zones\) is more appropriate for the Indus Basin as this basin produces the bulk of Pakistan's food output and supports the bulk of its population.](#) The following actions will make integrated approaches for the Indus Basin more effective:

- Modeling and analytical studies at agro-ecological zone level to understand productivity, substitution potential, constraints and opportunities., such that maximum productivity can be derived within the potential of the , by maintaining balance with environmental conservation;
- Advocating potential of high-productivity and high value crops such as maize oil seeds, fruits, vegetables, flowers, ornamentals, and condiments, to enhance returns to farmers and encourage them to use water judiciously;
- Advocating crop-livestock integrated agriculture that makes best use of land-water-labour-technology, conserves water, enhances environmental sustainability and market opportunities;

- Advocating processing, transportation, refrigeration, marketing and allied functions of the agribusiness sector for handling high value products;
- Setting up of an effective Prices Commission or institution at Federal and Provincial levels which generates and shares data on production, farm systems, cropping patterns, water usage and conservation and environmental sustainability;
- Using emerging technology tools in media, telephony and internet to provide daily information to farmers to take decisions on what, when, how, and in what quantities to produce, what amounts of water to use and where to market the crops.

IRBM Measures for Indus Basin

When we speak of Integrated River Basin Management, we ask the question 'what is being integrated? Experience has shown that to manage a River Basin to an optimal level, we need to integrate not only water supplies, water allocations, water use and water infrastructure, but also the land, policy, institutional and legal frameworks, conservation and protection imperatives, economic activities and returns, financial and incentive structures, access and use profiles (who can get what in terms of water and related resources for agriculture, industries, urban usages and environmental flows), preparedness for and handling of emergencies and most of all what people want for productive and fulfilling lives. To achieve this integration, changes are needed in the way water saving can be affected in agricultural water. But here the system is driven by political interests and is very rigid, so we must recognize that any proposed policy changes will elicit very strong opposition.

We must, however, accept that for long term sustainable development of Pakistan we must create both economic surpluses from land and water sectors and ensure water conservation and environmental sustainability. Therefore we must focus on agriculture as well as improved water conservation and environmental management in terms of IRBM in the Indus Basin. We have water, we have land, we have the hard working farmer, but we have inadequate science, low valuation, low level of water conservation, less awareness and programming for environmental sustainability, few incentives for conservation and poor management. If we are unable to conserve and ensure longevity and health of our water resources, our ecosystems and our environment, it will be hard to improve on the agro-ecological zones and increase the productivity of the Indus Basin.

Essential Measures for Revitalization of the Potential of the Indus Basin and for its IRBM Framework

- Make water conservation and environmental sustainability the bedrock of revitalization of the Indus River System;
- Strategically adopt water, energy, economic and food security as an interwoven and integrated nexus, so that the overriding determinant is the preservation, conservation and prudent use of scarce water resources;
- Develop agriculture business structures in line with stated national goals and vision (storage, processing, air-conditioning, transportation, international trade) to encourage improved production, water management and water resource conservation;
- All water infrastructure proposed for the future should be based on benefit-sharing approaches and mechanisms and prepared in consultation with all stakeholders;
- Bring science, technology and information on conservation and production to the forefront and make it available to farmers;
- Determine value and price of water;
- Change the basis of providing business loans for agriculture, so medium and small farmers can access credit;
- Introduce agriculture tax and remove constitutional and other legal flaws that prevent progressive agriculture taxation (so that the big farmers that are largely out of the tax net can be brought in and the revenues raised for improving government irrigation infrastructure and services);
- Move to planning based on agro-ecological zones in order to get the most appropriate combination of land, water climate, soil and crops, while focusing on water conservation.

- Design incentivized reforms to urge farmers to plant according to best conditions and use appropriate water and environmental conservation methods in specific agro-agricultural zones;
- Rationalize subsidization for water and agriculture (for both inputs and outputs) to encourage conservation and improved agricultural processes and methods;
- Remove anomalies in tariffs, quotas and VATs;
- Develop international trade links to market products of the Indus Basin, and highlight that products use water and environmental conservation;
- Leverage water and power infrastructure assets to raise water-sector financing for the future. – to repair systems, build new ones and maintain them;
- Reduce dependence on foreign resources through innovative re-structuring and local financing, including financing for water conservation methods (such as rip and micro-irrigation);
- Promote entrepreneurship led growth and a transformation model (which includes water conservation and environmental sustainability) as a prerequisite to see Pakistan achieve a sustained growth rate;
- Develop an accessibility framework for water and agriculture to counter the negative influence of political economy and interest groups;
- Make the irrigation department accountable for providing allocated water on time, to control illegal tapping of aquifers and preventing water for the environment being used for agriculture;
- Make the irrigation, agriculture and environment departments set targets for productivity and water conservation in each agro-ecological zone and prepare connective path;
- Overhaul and re-systemize the Revenue Department, including computerization of all revenue and productivity records and make this information available to the public;
- Apply GIS and remote sensing technology as regular tools in appraisal, monitoring and evaluation of all land, agriculture and water activities, including water conservation and environmental protection activities.

Next Steps Forward for WWF

There is need to revisit the current divide where government is seen to develop infrastructure and NGOs to favor conservation. This will require long-term work on developing a continuum of linked approaches, policies and interventions that will bring together infrastructure development and conservation, water use and environmental flows into a single integrated framework.

WWF has already worked extensively for water conservation, water quality, living rivers and related programmes and initiatives. In the light of this report and especially in the light of chapters 9 and 10, the following next steps are suggested for WWF - Pakistan:

Step 1 Set-up a Think Tank on IRBM

- Think tank should have about 10 people from across Pakistan (with one or two international experts, if possible)
- Meet once a quarter, with a special focus on implementation and follow up on all projects;
- Work on the theme of balancing development with conservation as the main pillar of IRBM in Pakistan and take up the challenge of working on rationalizing water resource allocation on River Basin basis for all of Pakistan (covering irrigated, rain-fed and arid areas);
- Interact with government on many levels to promote IRBM;
- Include people who can actually implement the plan with a multidisciplinary problem solving focus.

Step 2 Evolve WWF's Objectives and Approach

- Realign its work on the basis of 'sharing and caring' of rivers;
- Identify its niche based on a Strengths-Weaknesses Analysis;
- Use this or similar theme to engage with all stakeholders, including provincial governments to soften their current entrenched positions;

- Work out a schedule of advocacy on the priorities outlined in Chapter 10.

Step 3 Programmes for Advocating Agro-Ecological Zones

- Carry out modeling and analytical studies for identified zones by focusing on priority issues through twinning arrangements with relevant institutions located in the studied zones;
- Advocate these zones;
- Work with government to develop packages of support for these zones;
- Work with government to develop information system for farmers (media, telephony, internet).

Step 4 Programme on Climate Variability and Change

- Build research opportunities and linkages with academia, private sector and government on climate change data and reporting specifically for Pakistan;
- Set up hubs in selected universities;
- Support modeling and scenario generation through these hubs. (We need to tap the opportunities of research and scholarship from local universities. We need to establish the link with these universities. Financial incentive for research that can be used for practical use. Results of research can be used).

Step 5 Programme to Promote Environment Friendly Infrastructure

- Share new technologies;
- Help revive old sustainable systems;
- Promote successful models.

Step 6 Engage with Government on Policies and Legislation

- Bring international best practices to government and use them in such a way that they are relevant to Pakistan and can be owned by the people;
- Provide concrete inputs for new laws and policies;
- Assist in improving institutions and departments with tangible inputs;
- Become a partner in developing an evaluation and monitoring mechanism that provides sustained and regular feedback on how things are improving in the water sector.

Step 7 Involve Local Resources for Research from (Local Universities)

- Faisalabad University, Punjab
- Tandojam University, Sindh
- National University of Science and Technology (NUST), Islamabad
- University of Engineering and Technology, Lahore
- FAST, Islamabad
- NED University, Karachi

1.1 Background

WWF - Pakistan in collaboration with WWF - UK has worked on a project on Indus Basin Water Security, an advocacy driven approach to ensure that environmental flows are protected in the Indus River Basin, in the event of future water fluctuations. This report provides a broad contextual foundation to its existing work based upon its recommendations. Keeping that in perspective, measures are needed to ensure that the agricultural and natural ecosystems of the Indus Basin function well; the water resources, entitlements and services upon which people depend are strengthened, made more productive; and the adaptive capacity of the local people is enhanced.

The effects of the 2010 floods, their devastating impact on the social and economic fabric of the country, combined with the global financial crisis, the growing effects of climate change, and the prevailing water management crisis, has led to the need for a critical analysis of water management in Pakistan. The 2010 floods played havoc in the country. It was the worst flood in hundred years of recorded history and the devastation was beyond the government's ability and capacity to manage. Almost 2000 lives were lost while over 20 million were displaced, with their life supporting assets destroyed. The direct losses were estimated at over US \$ 20 billion¹.

In the current climate change scenario and the prevailing water crisis, there is an urgent need for a critical analysis of water management in Pakistan with a focus on both technical and policy implications. WWF – Pakistan strongly believes that there is a need to scientifically assess the causes that have exacerbated the current crisis, along with determining the loopholes in the overall administrative and response mechanisms that have contributed to the present situation besides the natural calamity. The analysis shall further give pragmatic solutions that will help counter any such future eventualities with greater preparedness.

Water usage, especially in the agriculture sector, is almost 90% of the total freshwater available. This needs a critical review in the context of changing circumstances and climate change, and it should be based upon an analysis of the water situation in different irrigated agro zones, through the lens of economics and availability of water for the best macro actions in each zone. Moreover, there is a need to question the rationale of the existing cropping pattern and to check whether it needs modification or a complete change within a pragmatic setting.

This study also reviews the present policy, institutional and legal framework for water resources, allocation and management. It presents a critical analysis of management of 2010 floods, and covers water economics and zoning focusing on irrigated ecozones of the River Indus. Finally, the study looks at international best practices, provides recommendations for an improved river basin management framework for the Indus Basin and identifies the elements of a proposed National Water Policy for Pakistan.

1.2 Study Objectives and Scope of Work

Objective 1: Review of the present institutional and legal framework for water resources, allocation and management

- Analysis of all the current available documents, (IBWT 1960, Water Accord 1991, IRSA, PIDA Acts, Water Vision 2025, Draft Water Policy, The World Bank, ADB reports, etc);
- Analysis of the watershed/catchment management and the reservoir enhancement/management issues;
- Analyze/ check viability for decentralized storage such as (upper-catchment) small(er) dams, on-farm storage, micro hydels, localized self help dams, capacity of headworks, barrages, embankment protection;

¹ "Pakistan Floods 2010: Preliminary Damage and Needs Assessment" World Bank: Pakistan. Web. 4 Mar. 2011. <http://siteresources.worldbank.org/PAKISTANEXTN/Resources/293051-1264873659180/6750579-1291656195263/PakistanFloodsDNA_December2010.pdf>

- Review the existing administrative set up and analyzing the role of IRSA, FFC, PIDAs, LGs, etc and suggest legislative and institutional arrangements;
- Review the best international/regional practices with special reference to Integrated River Basin Management (IRBM);
- Provision and implementation of environmental flows in the review of (1,2,3,4,5) for sustained development.

Objective 2: Critical analysis of management of 2010 floods

- Review existing floods management policy and roles of different departments;
- Analyze the natural, scientific, technical, social, administrative, and political reasons for the flood damages;
- Review the role of Meteorological Department, IRSA, FFC, PIDAs, NDMA, District Governments for better coordination in light of the lessons learnt from the 1954,1973,1975 and present floods and setting up a response mechanism protocol between departments;
- Analyze the impacts on rivers profiles;
- Recommendations considering climate change impacts and future preparedness.

Objective 3: Water economics and re-zoning of areas on basis of cropping patterns with special focus on irrigated ecozones of River Indus

- To analyze the existing cropping pattern in wake of the water availability/water economics /food security in Pakistan and global international trade trends;
- Current survey of the existing cropping patterns, analysis of basic layers through GIS surveys and review of historical availability of water and existing crop water requirement of the area;
- To determine that how much of the available water is being used based upon the low and high value crops keeping in mind the food security debate;
- Analyzing the current water footprint, (in terms of virtual water exports);
- Alternatives for the existing cropping patterns (if viable) given on basis of economic viability/marketability of the new crops suggested in light of food security debate.

Objective 4: Recommendations for an improved framework as an alternate National Water Policy

- Under objectives (1,2,3) recommend a Framework of IBRM in light of best international/regional practices bearing semblance with Pakistan in form of a draft report covering aspects of:
 - Legislation and institutional arrangement;
 - Stakeholder and public participation;
 - Economic measures and financial incentives.

1.3 Study Design and Methodology

The study commenced with a scoping meeting of the consultant with WWF, followed by an in-depth desk review beginning in the month of February, 2011. This desk review was designed to cover the scope of work as stated in the TORs. Subsequently, several meetings were held among the three consultants and the study team to set direction for the research, to identify documents for review, websites to access, and people to interview. A review and brainstorming workshop was held in May, 2011 to review the working draft of the research already completed, identify gaps and responsibilities for work still to be covered. This workshop was documented in detail and provided the basis for further work on the report.

In the end of May the consultant team met again to brainstorm about what the water policy of Pakistan should be and the IRBM Framework. Chapters 9, 10 and 11 are based on this brainstorming session.

This study reviews the present policy, institutional and legal framework for water resources, allocation and management, presents a critical analysis of management of 2010 floods, and covers water economics and zoning focusing on irrigated ecozones of the River Indus. It looked at international best practices, provides recommendations for an improved river basin management framework for the Indus Basin and identifies the elements of proposed Pakistan's National Water Policy for Pakistan.

More than 100 documents (reports, policies, papers, presentations, articles,) were reviewed and about 50 websites were consulted for the study. References to these documents and websites are footnotes within the report and also in the bibliography. Some of the key documents reviewed include the following:

- Indus Water Treaty 1960;
- Water Accord 1991;
- WAPDA Act 1958;
- Canal and Drainage Acts 1873;
- PIDA and related documents;
- Water Vision 2025;
- Draft Water Policy (several versions);
- World Bank reports;
- ADB reports;
- Reports of various commissions;
- WWF reports and publications;
- IUCN reports;
- Research and academic reports;
- Documents pertaining to international best practices;
- Global Water Partnership (GWP) publications;
- National Drainage Programme report;
- Planning Commission reports;
- Pakistan Millennium Development Goals Report 2010;
- UN reports and publications;
- Papers and book chapters by authors of this report.

1.4 Authors

The overall management and compilation of draft report has been the responsibility of Raasta Development Consultants. Ms Simi Kamal, Dr Pervaiz Amir and Mr Khalid Mohtadullah (collectively called consultants) are the authors of this study. The consultants nominated Ms Simi Kamal as the focal person on their behalf regarding the progress of work, delivery of components and any queries related to the project.

1.5 Stakeholder Workshop

A stakeholder workshop was organised in Islamabad on 16th July, 2011, by WWF - Pakistan and Raasta Development Consultants. The authors presented the main findings of the draft report, elements of a National Water Policy and IRBM framework with technical experts from the water sector. More than 100 participations attended the workshop. A smaller group of selected specialists, academicians, professionals, practitioners and government representatives took part in a dialogue session to debate and discuss the elements of a National Water Policy and IRBM Framework and suggested recommendations and the way forward.

1.6 Final Report and Policy Briefs

The five policy briefs were completed during the project. The policy briefs are on:

- IRBM for Indus River;
- Proposed elements of a National Water Policy;
- Institutional framework analysis;
- Lessons learnt from flood 2010;
- Water scarcity and impacts on cropping patterns in the Indus Basin.

The final report is structured in eleven chapters:

Chapter 1	Introduction
Chapter 2	Policy and Legal Framework for Water Resources Allocation & Management
Chapter 3	Analysis and Review of Water Management Institutions

Chapter 4	Managing the Indus Basin System and Its Infrastructure
Chapter 5	Environmental Flows for Sustainable Development
Chapter 6	Management of Floods of 2010
Chapter 7	Water Economics and Agro-Ecological Zoning of Indus Basin
Chapter 8	Best Practices in Integrated River Basin Management (IRBM)
Chapter 9	Elements of Water Policy
Chapter 10	IRBM Framework for Indus Basin
Chapter 11	Next Step Forward for WWF
	Bibliography

Policy and Legal Framework for Water Resources Allocation and Management

Pakistan is faced with a rapid population growth, water scarcity, system losses, distribution inequalities, loss of ecosystems, and the generation of effluents beyond its system capacity. The country is struggling to meet incremental demand for more irrigation water and to fulfill environmental flow requirements to deal with the disposal of salts and pollutants, and to meet urban, domestic and industrial needs².

Estimates from the Human Development Report (2010) show that Pakistan has a population of 184.8 million, of which at least 22.6 percent are below the poverty line, 10 percent do not have access to safe drinking water and 55 percent have no sanitation³. According to the World Bank⁴, Pakistan became a water-stressed country (1700 cubic meters per capita per year) in 2000.

According to a government source⁵, Pakistan reached 1700 m³ in 1992 and became a water-short country, and then went down to 1500 m³ in 2002. Water scarcity (1000 m³ per capita per year of renewable supply) is expected in about 2035⁶. However, a United Nations Development Programme source gives Pakistan's current water availability as 1090 m³ per capita per year⁷. This is because the terms "water shortage" and "water scarcity" are often used interchangeably, while both use the 1000 m³ per capita measurement as a benchmark, shortage is an absolute term and scarcity is a relative concept⁸.

It is important to understand the factors other than population growth that are driving Pakistan toward water scarcity. Reduction in the ice and snow areas of the Himalayas and rapid glacial melt means a lower quantum of annual snowmelts and, therefore, reduced water in the Indus River system. The decline in fresh water additions to surface water bodies has rendered them too saline and polluted for drinking and agricultural purposes⁹. Reduced holding capacity and more rapid runoff (when normal rains and snowfall return), lead to floods and lower reserves of water for drinking and agriculture. The drying up of the Indus Delta has led to losses in the coastal ecosystem and sea intrusion is up to 225 kilometers¹⁰.

While the realities of water availability, water regime, climate, and delta conditions have changed, the ways of using water have not. This has resulted in large scale degradation of the water resource base. **Thirty-eight percent of Pakistan's irrigated land is waterlogged and 14 percent is saline**; there is now saline water intrusion into mined aquifers. There has been a denudation of rangelands and watersheds, a depletion of forest cover and vegetation, a decline in the water table in Balochistan to alarming levels, and a drastic reduction of sweet water (fresh drinking water) pockets in the lower Indus Basin¹¹. It is now accepted among many water sector practitioners and professionals in Pakistan that the Indus Basin irrigation system is vulnerable, greater flexibility is required in the way water systems are envisaged and used, and there is an urgent need for trust building among water users and the institutions that control water.

The country as a whole has been engaged in protracted debate over the provincial division of water. Yet this division hides the more critical distribution - the various uses of water. **Irrigation and agriculture use up 97 percent of all of Pakistan's allocated**

² Kamal S "Pakistan's Water Challenges: Entitlement, Access, Efficiency and Equity" Running on Empty: Pakistan's Water Crisis. Washington DC: Woodrow Wilson International Centre for Scholars Asia Programme, 2009. 28-44. Print.

³ For latest figures, see Human Development Report 2010 at http://hdr.undp.org/en/media/HDR_2010_EN_Complete_reprint.pdf

⁴ Briscoe J and Qamar U, Pakistan's Water Economy: Running Dry (World Bank/Oxford University Press, 2006)

⁵ "Population Stabilization, a Priority for Development, United Nations Population Fund/ Ministry of Population Welfare, Government of Pakistan, undated.

⁶ Briscoe J and Qamar U, Pakistan's Water Economy: Running Dry (World Bank/Oxford University Press, 2006)

⁷ Economic Survey of Pakistan, 2007-2008, and Global Human Development Report 2007, quoted on UNDP website, www.undp.org.pk.

⁸ Kamal S, Pakistan's Water Challenges: Entitlement, Access, Efficiency and Equity, Running on Empty: Pakistan's Water Crisis. Washington DC: Woodrow Wilson International Centre for Scholars Asia Programme, 2009. 28-44. Print

⁹ Ibid.

¹⁰ Vision and Programme Document, Indus Delta Partnership, December 2001. Local inhabitants estimate sea intrusion to be spread across 200,000 hectares (See also, Tarbela Dam Case Study, WCD November 2000)

¹¹ Kamal S, Pakistan's Water Challenges: Entitlement, Access, Efficiency and Equity, Running on Empty: Pakistan's Water Crisis. Washington DC: Woodrow Wilson International Centre for Scholars Asia Programme, 2009. 28-44. Print.

surface water resources¹², while only 3 percent is left for all other uses, including drinking water for approximately 180 million people, supplies for municipal and industrial uses, and sanitation.

According to the Constitution of Pakistan, water is a provincial subject, but the Federal Government has to perform regulatory functions to ensure access and equity amongst the provinces. The Parliamentary Committee on Water Resources (PCWR) is the main parliamentary body of elected representatives that oversees all water-related affairs in Pakistan. The legal cover for carrying out regulatory functions is provided by the WAPDA Act (1958), IRSA Act (1992), and Environmental Protection Act (1997). The main legal frameworks for water resources management at the provincial level is provided by the Punjab Canal and Drainage Act (1873), the Sindh Irrigation Act (1879) and NWFP Canal and Drainage Act (1873).

There have also been special committees formulated by the Senate to undertake special investigation of issues of national importance. These committees have submitted their reports, but these reports cannot be said to have led to improvements in the legal environment around water.

2.1 Overview of Legal Framework for Water Resources in Pakistan

Water legislation in Pakistan has largely been disjointed and lacks proper structure. Existing policies have been pronounced on an ad hoc basis and are fragmented policies that pertain to only certain aspects of water resources management. The lack of stakeholder consultation has led to widespread criticism and lack of ownership of these policies. The existing legal framework for water resources allocation and management lacks a consolidated policy on water that integrates both the development and management of this precious and scarce resource. To date, there has been no comprehensive water policy implemented that deals with water resources management in a holistic manner, cutting across federal and provincial boundaries and competing water uses in Pakistan.

While the debate on a national water policy continues, the Government of Pakistan has made attempts to develop some policies that partially address a few water-related issues, in the endeavor of meeting targets set by the Millennium Development Goals (MDGs)¹³. However, these policies (National Drinking Water Policy and National Sanitation Policy) are still in the preliminary stages and it is too early to ascertain whether these have been effective in their implementation. Pakistan's National Water Policy is yet to be finalized, although a comprehensive exercise was carried out in 2002 to develop water-related strategies¹⁴, and there have been many versions of the National Water Policy that were not agreed upon by all the provinces.

There are two major water sharing legislations (a treaty and an accord) in effect in Pakistan today: the Indus Waters Treaty (1960) with India, and the Indus Water Apportionment Accord (1991) between the four provinces of the country. Both these agreements pertain to sharing of the Indus River Basin, the primary source of freshwater in Pakistan.

2.2 Indus Waters Treaty (1960)

The Indus Waters Treaty (IWT) of 1960 is hailed internationally as a model of a successful treaty dealing with transboundary river issues and is the only international water-sharing agreement of Pakistan. Despite the political conflicts and volatile relations between India and Pakistan, the IWT has withstood the test of time and is still an effective resolution to the water-sharing of the Indus Basin between the two countries.

The partition of the Indian subcontinent by the British Parliament in August 1947, with complete disregard for integrated watershed management, led to a division of the Indus River Basin such that the upstream reaches of the tributary rivers fell in Indian territory and Pakistan became lower riparian in that context, also headworks of the rivers fell within Indian control whereas the canals were located within Pakistani territory.

Following a Standstill Agreement in 1947 and another temporary sharing arrangement in 1948, there was a stalemate which lasted

¹² Pakistan Water Partnership (PWP), Pakistan Country Report Vision for Water for the 21st Century, June 1999.

¹³ Pakistan Millennium Development Goals Report 2010, Planning Commission, Government of Pakistan, online at <http://undp.org.pk/images/publications/mdgr2010.pdf>.

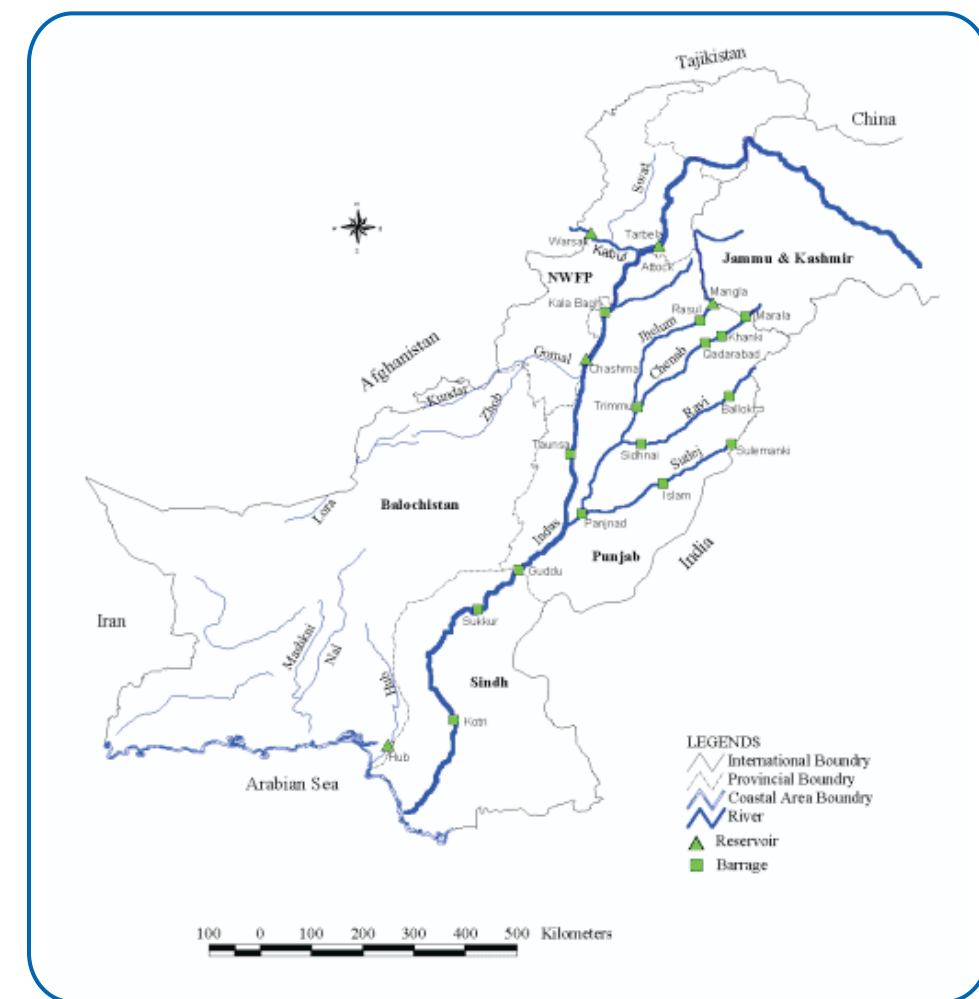
¹⁴ Water Resources Strategy Study, Asian Development Bank 2002 online at <http://cms.waterinfo.net.pk/pdf/vol4.pdf>

till 1950. In 1952, the World Bank invited engineers from both countries to meet in Washington and submit their proposals regarding water allocation and cooperative management in the Indus River Basin¹⁵. The bank shifted from its vision of integrated watershed management in favour of one of separation of the internal systems of India and Pakistan and submitted its own proposal¹⁶. Following several years of international mediation and positive arbitration by the World Bank, the Indus Waters Treaty was signed between India and Pakistan on September 19, 1960 and ratified in January, 1961¹⁷.

The features of the Indus Waters Treaty are well known. Pakistan received unrestricted use of the three western rivers (Indus, Jhelum and Chenab), which India allowed to flow unimpeded (with a few exceptions) and India was given exclusive use of the three eastern rivers (Ravi, Beas and Sutlej).

Provisions were also made for three dams, eight link canals, three barrages and 2500 tubewells to be built in Pakistan to compensate for the loss of the waters of the Ravi and Sutlej rivers, along with provisions for resolution for future disputes and financial provisions to support the development of irrigation infrastructure in Pakistan.

Map 1 – Provincial Boundaries and Main Rivers in Pakistan



Source: <http://www.wildlifeofpakistan.com/IntroductiontoPakistan/industributaries.jpg>

¹⁵ Wolf A & Newton J, Case Study of Transboundary Dispute Resolution: the Indus Water Treaty, online at http://www.transboundarywaters.orst.edu/research/case_studies/Documents/indus.pdf

¹⁶ Ibid.

¹⁷ Ibid.

The Indus Waters Treaty has been successful for the last five decades and promises to continue to do so. Many commentators are of the view that it would be ill-advised to revise or amend this Treaty as it is the primary factor contributing towards harmonious relations between India and Pakistan over sharing of the Indus River Basin. However, the IWT allows India to withdraw a fixed quantum of water from the western rivers. This could be a potential cause of conflict because the glaciers feeding the Indus River are melting at an alarming rate. As the physical quantity of water in the Indus Basin decreases, withdrawal of water from India would pose a threat to Pakistan.

The IWT has recently come under re-examination due to disputes arising over construction of new dams and barrages in the Indus River Basin. A couple of years ago, India and Pakistan were in dispute over the Baglihar Dam issue. India claimed entitlement to construct plants on the three western rivers (allocated to Pakistan for unrestricted use) for generation of hydel power if it did not construct spillways with submerged gates. Pakistan thought the Baglihar Dam had three spillways on the Chenab and objected¹⁸, Pakistan viewed the difference as largely a legal one, involving interpretation of the Treaty, while India viewed it mainly as an engineering one, regarding hydropower plants¹⁹.

A neutral expert concluded that the rights and obligations of the parties under the Treaty should be read in the light of new technical norms and new standards as provided for by the treaty²⁰ and the Baglihar difference was addressed bearing in mind the technical standards for hydropower plants as they have developed in the first decade of the twenty first century, and not as perceived and thought of in the 1950s when the Treaty was negotiated²¹. The Baglihar agreement thus provides an example where water disputes can be amicably resolved between the two countries and also brings forth a sound basis for the settlement of future water disputes between India and Pakistan on allocations, use of waters and enforcement²².

However, the most recent issue regarding the Wullar Barrage/Tulbul Navigation Project between Pakistan and India highlights the limitations of the Indus Waters Treaty. The Wullar Barrage has been contentious for 24 years²³. It was proposed to be built on River Neelum and has a storage capacity of 0.3 MAF. India claims that Tulbul/Wullar barrage is not a storage project and will only be used for navigation purposes. Pakistan is reluctant because it does not want to agree to any development project which would result in India gaining control over water from the Jhelum River²⁴.

There are two schools of thought on the Indus Waters Treaty – one group deems it to be 'sacrosanct' and therefore not open to revision, while another group recommend that the IWT should be revisited in the light of new realities facing the Indus Basin such as climate change, financial crisis, energy crisis, population growth etc.

The current debate on IWT emerges from the postulated changes in water flows as a result of climate change exaggerated by global warming. A recent IUCN policy paper points out that the Treaty does not elaborate how India will share shortages of water during the dry year, because India's entitlements of water storages on the Western Rivers are fixed in the Treaty²⁵. The real question is that when flows are variable, how can water entitlements for India be fixed? This is the issue, which needs further elaboration. The paper revolves around analyzing this issue and gives more attention to how the upper riparian controls the fate of the lower riparian and possible future conflicts if not resolved through mutual discussion.

Other research posits arguments based on ground realities and the changing situation²⁶. There is a felt need that the IWT should be revisited for possible positioning based on changed realities of climate change and minimum environmental flows. Both countries while lacking basic data and clear positions would request possible revisions in clauses with changed circumstances.

¹⁸ See online: www.dailytimes.com.pk/default.asp?page=story_24-6-2004_pg3_1

¹⁹ Ibid.

²⁰ Ibid.

²¹ www.dawn.com/2008/06/11/top10.htm

²² Kamal S and Baxamoosa S, Case Studies (Cauvery and Indus River Basin) for China's Basin Master Planning, Report. Pretoria, South Africa: Pegasys Strategy and Development, October 2009.

²³ Tulbul/Wullar barrage has come into the limelight recently with India and Pakistan holding talks over its proposed construction between May 12-15, 2011 in Islamabad

²⁴ Express Tribune online <http://tribune.com.pk/story/167201/pak-india-talks-on-wullar-barrage-begin/> May 12, 2011

²⁵ IUCN, Indus Water Treaty and Managing Shared Water Resources for the Benefit of Basin States – Policy Issues and Options, IUCN Pakistan, Karachi, 2010

²⁶ Bagla, Pallava, Along the Indus River, Saber Rattling Over Water Security, Science Mag 4 June 2010: 1226-7. www.sciencemag.org. Web. 6 June 2010.

2.3 Indus Water Apportionment Accord (1991)

The primary agreement that allocates water among the provinces of Pakistan is the Indus Water Apportionment Accord of 1991 (also called the Indus Water Accord and Water Accord for short)²⁷.

This agreement was hammered out after intense political debate which spanned three decades. The signing of the Indus Water Accord is upheld in Pakistan as a testament of political will. The Accord is considered to be a momentous occasion in the history of Pakistan with the coming together of the four provinces on a united platform and was adopted as a decision of the Council of Common Interests (CCI), the highest constitutional dispute resolution body in the country, on March 21, 1991²⁸.

Interprovincial water disputes, particularly between Punjab and Sindh, considerably pre-date the creation of Pakistan. Since the time of British rule, several attempts were made to resolve water-sharing and apportionment issues between the four provinces, namely: Anderson Committee (1935), Indus (Rau) Commission (1939), Akhtar Hussain Committee (1968), Fazl-e-Akbar Committee (1970), Anwar-ul-Haq Commission (1981) and Haleem Committee (1983)²⁹.

From the time of Partition in 1947 and through the 50s, 60s, 70s and 80s, through the development of huge water infrastructure (including two big dams), the Green Revolution and enhanced agricultural production, the two provinces of Sindh and Punjab continued to disagree over water-sharing³⁰, while the provinces of Balochistan and KPK were minor players in the debate. It appears that the succession of military governments in Pakistan was unable to resolve the water-sharing issue and it was during a short stint from November 1990 to July 1993, that a political government was able to address the problem³¹.

Under this Agreement, water allocation is made on the average annual basis of 117.35 MAF which includes 114.35 MAF of main flow and 3 MAF of ungauged canal flow. The division is as under:

Table 1 – Water Allocation between Provinces

Province	Allocation of Water Resources
Punjab	55.94 MAF
Sindh	48.76 MAF
NWFP	5.78 MAF
Baluchistan	3.87 MAF
Ungauged Canals	3.00 MAF
TOTAL	117.35 MAF

Source: Water Apportionment Accord 1991

The formula of water distribution was based on a ten day average use, system wise and seasonal adjusted for *kharif* and *rabi*, tables provided by the provinces. The Council of Common Interests (CCI) met again in September 1991, six months after the signing of the Accord, to agree to the ten daily water allocation use tables³². The system-wise allocation was worked out separately, attached with the Agreement as an integral part of it. The record of actual average system uses for the period 1977-82, formed the guideline for developing a future regulation pattern. These ten daily uses has been adjusted pro-rata to correspond to the indicated seasonal allocation of the different canal systems and has formed the basis for sharing shortages and surpluses on an all Pakistan basis³³.

²⁷ Indus Water Apportionment Accord 1991, Government of Pakistan, text available online at:

http://www.boellpakistan.org/downloads/Water_Apportionment_Accord_1991.pdf

²⁸ Sharif H, Inter-province Water Distribution Conflict in Pakistan, Available online at: www.intermedia.org.pk/pdf/.../Humaira_Sharif_Research_Paper.pdf

²⁹ Ibid

³⁰ Kamal S & Panda S M, Water Allocation within India and Pakistan, Report. WWF UK, 2010

³¹ Ibid

³² Kamal S & Panda S M, Water Allocation within India and Pakistan, Report. WWF UK, 2010

³³ Ibid.

On the whole, size, population and irrigated agriculture served as criteria for fixing the final share, which was accepted in 1991 by all provinces. However, it is being increasingly pointed out that while the Water Accord covers only river water, there are huge underground reserves, mostly in the Punjab, which supplements water supply in that province – a resource that other provinces have little of³⁴.

The Water Accord is managed by the Indus River System Authority (IRSA) that was established in 1992, to provide continuing interaction and a resolution of any disputes among the four provinces on matters relating to share of the Indus waters. The IRSA is comprised of one representative from each province and a member from the federal government³⁵.

Despite its brevity, the Water Accord is considered credible and is widely accepted as legally binding on all four provinces. It is one instrument that partially resolved the allocation issue and serves as a good starting point towards more equitable resource sharing in the Indus Basin.

Many issues remain in spite of the signing of the Accord. There are several differences amongst the province regarding the interpretation of the Accord of 1991. These include the following:

- Construction of additional storages (section 6 of the Accord)

The Federal Government and the Punjab Government feel very strongly that this section validates the construction of Kalabagh, Diamer-Bhasha and other dams on the river Indus. The other three provinces have raised concerns and objections to these development projects. In their view, new storage projects will lead to reduced flows downstream.

- Minimum escapage to sea downstream Kotri (section 7 of the Accord)

Although the Water Accord recognizes a fixed quantum of environmental flows (39.5 MAF per year), these are not released in a consistent way each year, and this inconsistency is justified on the grounds that there is an “average” amount over time (when flood flows even out the dry years). What is needed, however, is a regular, controlled flow each year, to be guaranteed through strict regulation and implementation³⁶, to reflect the seasonal requirements of the freshwater ecosystem and the flows necessary for maintaining the ecosystem functions.

- Mode of sharing shortages (section 14b)

Pakistan has experienced severe shortages of water during 1994-95, 1997-98 and from 1999-2003. During this period, Sindh and Punjab differed seriously on their share of water during the shortages. In the Accord, Punjab agreed to a share of water that was 2.7% less than its historic share, while Sindh was apportioned a share that was 1.2% higher than its historic share. Disputes over sharing of shortages still ensue between the provinces and are likely to become a potential source of conflict as climate change aberrations are witnessed that lead to extreme floods and drought.

- Construction of Greater Thal Canal in Punjab³⁷

The construction of Greater Thal Canal is in progress in the Punjab but at a very slow pace and financial allocations have been negligible under the present government. So is the construction of Rainee- Canal in Sindh, Kachhi Canal in Balochistan and Chashma Right Bank Lift Canal in the KPK. The Provincial Assembly of Sindh has passed two (2) unanimous resolutions against the construction of the Greater Thal Canal. Sindh feels that since sufficient water is not available in Indus River to supply water to

³⁴ Ibid.

³⁵ Ibid.

³⁶ Kamal S, Use of Water for Agriculture in Pakistan: Experiences and Challenges, Conference on The Future of Water for Food. University of Nebraska. University of Nebraska, Lincoln. 3 May 2009. Speech.

³⁷ PILDAT Inter Provincial Water Issues in Pakistan Background Paper (draft), PILDAT - Pakistan Institute of Legislative Development and Transparency.

<<http://pildat.org/Publications/publication/WaterR/Inter-ProvincialwaterissuesinPakistan-BackgroundPaper.pdf>>. September 2003.

Greater Thal Canal, the new canal will eventually become a means of siphoning off extra water beyond the due share of the Punjab. Although the Federal Government and the Punjab Government claim that the Greater Thal Canal will only use flood water for about 90 days in a year, Sindh feels that once the land owners and tillers start depending on the canal water for irrigation, they will develop sufficient pressure and clout to make the canal perennial, withdrawing extra water beyond its due share.

Sindh also complains that due process and procedure was not adopted in approving the Greater Thal Canal project and its construction was hurriedly started despite the objections of the Sindh province. Punjab and the Federal Governments contend that according to the 1991 Water Accord, each province is allowed to develop water-related projects within its share of water as agreed in the Accord.

- Reduction in storage due to siltation of reservoirs

The state of technology at the time of construction of the three (3) main reservoirs, Tarbela, Mangla and Chashma did not provide for any de-siltation of the reservoirs. It was therefore anticipated that these reservoirs would have a limited life and substitute arrangements would have to be made. By 2002, Tarbela had lost 3.03 MAF or 26 per cent of its original storage capacity, Mangla 1.18 MAF or 20 percent of its original storage capacity, and Chashma 0.37 MAF or 43 per cent of its original storage capacity. In total 4.58 MAF or 25 percent of the total storage capacity of the three reservoirs was lost by 2002. It is anticipated that by 2013 and 2020, we would have lost 6.27 MAF or 34 percent of the total capacity and 7.27 MAF or 40 percent of the total storage capacity respectively³⁸. The federal government is convinced that construction of new storage is the only effective response to this situation besides the overwhelming demand for hydropower. Some opponents of the new storages suggest that instead the possibility of desilting of the reservoirs should be explored. This issue has been analyzed in WCD, 2000 under the Tarbela Dam Case Study³⁹.

- Wastage of water in the irrigation system

Pakistan has the largest contiguous irrigation system in the world. Of the 114 MAF of sweet water currently diverted for use in agriculture, by the government's own account, two-thirds (approximately 76 MAF) is lost due to poor transmission and seepage in the canal system. Additionally, another 25 percent is lost within the farms. Water losses between canal heads and water courses, and losses within water courses, are generally accepted to equal one-third of the total amount of water delivered⁴⁰. The Accord is not clear about how to solve this problem and whether provinces will allow closure of canals so that they can be fixed.

- Low productivity of water

Another aspect of this issue is the productivity of the farms against per cusec of irrigation water. Pakistan has a much lower rate of production than other countries, including its neighbour India, where agriculture is organised on similar lines. The irrigation efficiency therefore needs to be enhanced, but the Accord is concerned with the quantum of water, and not its productivity.

- Groundwater reserves

The Indus Basin also has fresh groundwater reserves of about 55 MAF, most of them in Punjab. Groundwater has become a major supplement to canal water, especially in the Upper Indus Plain, where groundwater quality is good. In fact, groundwater now accounts for half of all farm irrigation requirements, but it is not a part of the Water Accord⁴¹.

³⁸ PILDAT Inter Provincial Water Issues in Pakistan Background Paper (draft), PILDAT - Pakistan Institute of Legislative Development and Transparency.

<<http://pildat.org/Publications/publication/WaterR/Inter-ProvincialwaterissuesinPakistan-BackgroundPaper.pdf>>. September 2003

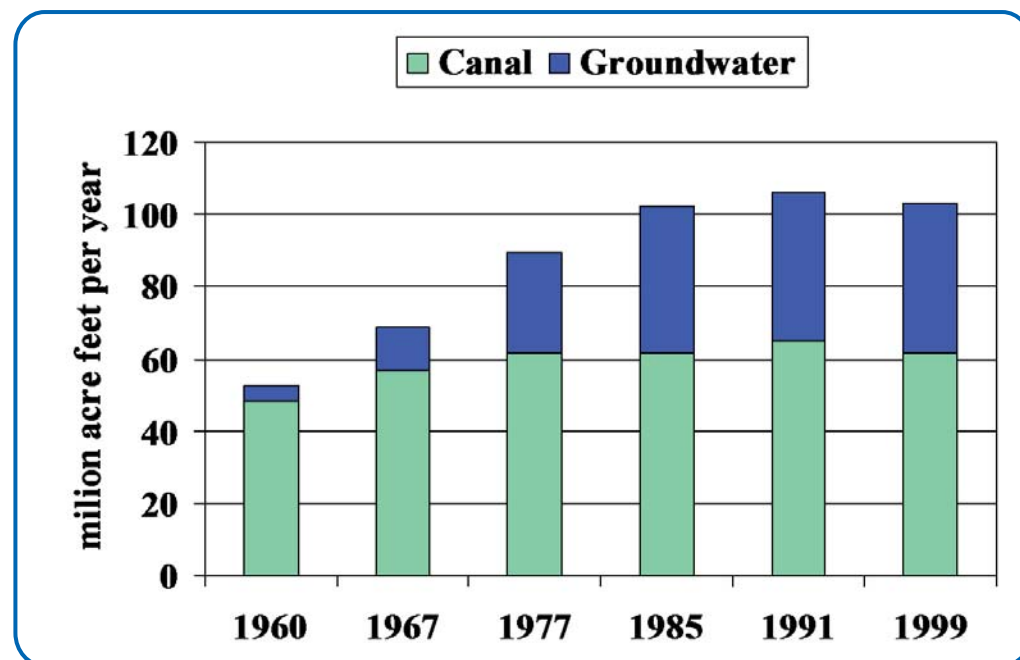
³⁹ A detailed analysis can be found in Tarbela Dam and related aspects of the Indus River Basin Pakistan, WCD 2000 online at

<http://www.adb.org/water/topics/dams/pdf/cspkmain.pdf>

⁴⁰ Kamal S and Baxamoosa S, Case Studies (Cauvery and Indus River Basin) for China's Basin Master Planning. Report. Pretoria, South Africa: Pegasys Strategy and Development, 2009.

⁴¹ Kamal S and Panda S M, Water Allocation within India and Pakistan, Report. WWF UK, 2010.

Figure 1 – Growing Rate of Groundwater Irrigation



Source: Steenburgen and Gohar 2005, quoted in Pakistan's Water Economy: Running Dry, Report, The World Bank, November 8, 2005, pg 60

2.4 National Water Policy (Draft 2006)

The National Water Policy of Pakistan has been in the making for last 20 years and is still not final, to the knowledge of the authors of this report.

The most recent draft (2006)⁴² has been based on the premise that Pakistan needs to develop a “blue revolution” through which there will be increase in water availability, improved service delivery, increase efficiency in water consumption and equity to access water resources. It aims to provide a framework to optimize the development of both surface and groundwater and contribute to food security and poverty alleviation and also to deal with the integrated planning and development of water resources.

The current preamble to the policy includes a detailed discussion on the need of an integrated National Water Policy and the key issues facing Pakistan's water sector. This discussion is followed with clear identification and descriptions of the different uses of water. Policy recommendations are provided to serve as guidelines to improve water management and consumption patterns at each level, and provisions for each policy given are concise so as to avoid misinterpretation and confusion in the future.

The salient features of the National Water Policy are outlined below:

- Water rights and allocation are given due consideration;
- Recognition that water is not a “free” good and has an economic value;
- Groundwater issues are addressed;
- Stakeholder participation is encouraged;

⁴² Draft National Water Policy (2006), Ministry of Environment, Government of Pakistan. Available online at: <http://202.83.164.27/wps/wcm/connect/08e345804199699abe7afec5b4dad69b/National+Water+Policy.pdf?MOD=AJPERES&CACHEID=08e345804199699abe7afec5b4dad69b&CACHEID=08e345804199699abe7afec5b4dad69b&CACHEID=08e345804199699abe7afec5b4dad69b&CACHEID=08e345804199699abe7afec5b4dad69b>

- Provisions and measures are suggested for improved flood and drought management;
- Drainage and reclamation issues are addressed;
- Water quality problem is addressed;
- Wetlands, ecology and use of water for recreation are given due importance;
- Emphasis is made on information collection and sharing;
- Transboundary water sharing issues are given consideration;
- Institutional and legal aspects are examined.

2.5 Irrigation and Water Acts

Since the management of water is considered a provincial issue in Pakistan, the policies related to (irrigation) water management can be divided into two categories: federal and provincial. The acts related to federal water management are the Indus River System Authority Act (1992) and the Water and Power Development Authority Act (1958) and these primarily concern the national authorities IRSA and WAPDA, while provincial water management is driven by the Punjab Irrigation Act (1873), Sindh Irrigation Act (1879), NWFP Act (1873), Balochistan Ordinance (1980), Punjab Soil Reclamation Act 1952), Water Users Association Ordinances (1981) and the Provincial Irrigation and Drainage Authority (PIDA) Acts (1997).

These policy documents generally pertain to institutional aspects of the different water management organisations and thus have been examined in detail in chapter 3.

2.6 Other Policies of Relevance to Indus Basin and Water

Some other policies in Pakistan have implications for water resource development and management and for the Indus Basin.

2.6.1 Pakistan Environmental Protection Act (1997) and National Environment Policy (2005)

The Pakistan Environmental Protection Act (PEPA) was promulgated in 1997 with the aim to protect, conserve and rehabilitate the environment. It also includes provisions for the prevention and control of pollution and the promotion of sustainable development⁴³. PEPA was pronounced as an improvement to the Pakistan Environmental Protection Ordinance 1983, which was subsequently repealed⁴⁴.

PEPA describes the rules by which the Environmental Protection Agency (EPA) is supposed to function. It advises the EPA to “establish standards for discharge or emission of the ambient air, water and soil, coordinate environmental policies and programmes, nationally and internationally, designate laboratories for conducting tests and analysis for surveillance, monitoring, measurement, examination, investigation, research, inspections and audits to prevent and control pollution and estimate the cost of cleaning up and rehabilitation”.

The National Environment Policy (NEP) of 2005 provides an overarching framework for addressing the environmental issues facing Pakistan – particularly pollution of freshwater bodies and coastal waters, air pollution, deforestation, loss of biodiversity, improper waste management, natural disasters and climate change⁴⁵. It aims to protect, conserve and restore Pakistan's environment in order to improve the quality of life of the citizens through sustainable development. The main objectives of the policy pertain to the conservation and rehabilitation of the environment, integration of environmental objectives in policymaking and capacity building of various institutions for improved environmental management⁴⁶.

⁴³ Pakistan Environmental Protection Act 1997, Pakistan Environmental Protection Agency. Web. 28 Feb. 2011. <<http://www.environment.gov.pk/act-rules/envproact1997.pdf>>.

⁴⁴ Ibid.

⁴⁵ National Environmental Policy 2005, Pakistan Environmental Protection Agency. Web. 28 Feb. 2011. <http://www.environment.gov.pk/nep/policy.pdf>

⁴⁶ National Environmental Policy 2005, Pakistan Environmental Protection Agency. Web. 28 Feb. 2011. <http://www.environment.gov.pk/nep/policy.pdf>

The National Environment Policy provides an enabling framework for addressing environmental issues sector by sector and also provides guidelines for addressing cross sectoral issues. This is a much needed improvement from the Pakistan Environmental Protection Act 1997 which uses 'environment' as an umbrella term to include air, land, water, ecosystems, and living organisms.

Among the sectoral guidelines the policy has a section on water supply and water management: to provide sustainable access to safe water supply and effectively manage and conserve the country's water resources, the government may:

- Develop legal and policy framework for promotion of safe drinking water in Pakistan;
- Increase coverage of water supply and water treatment facilities;
- Establish a water quality monitoring and surveillance system;
- Make installation of water treatment plants as an integral component of drinking water schemes;
- Promote low cost water treatment technologies at household and community levels;
- Promote appropriate technologies for rain water harvesting in rural and urban areas;
- Encourage artificial recharge of groundwater in arid and semi-arid areas;
- Promote metering the water consumption to discourage the indiscriminate use of water for industrial and municipal purposes;
- Enact the Water Conservation Act and relevant standards to foster water conservation;
- Promote integrated watershed management;
- Monitor sustained freshwater flows into the marine ecosystems;
- Establish standards for classification of surface water bodies;
- Launch phased programmes for clean and gradual up-gradation of the quality of water bodies.

2.6.2 Drinking Water and Sanitation Policies

Recent attempts have been made by the Government of Pakistan to enact effective policies to overcome issues of safe drinking water supply and sanitation in the country. Of these, the National Sanitation Policy (2006), the Safe Drinking Water Act (2007) and the National Drinking Water Policy (2009) are directly relevant.

The National Drinking Water Policy (NDWP)⁴⁷ was initially drafted in 2002 and approved by the Federal Cabinet in September 2009. The NDWP is intended to provide an enabling framework for the government to address the key issues and challenges that the Pakistan government faces in terms of provision of safe drinking water to its citizens.

The NDWP is based on the recognition that safe drinking water is a fundamental human right and that the provision of drinking water is a constitutional responsibility of the provincial governments. In this regard, the NDWP is intended to guide and support the responsible agencies in executing their tasks in a manner so that there is adequate and safe drinking water for all the citizens of Pakistan, whilst addressing the issues of equity, efficiency and sustainable water distribution⁴⁸.

The National Sanitation Policy (NSP) of 2006 provides a broad framework and policy guidelines to enhance and support sanitation coverage in the country through formulation of sanitation strategies, plans and programmes in order to improve the quality of life for the people of Pakistan.

The primary focus of the policy is on the safe disposal of excreta away from dwelling units and workplaces by using sanitary latrines. It also envisions an open defecation free environment along with the safe disposal of liquid and solid waste matter, and the promotion of health and hygiene practices in the country.

The Safe Drinking Water Act (2007) was prepared by the Health Services Academy in Islamabad under a Joint Programme Review for the World Health Organisation and the Pakistan Federal Ministry of Health in December 2007. This Act is still in the

⁴⁷ National Drinking Water Policy 2009, Ministry of Environment, Government of Pakistan, Available online at: <http://moenv.gov.pk/>

⁴⁸ National Drinking Water Policy 2009, Pakistan Environmental Protection Agency.

Web. 3 Mar. 2011. <http://www.environment.gov.pk/NEP/DWPolicyOct2009.pdf>

drafting stage and has not yet been finalized. The Act primarily serves the purpose of making provisions for the supply of safe drinking water⁴⁹. It also establishes procedures to ensure the adherence of safe technical and supply standards on the part of drinking water suppliers and makes these bodies accountable to the general public. In doing so, it withholds the belief that safe drinking water is a fundamental human right.

The salient features of the Safe Drinking Water Act 2007 are outlined below:

- Water suppliers, services providers and water storage managers are required to prepare and implement plans in case of a risk related to drinking water;
- Requires water suppliers, storage managers and service providers to ensure that the water they supply meets quality standards;
- Establishes transparency whereby the public is made privy to information regarding the quality of drinking water.

2.6.3 National Climate Change Policy

The goal of the Draft National Climate Change Policy 2011⁵⁰ is "to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate resilient development." The climate change threats to Pakistan identified in the policy are related to extreme weather events, melting of glaciers, siltation of dams, global warming, deforestation, sea water intrusion, vulnerability of coastal areas, water sharing disputes, and health risks. To this end, the policy aims to meet certain objectives by providing policy measures to enhance the adaptive capacity of the country in times of extreme events. A key component of this draft policy is the focus on using an Integrated Water Resources Management (IWRM) approach to form the framework for addressing the impending climate change issues of Pakistan.

The Prime Minister's Task Force on Climate Change, 2010 held extensive meetings on various climate change related issues confronting Pakistan. Its report describes Pakistan's vulnerability to climate change due to the impact on various socio-economic sectors⁵¹. It recommends a number of adaptation and mitigation measures based on the initial available assessment of different sectors and reviews the country's implicit ongoing and planned responses. It also provides recommendations on issues such as the need for capacity building and international cooperation to overcome the global issue of climate change.

2.6.4 National Energy Conservation Policy

The National Energy Conservation Policy, prepared by ENERCON through an extensive consultative process involving all stakeholders, is a contribution to the national effort to steer the country out of a difficult energy supply situation by promoting efficient use of energy resources⁵². The policy enumerates broad guidelines to enhance end-use efficiency in various energy consuming sectors of the economy. The policy is likely to create an enabling environment to support energy security plans of the government and for effecting a change in course to sustainable energy and environment patterns in the future. Initiatives include formulating legislation, developing codes and standards, create public awareness, and capacity building.

2.7 Water Related Strategies

There are a number of other documents that are not policies or acts, but which have gone through some participative processes and consultations, and that form part of the envisioning, strategizing and planning processes in the water sector.

2.7.1 Medium Term Development Framework (MTDF)

The Medium Term Development Framework (MTDF) prepared by the Planning Commission of Pakistan is a comprehensive

⁴⁹ Safe Drinking Water Act 2007, Health Services Academy, Islamabad Pakistan.

Web. 1 Mar. 2011. <http://www.hsa.edu.pk/aboutus/news/2008/Microsoft%20Word%20-%20Final%20Draft%20SDWA.pdf>

⁵⁰ Last updated on 12th April, 2011

⁵¹ Mulk S and Dr A I, Task Force on Climate Change: Final Report, Planning Commission - Official WebSite. Government of Pakistan, Web. 3 Feb. 2010.

<http://www.planningcommission.gov.pk/usefull%20links/Taskforces/TFCC%20Final%20Report.pdf>

⁵² For details on the policy, see ENERCON website http://www.enercon.gov.pk/index.php?option=com_content&view=article&id=54&Itemid=15

document that covers multiple facets for the economic development of the country. For our relevance, only the sections on Water and Sanitation and Water Resources will be examined here.

In the Water and Sanitation sector, the MTDf identifies the shift from the provision of water and sanitation services to the provision of reliable, sustainable and affordable water supply and sanitation services. The MTDf was prepared at the time of the Local Government Ordinance (2001) and thus placed the responsibility of water supply and sanitation services with improved governance and better management and higher community involvement. However, with the recent devolution of the local governments, this strategy has been rendered obsolete and thus must be revisited in the near future. The Water Resources chapter outlines the draft National Water Policy as its main policy strategies to overcome challenges in the water sector.

2.7.2 Ten Years Perspective Plan

The Ten Year Perspective Plan prepared by the Planning Commission of Pakistan pertains to development projects between 2001 and 2011. In terms of water resources, the Perspective Plan identifies key sectoral issues as shortage of additional storages, inefficient operation and maintenance of existing water infrastructure, increase in waterlogging and salinity, excessive groundwater pumping and salinization, effluent disposal and waste treatment, absence of integrated water resources management etc. To this end, its objectives include:

- Overcoming water scarcity through augmentation and conservation;
- Restoring productivity of agricultural lands;
- Managing quantity and quality of drainage;
- Groundwater management;
- Promoting beneficiary participation;
- Enhancing performance of water institutions.

Proposed development projects and their rationale are also provided in this policy document. While it is already 2011 and the success of this plan is yet to be ascertained, the programme it outlined was quite significant.

2.7.3 Pakistan Water Vision / Framework for Action – 2025 (Global Water Partnership-GWP)

Although produced in 2000, the Pakistan Water Vision and Framework for Action produced by Pakistan Water Partnership is very relevant. This framework identifies the inherent weaknesses within the current water management system of Pakistan and identifies key strategies and policies to rectify these shortcomings. The documents pay particular attention to gender issues, which are not accounted for in most of the other policy documents reviewed here. The FFA and Water Vision also provide policymakers with a sound basis of developing an integrated approach to water resources management in Pakistan and could well inform Pakistan's National Water Policy.

2.7.4 WAPDA Vision 2025

The WAPDA Vision 2025 outlines hydropower, water sector and channel storage projects that are proposed to be developed in three phases to overcome water scarcity, energy crisis and food security in Pakistan⁵³. However, this document is more a list of projects rather than a well thought out long-term perspective on water or the Indus Basin.

2.8 Recent Reports and Projections CAS, WAPDA etc

2.8.1 Pakistan Country Water Resources Assistance Strategy – World Bank

In 2003, the World Bank executed an extensive process of linking investments to incorporate water-related issues within the development paradigm of the country. To this end, the World Bank developed water resources assistance strategy documents for

⁵³ See WAPDA website <http://www.wapda.gov.pk/vision2025/default.asp>

countries around the world. It was decided that the World Bank would prepare a Pakistan Water CAS for the period 2006-2010 as part of its country assistance strategy programmes. This document was published in 2005 and is a key policy document that forms the current institutional framework of water resources management in Pakistan. The Pakistan Water CAS report effectively identifies the challenges that Pakistan faces in terms of its water resources, and the necessary responses of the future. It raises legitimate concerns regarding the trust deficit between provinces, unregulated mining of the resource base, climate change issues, the dismal condition of infrastructure etc and cautions that a paradigm shift in thinking towards water resources planning, management, consumption and implementation is necessary to overcome these challenges.

2.8.2 Pakistan Water Resources Strategy Study – Asian Development Bank

The Pakistan Water Resources Strategy study was executed in 2002 with the aim of developing an updated and comprehensive water sector strategy with a planning horizon of 2025. It includes guidance on planning, investment in and management of the water sector. The outcomes of the study are presented in two volumes: volume 1 covers preliminary national water sector strategy and volume 2 pertains to a medium term investment plan. Volume 1 pertaining to the strategy is divided in terms of water sub sectors that include urban water supply and sanitation, irrigation and drainage, industrial water supply, hydropower, environment, and flood protection, among others⁵⁴.

While the Water Sector Strategy is national in scope, there are several Medium Term Investment Plans which address each of the provinces separately since water is a provincial subject in the context of Pakistan, and a fifth Federal MTIP which includes interventions of national scope as well as for the federally administered areas.

2.8.3 Technical Committee on Water Resources

The report published by the Technical Committee on Water Resources⁵⁵ chaired by A. N. G. Abbasi, deems the Inter Provincial Water Accord of 1991 as 'sacrosanct'. All their computations are based on tables as mentioned in the Accord. The report prioritizes the construction of new storages over the construction of flood irrigation schemes. Although, the issue of environmental flows is addressed, no clear policy measure is made to ensure the sustainability of the downstream ecosystems. Instead, the report simply states that 10 MAF (or any other amount based on future studies conducted by the government) of water should be released downstream of Kotri.

2.8.4 WAPDA Report 2010

The recently released (November 2010) WAPDA report outlines the potential of hydropower development in Pakistan. WAPDA is vigorously carrying out feasibility studies of various hydropower development projects to increase the overall capacity of power generation. Most of these studies are at an advanced stage of completion and this report primarily gives a current status update of the ongoing development and rehabilitation projects⁵⁶.

2.9 Conclusions and Recommendations

Pakistan could have determined provincial water allocation at the time of the signing of the Indus Waters Treaty, and both groundwater and urban water issues should have been addressed in the Accord. It is recognized that while the IWT has prevented India and Pakistan from too much acrimony and while the Water Accord was quite an achievement in an environment of distrust and grief, much remains to be done to bring about a policy and legal environment that will allow integrated approaches for the Indus Basin and for other geographical and hydrological zones of Pakistan. It will be hard to develop the political will for this kind of change when politics and economic gain are ostensibly tied to provinces and administrative units, which also form the

⁵⁴ Pakistan Country Water Resources Assistance Strategy, World Bank: Pakistan.

Web. 1 Mar. 2011. <siteresources.worldbank.org/PAKISTANEXTN/Resources/PWCAS-Full.pdf>.

⁵⁵ Technical Committee on Water Resources, Ministry of Water and Power, Government of Pakistan. Full text available online at: <http://www.cssforum.com.pk/css-compulsory-subjects/pakistan-affairs/2009-technical-report-water-resources.html>

⁵⁶ For details on development projects, see online <http://www.wapda.gov.pk/pdf/BroHydrPotentialPakNov2010.pdf>

basis of planning and execution. It is also clear that the entrenched positions on water sharing and related issues are political and if benefits can be designed in an equitable way, among provinces and areas within provinces, then there would be less argument on the nature of water sharing and water resources development, and more compliance with policy and better adherence to legislation.

The new realities of climate change, energy crisis, global economic recession, extreme weather patterns, security issues, social dynamics and population growth dictate that Pakistan's current legislative and policy framework for water resources planning, development and management needs to be revisited and reformulated. This reformulation and reform will, however, imply changes in policy, governance, institutions, laws, regulations and processes that impact on the way water is used, shared, conserved, and valued. For example the draft water policy⁵⁷ at its current stage reads like a list of actions and has no real vision or comprehensive approach. In the same way the Water Accord does not address contentious issues.

While there are laws to govern water distribution at different levels, there is little effective regulation, penalties, or conservation guidelines. To date, Pakistan does not have a single national regulatory framework dealing with the use of water.

The single most important way forward would be to highlight sharing of benefit among key stakeholders (provinces and other territories) in shares determined by mutual negotiations and within the broader framework of the Constitution and in relation to common interests. When benefits are seen to be shared, the parties will automatically relax their stance and positions. For example if the electricity generated from an upstream dam is sent via the national grid to a far-away area in a downstream province, and this reduces the cost of electricity across the board (by saving on expensive petroleum or coal-based generation), then there will be less opposition to the dam scheme.

In terms of policy and legislation, the following are recommended:

- Make benefit sharing the corner-stone of all future water resources development initiatives including the conservation and management of ecosystems and their services that people depend on;
- For those treaties and accords that are 'sacrosanct' (including the Indus Waters Treaty and Water Accord), draft new additions/amendments/conditions within the existing ambit to bring in benefit sharing;
- Bring in equity and fair distribution in the context of benefit sharing;
- Insist on equitable distribution within provinces (i.e. work on the basis of a balance of benefits to head, middle and tail farmers) rather than between provinces;
- Incorporate integrated approaches at Basin level for irrigated, rain-fed and arid areas;
- Use modern tools of verification including GIS and remote sensing for greater transparency.

In terms of water sharing among provinces it is recommended that some specific issues should be addressed directly in policy:

- Storages at different levels;
- Modes of sharing water shortages among provinces when they occur;
- Modes of sharing flood water;
- Modes of generating environmental flows;
- The issue of new canals and the repair of the degenerating infrastructure;
- Countering the siltation of dams and improved watershed management;
- Strengthening the barrages;
- Increasing the productivity of water use in agriculture;
- Tackling low productivity including groundwater in the water resources of each province and/or River Basin.

And finally to be relevant and comprehensive, Pakistan's ongoing water policy exercise needs to be revisited in the light of climate change; develop the concept of agro-ecological zoning; and divide the Indus Basin into its sub-regions and devise targeted long-term water strategies and programming for each. This will mean different actions in different zones to get maximum leverage in

⁵⁷ Pakistan Water Policy Draft, 2006, <http://www.waterpakistan.com/OtherNationalWaterPolicy.PDF>

managing water for all its uses. The guiding principles should include making the greatest savings where there is the greatest amount of use. This means rationalizing the use of water in agriculture; encouraging more crop-per-drop processes; and reducing the use of precious river water in cities by encouraging urban desalination, recycling, and reuse. Introducing water quality standards; aggressively promoting conservation across the board; keeping all natural water bodies replete with water; taking measures to rehabilitate the freshwater-seawater interface on the coasts; adaptation to climate change. These would all be essential elements of a revamped Pakistan water policy.

Once the water policy is in place, a Water Act will need to be prepared to allow implementation of the policy.

Analysis and Review of Water Management Institutions

In the previous section, we examined the policy and legislative structure of the country geared towards resolving water issues. In this section, we focus on analyzing the administrative and institutional mechanisms, and make conclusions on the state of their performance in the context of water resources management.

Water resources management in Pakistan is divided into two tiers: Federal and Provincial. Several major institutions are involved in water resources management at both these levels. In general, the institutional framework for water management in Pakistan is mainly geared towards implementation of the Water Accord of 1991. Water is a provincial issue, and efforts are focused upon maximizing provincial water shares for agriculture to optimize social equity, food security and development⁵⁸.

Federal level:

- Ministry of Water and Power (MoWP);
- Federal Flood Commission (FFC);
- Indus River System Authority (IRSA);
- Water and Power Development Authority (WAPDA);
- Pakistan Meteorological Department (PMD).

Provincial level:

- Provincial Irrigation Departments (PIDs);
- Provincial Irrigation and Drainage Authorities (PIDAs);
- Provincial Agriculture Departments (PADs);
- Provincial Environmental Agencies (EPA).

Institutional reforms in the irrigation and drainage system were introduced in 1997 to make the country's largest and contiguous (approximately 64,000 km) canal irrigation system more efficient, self sustainable and user participatory⁵⁹. Under the National Drainage Programme (NDP), the government established Provincial Irrigation and Drainage Authorities (PIDAs) to supplement the work done by the Provincial Irrigation Departments. In an attempt to shift water management from the centre to the grassroots, reforms were introduced again in 2002 viz a viz the Sindh Water Management Ordinance (SWMO) where a four-tier institutional hierarchy was established at the canal level, Area Water Boards, Farmer Organisations and Watercourse Associations.

3.1 Ministry of Water and Power (MoWP)

The Ministry of Water and Power (MoWP) is responsible for all policy matters relating to the development of water and power resources. One of its main functions is to carry out long term financial and strategic planning in both the public and private sector for the development of these two resources. All public sector water and power projects proposed by WAPDA are first sent to the MoWP for approval. The Ministry examines and analyzes these proposals for their technical and financial viability. Similarly, all private sector power projects are assessed by the Private Power and Infrastructure Board (PPIB) that works under the supervision of the Ministry of Water and Power.

The Water and Power wings are the main functionaries of the Ministry. Power generation, transmission and distribution activities are monitored by MoWP and it also performs an advisory role to ensure the smooth operation of the power sector. The Ministry

⁵⁸ Pakistan's Waters at Risk: Water & Health Related Issues in Pakistan & Key Recommendations, Lahore, Pakistan: WWF - Pakistan, 2007.

⁵⁹ Raasta Development Consultants, Sindh Development Studies Center, and Mehran University of Engineering and Technology, Jamshoro. Third Party Monitoring and Evaluation of Institutional Reforms in Water Sector in Sindh, Report. Sindh: National Drainage Programme, 2004.

coordinates interprovincial water sharing issues including irrigation and drainage and is also responsible for the smooth functioning of the Indus Waters Treaty 1960 with neighboring India⁶⁰.

3.2 Indus River System Authority (IRSA)

To implement the Indus Water Accord 1991, the Indus River System Authority (IRSA) was established in 1992. IRSA is comprised of one representative from each province and a member from the federal government, and is designed to provide continuing interaction among the provinces and to act as a forum for resolution of any disputes among the four provinces on matters relating to sharing the Indus water⁶¹. Each year IRSA projects and determines the available water for Pakistan in the Indus system and makes public the amounts to be released to each province as per the agreed formula⁶². It also operates a Telemetry System at 23 locations of dams, barrages and headworks to monitor water flow and water distribution among provinces⁶³.

IRSA is purported to be a pivotal institution for water resources management in Pakistan. At present, IRSA is specifically structured for its particular tasks and does not have the capacity for a larger involvement in water resources management or basin management.

3.3 Water and Power Development Authority (WAPDA)

The Water and Power Development Authority (WAPDA) was created as the result of the WAPDA Act in 1958 as a semi autonomous body responsible for planning and execution of schemes pertaining to the following⁶⁴:

- Generation, transmission and distribution of power;
- Irrigation, water supply and drainage infrastructure;
- Prevention of waterlogging and reclamation of waterlogged and saline lands;
- Flood control;
- Inland navigation;
- Data collection.

WAPDA was created for the purpose of unifying and giving direction to the development of schemes in the water and power sectors which were previously under the responsibility of the respective electricity and irrigation departments of the provinces. WAPDA carries out several key functions in the water and power sectors. It is the only institution responsible for the execution of all water and power schemes (including irrigation, hydropower and drainage). WAPDA is also completely responsible for operation and maintenance of Pakistan's large multipurpose dams, which are the main hubs of freshwater reserves. It is also responsible for the dissemination of water flow data to different relevant authorities such as the Indus River System Authority⁶⁵.

Since October 2007, WAPDA has been bifurcated into two distinct entities: WAPDA and Pakistan Electric Power Company (PEPCO). WAPDA is still responsible for water and hydropower development, and PEPCO is primarily in charge of thermal power generation and transmission⁶⁶.

WAPDA is regarded as the most powerful entity in Pakistan in both the water and power sectors. **Its main strength lies in its track record and capacity to undertake huge infrastructure projects and attract investments, but among its weaknesses is the perceived hard core engineering approach that bypasses consultation, equity and participatory considerations. It also appears that sustainable development of hydropower has not been given any attention. Nonetheless, WAPDA has given Pakistan some of its best minds in the water sector, including those who have promoted Integrated Water Resources Management (IWRM) and propelled the Pakistan Water Partnership (PWP).**

⁶⁰ MoWP website www.mowp.gov.pk

⁶¹ Kamal S and Panda S M, Water Allocation within India and Pakistan. Report. WWF UK, 2010.

⁶² Ibid.

⁶³ Ibid.

⁶⁴ Ibid.

⁶⁵ Osmani & Co. (Pvt.) Ltd. Integrated Social and Environmental Assessment (ISEA) For A Proposed Sindh On-Farm Water Management (SOFWM) Project, Report. Government of Sindh, 2003.

⁶⁶ WAPDA website www.wapda.gov.pk

3.4 Federal Flood Commission (FFC)

The Federal Flood Commission's main function is to coordinate the planning, development and management of flood protection infrastructure. Prior to 1976, provincial governments were responsible for the planning and execution of flood protection works across the country. However, the devastating floods of 1973 and 1976 proved the inadequacy of the existing flood protection facilities in providing effective protective measures for the country. As a result, the Federal Flood Commission was established in 1973 to oversee planning and execution of flood protection on a countrywide basis⁶⁷. In recent years this Commission became the custodian of the Pakistan's Draft Water Policy.

A more thorough discussion of the role of this Commission during the recent floods is presented in chapter 6.

3.5 Pakistan Meteorological Department (PMD)

The Pakistan Meteorological Department (PMD) is both a scientific and service organisation that functions under the tutelage of the Ministry of Defense. In addition to providing data on meteorology, the department is also concerned with Agro meteorology, Hydrology, Astronomy and Astrophysics (including solar physics), Seismology, Geomagnetism, Atmospheric Electricity and studies of the Ionosphere and Cosmic Rays. Pakistan Meteorological Department shoulders the responsibility to investigate the factors responsible for global warming, climate change its impact assessment and adaptation strategies in various sectors of human activities⁶⁸. For the intents and purposes of this report, the PMD essentially provides data on precipitation, glacier melt, river flows and related areas⁶⁹.

This department's mandate is extensive and its ambit appears adequate to handle the requirements of integrated basin management approaches and climate change.

A more thorough discussion of the role of this department during the recent floods is presented in chapter 6.

3.6 Provincial Irrigation Departments (PIDs)

The provincial irrigation departments have historically been responsible for all water sector activities at the provincial level, including planning, development, and the operation and maintenance of irrigation, drainage, flood control and reclamation works⁷⁰. However, in recent years, the role of WAPDA has progressively grown in relation to several of these activities. Currently the main responsibility of the PIDs relates to the operation and maintenance of the irrigation, drainage and flood control systems. Within the province, PIDs receive daily data on water levels and flows in rivers, canals, minors etc, to check water availability at each successive level. They also maintain the barrages and other irrigation infrastructure.

Under the provision of the Provincial Irrigation and Drainage Act, the PID is responsible for all aspects of the distribution and use of irrigation supplies including on-farm use. However, in practice, this responsibility ends at the end of the water course⁷¹.

The Provincial Irrigation Departments are known as the most powerful provincial departments, because they are the custodians of the most precious resource and responsible for the delivery and management of provincial waters, once water share is allocated to each province. In this position the department is also subject to great political pressure to facilitate irrigation water out of turn to the powerful, and there are many opportunities for corruption that disturbs the system of entitlements in the Indus Basin.

Theoretically, the PIDs should be amenable to working with the idea of basin management, because their 'water districts' are quite differently demarcated than the administrative districts and follow more rational hydrological features.

⁶⁷ FFC website www.ffc.gov.pk

⁶⁸ PMD website www.pmd.gov.pk

⁶⁹ Kamal S and Panda S M, Water Allocation within India and Pakistan, Report. WWF UK, 2010.

⁷⁰ Ibid.

⁷¹ Ibid.

In recent years the PIDs have also come under pressure from institutional reforms in the water sector that have set up PIDs and AWBs which they see as undermining their authority. The tug of war is not yet resolved and in Sindh and Punjab there continues to be a dual system in operation: i.e. some areas under PIDs and other directly under PIDs.

3.7 Provincial Irrigation and Drainage Authorities (PIDAs)

With the introduction of the institutional reforms in the irrigation sector in 1997, the Provincial Irrigation and Drainage Authorities (PIDAs) were established parallel to the PIDs to ease their workload in each province. The PIDs are supposed to operate and maintain all the canals, branch canals, drainage systems, and manage the flood protection infrastructure within the command areas. Under the PIDA are Area Water Boards, which divide up the irrigation system into manageable size. Each AWB has a number of Farmers Organizations and Water User Associations – an effort to make management of the water system more transparent⁷². At the moment PIDs operate in a parallel mode with PIDs and it is not clear how this will be resolved.

3.8 Provincial Agriculture Departments (PADs)

The provincial agriculture departments (PADs) are mainly responsible for organizing input distribution and the extension service to farmers, and notably farm management and the implementation of on farm water management programmes⁷³.

Theoretically the PADs have the mandate and extension services to be key actors in a system of integrated river basin management.

3.9 Area Water Boards (AWBs)

Area Water Boards are active at the canal level. They are responsible for operation and maintenance of the canal and branch canal and related infrastructure under their jurisdiction. The AWB is also responsible for operation and maintenance of drainage infrastructure as well as collection of their share of *Abiana*⁷⁴ from the FOs in their area.

The AWBs are supposed to consist of 12 Members as follows⁷⁵:

- A nominated member from the provincial irrigation and drainage authority;
- A nominated member from the local Chamber of Agriculture;
- Four elected representatives of the FOs;
- Four academicians as co-opted members;
- *Naib Nazim*⁷⁶ or his nominee of the *zila*⁷⁷ having largest area within AWB jurisdiction;
- Director of the AWB – Advisory member and secretary.

The AWBs were designed to be the apex body in a system of stakeholder-based bodies to oversee the irrigation and drainage systems and maximize their use, also ensuring equity and conservation. An assessment carried out in 2004 showed that their performance was variable, but the concept was both strong and feasible⁷⁸.

3.10 Farmer Organisations (FOs) and Water User Associations (WUAs)

Farmers Organisations (FOs) are formed at the Minor/Distributary level, provided that two-thirds of the area of the FO is covered by the Water Course/User Associations. The formation of FOs is the first step in the transfer of management of the distributary/minor from the government department to the water users.

⁷² Kamal S, Use of Water for Agriculture in Pakistan: Experiences and Challenges, Conference on The Future of Water for Food. University of Nebraska. University of Nebraska, Lincoln. 3 May 2009. Speech.

⁷³ Kamal S and Panda S M, Water Allocation within India and Pakistan, Report. WWF UK, 2010.

⁷⁴ Service charge levied on farmers for the supply of surface irrigation water and the provision of drainage

⁷⁵ Osmani & Co. (Pvt.) Ltd. Integrated Social and Environmental Assessment (ISEA) For A Proposed Sindh On-Farm Water Management (SOFWM) Project, Report. Government of Sindh, 2003.

⁷⁶ Local deputy mayor

⁷⁷ Town or jurisdiction

⁷⁸ Raasta Development Consultants, Sindh Development Studies Center, and Mehran University of Engineering and Technology, Jamshoro. Third Party Monitoring and Evaluation of Institutional Reforms in Water Sector in Sindh, Report. Sindh: National Drainage Programme, 2004.

FOs are also responsible for operation and maintenance of field canals and their own water channels. They operate and maintain the irrigation system associated with their canal and are responsible for ensuring equitable and judicious distribution of water, including water for small and tail-end farmers, and non-agricultural and domestic water users. The FOs are supposed to guarantee a minimum drinking water supply and provide flood protection. In exchange for their services, FOs collect the largely nominal water tax or *abiana*⁷⁹.

Water User Associations (WUAs) / Water Course Associations (WCAs) are formed at the grassroots level and conceptually are supposed to comprise of two thirds of the landowners and leaseholders on that particular watercourse. The WCA is also supposed to be registered with that relevant FO. WUAs are responsible for the operation and maintenance of the watercourse as well as equitable distribution of water within the command area of that particular watercourse. The management of the WUA consists of a Chairman, Secretary and a Treasurer⁸⁰.

The FOs and WUAs were designed to be the middle and grassroots level stakeholder fora in a system of stakeholder-based bodies to oversee local irrigation and drainage systems and maximize their use, also ensuring equity, especially for the tail-end farmers. An assessment carried out in 2004 showed that these institutions were very much in tune with the devolution system of that time and with the idea and system of local government⁸¹. While their performance was varied, one or two FOs were doing quite well at that time, especially in areas where the FO members were peers – i.e. farmers with similar landholdings, rather than one big landlord.

In terms of integrated basin management, these participatory institutions could play a constructive role and would be amenable to conservation measures as well as working with agro ecological zoning.

3.11 Local Government System

The local government system was introduced in 2001 with the promulgation of the Local Government Ordinance in August 2001. The new system reoriented the administrative system to allow for public participation in decision making. The rationale for the new government system was to make local governments accountable to the public for their decisions and actions⁸².

The new system provided a three-tier local government structure whereby there was only one line of authority in each district and district bureaucrats were further responsible to elected representatives.

The local government structure had the following tiers:

- Union
- Tehsil (Taluqa) / Town
- District; City District

Unfortunately this system has been either done away with altogether (as in Punjab) or put on hold (as in Sindh). It had provided local people with a voice and with the opportunity to participate in consultative and decision-making platforms. It had allowed women and the marginalized to be represented and had the potential to play a role in integrated approaches in the Indus Basin.

3.12 Patterns and Trends That Affect Institutional Framework

In addition there are some patterns and trends that are crucial to understanding the institutional framework of the Indus basin and the way it actually works. They affect the institutional framework (by impacting how effective they can be) and are themselves affected by the institutions (that can sometime marginalize certain groups). These patterns and trends include the following:

⁷⁹ Osmani & Co. (Pvt.) Ltd. Integrated Social and Environmental Assessment (ISEA) For A Proposed Sindh On-Farm Water Management (SOFWM) Project Report. Government of Sindh, 2003.

⁸⁰ Ibid.

⁸¹ Raasta Development Consultants, Sindh Development Studies Center, and Mehran University of Engineering and Technology, Jamshoro. Third Party Monitoring and Evaluation of Institutional Reforms in Water Sector in Sindh, Report. Sindh: National Drainage Programme, 2004.

⁸² National Reconstruction Bureau, Government of Pakistan website. http://www.nrb.gov.pk/local_government/default.asp

a. Landholding Patterns and Water Rights

Given that in Pakistan land rights are a proxy for water rights in agriculture (in that those who do not own land cannot lay claim to irrigation water) Southern Punjab and upper Sindh are characterized by large landholdings, where big landowners have appropriated water entitlements on the strength of the size of their holdings. The frequent cry for more water is orchestrated by this set of people, and their representatives fill the assemblies of the country⁸³.

The predominance of rural landholding families in the national and provincial assemblies of Pakistan means that any reform legislation on water and attempts to reform water institutions meet with stiff resistance. It is often said that if Pakistan can solve land ownership issues and have land reforms, it will be well on the way to handling and meeting its water challenges. This is endorsed as a basic requirement for improved management of the Indus Basin.

b. Gender and Equity Issues

The issue of clout emanating from land ownership comes to the forefront again when attempting to develop local participative frameworks for improved local water management. Men and women who are medium-size and small farmers, as well as haris (sharecroppers) or wage laborers, may be members, but there is a propensity for the big land owners to appropriate leadership⁸⁴. Since women do not have a clearly defined right over land as a proxy for water rights, their interest in participatory water management is not too high.

In the meantime, carrying water continues to be defined as “women's work,” and remains the main focus of gender interventions, given that women expend much time, effort, and energy in this crucial domestic responsibility. Within these realities, the potential offered by gender mainstreaming strategies and engendered statements in water policy will not be realized very easily.

c. Benefits of Irrigation

While it is partially recognized in Pakistan that water does have “value,” common perceptions do not include an awareness that irrigation water is currently provided far below its economic value. The very low irrigation service charges in Pakistan are usually justified as benefiting the poor. In fact, the organisation of production remains heavily dominated by sharecropping arrangements in which the tenants are insecure⁸⁵. In this arrangement, the benefits of irrigation infrastructure and rehabilitation - including increases in land values of 30 percent over the past decade - have directly enriched the landowners. Unless the tenancy position of the sharecropping farmers is improved through reforms in Pakistan's tenancy laws, landowners are likely to continue to receive the lion's share of the benefits of low water charges and infrastructure improvement, a substantial part of which is subsidized by the government.

Most importantly, a shift is needed from management of water supply to management of water demand. The entire edifice of the argument for more irrigation infrastructure is based on an uncritical capitulation to the demand for more irrigation water for agriculture. There is a need to unpack this demand - who exactly is making this demand, and why should this demand be considered when agriculture already absorbs 97 percent of the total mobilized surface water, and almost all the groundwater, for supporting one of the lowest agricultural productivities in the world per unit of water and land? Can this demand for more water for agriculture be reduced by producing more with less water? The answer is yes. During the drought of 1999-2000, when water availability was drastically reduced, one would have expected lower production. Instead there was a bumper wheat crop, proving that higher yields are possible with less water.

d. Shortcomings of Water Management System

Increasing appointments on criteria other than merit, lack of budgets, absence of a clear definition of roles, responsibilities and targets, lack of coordination and communication between federal, provincial and local administrative departments, mistrust of government and lack of commitment from the people hamper the effectiveness of the water management system and water

⁸³ Also see Imran Ali (2006) in his background paper on Political Economy of Water in Pakistan, LUMS

⁸⁴ IWMI, Irrigation Management in Pakistan and India

⁸⁵ Government of Sindh, Pakistan, Integrated Social and Environmental Assessment (ISEA) for a Proposed Sindh On-Farm Water Management (SOFWM) Project, July 2003.

management institutions.

Although, technically there is a good system of monitoring and checking compliance, water theft and unauthorized withdrawals are also quite common at the canal level and below. And while theft of water is noted, people are often reluctant to go to the police and lodge a complaint, because the police (and often the irrigation department staff as well) do not want to confront the big landlords, who have clout and power (including political power)⁸⁶.

Actual water allocation is also affected by new modules (opening in canals) as any new outlet means less water to the downstream users and tail end users. As landholdings become smaller due to land division or death of landowners, cultivating only 27 percent of available land means lower total output and then people try to increase their water allocation in two ways:

- Authorized way: by getting the Chief Minister of the province to sanction an amount above the regular share of water;
- Unauthorized way: by stealing water through lifting directly from canals and other means.

In addition, while the cropping intensity as per water allocation is to be followed by tradition, there is no penalty if farmers exceed this, and they frequently do⁸⁷. Under the ordinance governing these water management organizations, there are no provisions for these water management organizations to articulate water requirements at the field level⁸⁸. Moreover, a farmer is defined as someone who owns land, while the farmers (sharecroppers) who actually work the land, handle the water and grow the crops usually do not own the land and so are left out of the system and are not very committed to it⁸⁹.

The result is that, while an appropriate and necessary administrative framework exists in theory, its effectiveness is seriously curtailed in practice due to these shortcomings.

3.13 Conclusions and Recommendations

Although WAPDA was stipulated to be the custodian of the Indus Basin, in reality, this has not happened due to the ambiguous and overlapping roles and responsibilities of the several water related institutions.

The Indus River System Authority (IRSA) operates at the federal level, as do the Ministry of Water and Power and the Water and Power Development Authority (WAPDA). Additionally, the provinces have irrigation and public health departments. Since devolution, districts, towns, and union councils have taken over water supply and sanitation (now in disarray). Farmer organizations are also present in some areas. A who's who of water institutions⁹⁰ is now produced and describes 10 public sector institutions, 28 national organisations, and 19 academic and research institutions covering the water sector. So it can be concluded that a good institutional base exists.

In terms of the Sindh-Punjab debate, it can be concluded that not everyone in Punjab has excess, or even adequate, water and not everyone in Sindh is deprived of water. Both provinces face the same issues in terms of equitable distribution among users.

[Integrated water resources management approaches, with their three Es of economic efficiency, environmental sustainability, and equity, may provide a useful framework to reorient water demand and improve water management.](#) From this perspective, Pakistan is not entirely without traditions and options. However flawed it may be, there is a system of water entitlements within the irrigated areas. There are options for increasing water supply from within the system without investing huge amounts in new infrastructure. One such option would be to repair and upgrade the canal system where feasible, while allowing water to seep from canals in areas where ground water needs to be critically recharged. Additionally, there is tremendous scope to increase water productivity by investing in agriculture.

In terms of water rights, in situations where land ownership determines water rights, it is land ownership that needs to be tackled

⁸⁶ Kamal S and Panda S M, Water Allocation within India and Pakistan, Report. WWF UK, 2010.

⁸⁷ Ibid.

⁸⁸ Jan S E, Recommendations for Water Policy Reforms, Report. WWF Pakistan, 2010.

⁸⁹ Kamal S, Use of Water for Agriculture in Pakistan: Experiences and Challenges, Conference on The Future of Water for Food. University of Nebraska. University of Nebraska, Lincoln. 3 May 2009.

⁹⁰ World Bank Report, Who is Who in Water Sector in Pakistan, unpublished, 2007.

effectively. In cases where a right to water is determined by type of use, tradition, or legal entitlement, water reform will need to ensure that all those that are entitled are clearly defined as such.

Given that Pakistan has millions of farmers both land-owning and landless and millions of people who have direct environmental entitlements, it would be extremely challenging, if not impossible, to recognize individual water rights. The arguments for secure rights to land are much more compelling in the Pakistani context than water rights.

There is an urgent need for a paradigm shift in thinking about water resources management. Currently, there is no single organisation that is responsible for the integrity of water resources or for the Indus River Basin.

To cope with the changing regimes of climate change, food security, and global financial crisis, it is recommended that Pakistan must move from a business-as-usual scenario to benefit sharing mechanisms between provinces, so that the needs and priorities of all provinces are met by the new water management legislative and institutional frameworks.

It is recommended that instead of setting up any further institutions, the existing ones be rationalized and their roles delineated carefully, such that they can collectively cope with all the challenges ahead.

It is recommended that the water discourse needs to be redefined in terms of head, middle, and tail farmlands in irrigated areas and in terms of other ways of water resources management in non-irrigated rain-fed and arid areas.

Irrigation and agriculture reforms can generate significant outcomes if some or all of the following conditions are created:

- Land holdings of more or less of the same size (and not skewed between some huge farms and many tiny ones);
- Socioeconomic homogeneity among farmers (i.e. all hold land titles rather than some owning land while the others are landless and caught in a system of sharecropping);
- Incentives in place for better managing service delivery and quality;
- Farmers pay for water based on satisfactory service delivery (i.e. service providers are made accountable);
- Irrigation schemes and programs specifically designed to benefit the poor by putting in specific conditions for investments, repairs, and rehabilitation of water infrastructure.

This chapter covers an analysis of the watershed/catchment management and the reservoir enhancement/management issues and analysis, check the viability of decentralized storage such as (upper catchment) small(er) dams, on-farm storage, micro-hydel, localized self dams, capacity of headworks, barrages, and embankment protection.

4.1 Watershed and Catchment Management

Catchment areas within the Indus Basin System are rather haphazardly managed. Silting of Tarbela and Mangla dam and mitigating such siltation to prolong the life of these dams is an overriding concern of catchment management in the main watersheds. Pakistan has implemented extensive watershed projects above the Tarbela dam with a view to reduce the sedimentation load in its river system. This includes a Social Forestry Project in the 1990's in Malakand (I and II) and projects in Manshera and Abbottabad districts above Tarbela. While having some element of community participation these projects fell short of mass scale plantation led by communities with a view to develop partnerships and long term benefit sharing from the trees planted. It was estimated that the sedimentation load on Indus at Durband gauging station above Tarbela would be around 440 million tonnes or 0.24 MAF per annum. The silting rate of Tarbela was estimated to be around 2 percent per annum. The Tarbela Dam case study, 2002 noted that sedimentation accumulation was much lower than observed and the predicted useful life of Tarbela of 50 years could possibly be 85 years at the prevailing rate of sedimentation.

Reducing sedimentation load has been approached by several watershed management projects above Tarbela. For instance a Pilot project was initiated in 1964-65 for part of the Siran catchment. This was expanded in 1971-72 into the Daur watershed of the Siran River. Again the project was expanded to include 4 divisions of then NWFP (now KPK) on the east of the Indus. However, all these efforts have yielded minimal results. One reason is that the Tarbela watershed management programme has limited impact on sedimentation control as these cover only 6 percent of the area of drained water into Tarbela. More important is the fact that 90 percent of the run-off is dominated by snow/glacier melt over which the watershed activities have little impact. However, constructing storage structures like Basha Diamer dam could significantly reduce the sedimentation load into Tarbela and consequently extend its life.

Similar attempts through large scale plantation campaigns in Kashmir above the Mangla dam have had less impact on siltation of these reservoirs. In fact the only tool actually used for catchment management has been to stock up depleted forest areas (Pakistan has less than 4.8 percent tree cover). Even, here there are serious limitations on being able to reduce sedimentation given the geological and morphological characteristics of the mountainous terrain. Since Pakistan's rivers are primarily fed through glacier/snow melt widespread land sliding and unabated debris enters the river systems which is largely independent of the tree cover. Even though there are studies by the Pakistan Forest Institute that show positive impact of tree plantations on upper catchment management.

Pakistan has engaged in Social Forestry Projects in Malakand division with good results on improving tree cover. As catchment management revolves around land water relationships that are interwoven with stakeholder and community participation often the engagement of stakeholders in design, implementation, monitoring and evaluation of projects has been the major missing link. Flooding has occurred in major rivers due to unabated tree cutting that leaves any strategy for catchment management in the doldrums and renders it in-effective.

Recent attempts to employ Geographic Information System (GIS) tools to delineate areas of intervention have helped improve the planning of catchment management within the Ministry of Environment. The government now recognizes the need for Integrated Catchment Management that utilizes multiple approaches, for example rain harvesting, flood control, tree plantation, social

Table 2 – Source of Water Flow in Main Rivers of Pakistan

	% of IRS Inflows	% Seasonal Distribution		Dominant Source in Summer	Dominant Source in Winter
		Summer (Apr-Sep)	Winter (Oct-Mar)		
Indus	44	86	14	Snow/Glacial melt	Winter Rainfall + Baseflow
Chenab	19	83	17	Snow/Glacial melt + Monsoon	Winter Rainfall + Baseflow
Jhelum	16	78	22	Snow/Glacial melt + Monsoon	Winter Rainfall + Baseflow
Kabul	16	82	18	Snow/Glacial melt	Winter Rainfall + Baseflow
Others	5				

Source: GISC, Islamabad, Pakistan

mobilization, pasture and land rotations, slope stabilization through grass, shrubs and aerial seeding in highlands to increase vegetative density. While the National Forest Policy developed by the Ministry of Environment addresses different forest areas it fails to recognize the importance of forests in catchment management, and thus a clear strategy for upper catchments is absent in the policy framework.

Besides the main Indus catchment areas, technical assistance has been sought (JICA- Japan International Cooperation Agency) for specific problems like the problem of Lai Nullah drainage near Rawalpindi. GIS approaches are being used to introduce catchment management practices that reduce the occurrence of floods in this heavily populated urban stream that has caused extensive damage to life and property in the past. There could be minor trade-off by increases in evapotranspiration in upper reaches and some reduction in river flows due to water shed developments upstream.

4.2 Reservoir and Hydropower Initiatives

WAPDA has recently revealed its hydropower development strategy on sites above Tarbela (see Table 3)

Table 3 – Outlook of Hydropower Development

S#	Project	River	Location	Capacity (MW)	Earliest Project Initiation
1	Diamer Basha	Indus	GB	4500	2010
2	Golen Gol	Chitral	KPK	106	2010
3	Tarbela 4 th Ext.	Indus	KPK	960	2010
4	Kurram Tangi	Kurram	FATA/KPK	84	2011
5	Kohala	Jhelum	AJK	1100	2010
6	Dassu	Indus	KPK	4320	2012
7	Bunji	Indus	GB	7100	2012
8	Others (Bara, Tank Zam Matiltan & Palas Valley etc.)		KPK/GB/AJK	1500	2011-2015
9	Munda	Swat	FATA/KPK	740	2012
10	Patan	Indus	KPK	2800	2013
	Total			23,210	

Source: WAPDA, 2010

The development of such projects while contributing to hydropower generation in the country will also help reduce sediment load downstream. Both Basha and Dasu are projects that can help better manage floods provided simultaneous attempts are made to use integrated catchment management by engaging populations in the Gilgit-Baltistan areas. On the Swat River it is expected that Munda Dam will contribute significantly to mitigate the negative impacts of floods on Nowshera and other parts of KPK. However, despite almost 40 percent operations of the project the local influential started making unreasonable financial demands and the security situation forced an exit, and the project lies abandoned. [Needless to say, that any dam construction should adhere to international guidelines and ensure that social and environmental costs are calculated and reflected in the project appraisal documents. Special care should be taken to address environmental concerns at the Environmental Impact Assessment \(EIA's\) stage which should be broad based with extensive stakeholder consultation.](#) At the sub basin levels in Balochistan particularly IWRM approaches are being encouraged through the Embassy of the Kingdom of Netherlands and IUCN.

IWRM approaches are helping to improve catchment management through small dams like Sabakzai. New proposals of the Hingol Dam aim at improving watershed and catchment management above the dam site, thus consequently allowing command area development of several thousand hectares for high value agriculture. Saving the Hingol National Park and better management of flash floods, erosion losses are subsidiary objectives of such projects.

4.3 Groundwater- An Alarming State of Affairs

The Indus Basin has fresh groundwater reserves of about 55 MAF⁹¹ most of them in Punjab. The use of groundwater for agriculture in the Indus Basin and in *barani* areas began on a larger scale in the mid 1960s and has escalated rapidly to date.

Groundwater has become a major supplement to canal supplies, especially in the Upper Indus plain, where groundwater quality is good. There are presently more than 1.5 million tube wells in the Indus Basin area. Over the past 40 years, while the unchecked exploitation of groundwater has brought many economic results, there are now clear indications of aquifer mining (which occurs when too much water is pumped from aquifers). Groundwater now accounts for half of all farm irrigation requirements; therefore, it is supplementing the 34 MAF of surface water that reaches farmlands⁹². This conjunctive use of surface and groundwater has been hailed as a giant step forward in some quarters, especially because it has enhanced access of both big and small farmers to what is seen as additional water for irrigation.

Almost 50 MAF of water is abstracted from aquifers in both irrigated and *barani* areas. The Indus River system provides a variable flow but recharges groundwater. Punjab's groundwater resources are mostly useable for agriculture and much of the water logging and salinity problems are brought under control. In Sindh, groundwater is saline and requires mixing with canal water to be useful for growing most of the economically important crops.

The quality of groundwater ranges from fresh (salinity less than 1000 milligrams per liter, or mg/l Total Dissolved Solids) near the major rivers to highly saline further away, with salinity more than 3000 mg/l TDS. Close to the edges of the irrigated lands, fresh groundwater can be found at a depth of 20-50 meters⁹³. Large areas of the lower Indus Basin are underlain with groundwater of poor saline quality, but with lenses of sweetwater on top. Indiscriminate pumping and the heavy use of pesticides have resulted in contamination of the aquifer at many places where the salinity of tube well water has increased.

In the wake of canal irrigation, water shortages and reduced water flows to middle and tail ends this forces farmers to place heavy reliance on groundwater. In many areas groundwater is the only assured source of water and vital for continuity of agriculture in the Indus Basin. However, such unabated and continuous dependence is resulting in falling water tables forcing farmers to install tube wells at even greater depths of ground boring. Traditionally water boring in Punjab was undertaken at 120-150 feet. At present boring depths of 300-400 feet are common with replacement bores required every 5-8 years.

Groundwater quality and quantity is decreasing in and around cities and towns in some parts of the country (Balochistan, Potohar, Thar, Kacho, and parts of KPK) where groundwater is the only or major source of water for all uses. In and around the city of

91 Pakistan Water Partnership, South Asia Water Vision, Country Report Pakistan, July 2001, pp 6

92 Kamal S, Pakistan's Water Challenges: Entitlement, Access, Efficiency and Equity' Running on Empty: Pakistan's Water Crisis. Washington DC: Woodrow Wilson International Centre for Scholars Asia Programme, 2009. 28-44, Print.

93 Ibid.

Quetta, the mining of groundwater has reached a point where predictions are being made that in the next 5-10 years we will see the loss of the aquifer⁹⁴.

Due to this over-exploitation of groundwater, the province has been in a crisis for many years. The famous traditional apple orchards that depended on groundwater are gone and the trees are being cut-down in many areas. The flat rate of electricity charges in Balochistan has been identified as the major culprit of unabated water abstraction. Groundwater exploitation through tube wells places great burden on fuel and electricity resources of a power deficit nation.

In Punjab, the Vehari area and in districts along the Sutlej many farmers are abandoning agriculture and land prices are declining because groundwater pumping and drilling costs are becoming prohibitive. At present rates of groundwater abstraction and especially with climatic changes, within 50-80 years, agriculture in Punjab will most likely be severely affected due to a complete decrease of aquifers beyond economical abstraction level⁹⁵.

Earlier, the practice was to regularly take measurements of groundwater and river flows and regular maps were prepared by WAPDA on the basis of this data. Unfortunately, this practice has been discontinued.

While agriculture is the main user of groundwater, industries in Pakistan and urban water supply are to a large extent dependent on groundwater sources. Over use is creating health problems as industrial pollutants and arsenic are entering groundwater resources beyond permissible levels in many areas. This problem is emerging as a serious issue in cities like Hyderabad, Nawabshah and other parts of lower Sindh.

4.4 Small Dam Potential

Pakistan has extensive potential for construction of small dams on its tributaries that feed into the Indus Basin system. More recently small dams have received renewed interest with the government announcing over 50 small dam projects. A study of the Flood Commission of Pakistan is underway to screen 10 small dams from over 100 that were identified during a pre-appraisal. According to the definition by the (ICOLD), large dams are defined as: those having a height of 15 meters from the foundation or, if the height is between 5 to 15 meters, having a reservoir capacity of more than 3 million cubic meters'. Small dams are normally less than 15 meters in height. This category includes, for example, farm ponds, local silt retention dams, and low embankment tanks.

Pakistan coordinates its small dam activities through the Small Dams Organisation (based in Islamabad). Each district with the potential for small dams places a regular call for proposals to undertake a feasibility, and take on projects for the Federal and Provincial Governments. The overwhelming potential of small dams lies in KPK, Punjab, Balochistan and AJK.

At present, Pakistan has over 68 listed small dams with an average capacity to irrigate 6800 acres. Are small dams a substitute to large dams? It does not seem so. According to former Chairman of WAPDA Mr. Shamsul Mulk it would take 750 small dams to develop the capacity of just one Kalabagh dam (around 6 MAF)⁹⁶. Moreover, engineers also feel that there are just only a number of places where small dams of appreciable size can be developed. Recently, the government announced its plans to develop over 314 dams but later withdrew its support stating that the feasibility reports did not conform to standards, costs were over 180 percent higher than originally estimated, and it had serious doubts about the effectiveness of such dams to curb or address the hydro power crisis of the country⁹⁷. Concerns have also been raised that small dams are not supervised or properly maintained and cautions against dam failure and risk have been expressed⁹⁸.

Whereas small dams are not a substitute for large mega dams they provide the following functions:

- Serve as storage for drinking water in areas where there is acute shortage;

⁹⁴ Ibid.

⁹⁵ See Water Country Assistance Strategy, 2005 and <http://www.faqs.org/periodicals/201009/2173656211.html> Ind Pakistan: Indus Basin Water Strategy - Past, Present and Future.

⁹⁶ <http://www.pakrealestatetimes.com/showthread.php?tid=2626>

⁹⁷ <http://www.defence.pk/forums/economy-development/75711-president-shelves-small-dam-projects.html>

⁹⁸ Rahman A, For concerns on dam safety and notes on failure of dams historically see <http://pecongress.org.pk/images/upload/books/612.pdf>

- Used for irrigation and as source of water for livestock;
- Water security in far flung areas;
- In higher reaches there is some hydropower potential;
- Fish production and recreation.

Small dams are often promoted as low cost solutions in comparison with large dams that cost billions of dollars. These dams can be constructed in a short period of time and communities in distant places can benefit from the technology. Since, these dams are built as off channel storage they create less resistance, and benefits can be shared with the communities residing in the vicinity. **The appraisal of such dams is much faster with fewer environmental impacts often gaining immediate community support.** Also, since most of the excavation equipment is readily available in Pakistan, and the technology is simple, such projects often engage local communities thus serving as a source of income to a wider segment of the population with local multiplier affects.

In certain cases small dams have been constructed within the private sector solely by local residents. These dams provide much needed drinking and irrigation water and help store valuable water during periods of scarcity.

4.5 On-farm, Village and Underground Storage

Traditionally each village in Pakistan would have its own village pond that served as water storage and met the basic needs for animal watering, bathing and washing. However, population increase has largely diminished this community water storage. At the farm level the traditional Persian Well is also on the decline and has been replaced with the popular diesel operated tubewells. Whether the pumping action is diesel (high cost) or electric (uncertain supply/load shedding) it relies on the mechanical uplift of water. Access is also limited to those who own the land and thus control the water resource.

Spat Irrigation and Rodh Kohi agriculture that utilize techniques of rain harvesting by construction of smaller bunds is also a means to temporarily capture water and encourage underground storage and reduce run-off. This type of water management is widely practiced in Southern parts of KPK and Balochistan. Rain water harvesting especially roof harvesting is a viable solution for urban areas where households can store critical rain water for home and garden use in storage tanks and can also improve water recharge by targeting water to the recharge wells.

4.6 Micro Hydel Potential

Utilizing stream flow to propel turbines that eventually are hooked to generators which produce electricity has long been utilized to provide power to far flung areas. Pakistan has extensive experience with micro hydel generation in the upper catchment areas. A report by AKRSP suggests that more than 180 projects were initiated by 2005 in Chitral and Gilgit, and these schemes helped micro hydel power which is plentiful in the Northern Areas and eased the power and heating crisis, thus averting widespread deforestation in the process.

The hydro potential of Pakistan is estimated to be about 41 GW, out of which 1,290 MW can be generated by micro-hydro systems. These potential off grid micro-hydro systems are essential for the communities living in the remote areas of Pakistan and may be installed on canals and water falls which are abundant in the remote areas. Cross flow turbines are being manufactured in Pakistan and are usually quite successful for micro-hydro systems. However, cross flow turbines are not suitable for a majority of the prospective site conditions. Furthermore, custom made conventional turbines are not mass produced and for the micro-hydro systems, standard centrifugal pumps may be used as turbines⁹⁹.

According to the Alternate Energy Board (AEB) the maximum potential of micro hydel is in the Gilgit-Baltistan region. Pakistan has an installed hydroelectric capacity of 5,928 MW of large (>250 MW), 437 MW of medium (>50 MW and <250 MW), and 253 MW of small to micro (<50 MW) plants, mostly in the northern parts of the country. This amounts to 6,608 MW of total capacity, or less than 15 percent of the identified potential.

⁹⁹ Chatta et al, 2009

The Government of Punjab has embarked on a major initiative both with public and private sector engagement for expanding the micro hydel network on its major canals. It presently has 5 projects with planned generation of 25 MW on Marala, UCC, UCC-tail, Okara and Pak Pattan canal sections. Several small projects were installed on the canal reaches (e.g. Rasul headworks sections). The total estimated potential planned for Punjab canals is 366 MW. While plans are to take advantage of the current flow of canals, artificially induced flow is also possible¹⁰⁰. Micro Hydel power generation in Punjab is not new and one historically important project planned and executed by the famous Sir Ganga Ram (of Ganga Ram hospital fame) initially for 1 MW is now being upgraded to 4 MW capacities. Incidentally, a potential site at the fall of the Jhelum-Chasma is being stalled with possible objections on canal operation and dispute arising with Lower Riparain Sindh that is objecting to the operation of this canal for inter water transfers from Indus to Jhelum River. These small projects can be linked directly to the main transmission lines and thus supplement power shortages that are now affecting the economic development of Punjab.

Box 1 Advantages of Hydel Power

1. The natural flow of streams is utilized without incurring great infrastructure cost like building specialized storage;
2. Earlier turbines were imported, but now the technology is available in Pakistan and can be tailored to suit local conditions with low cost maintenance;
3. Once installed power generation is virtually free;
4. Village level transmission lines can be installed directly from the generator;
5. The tariff structure can be developed by the village community based organisation to cover the capital and operational costs and tariff rates are often much lower than large scale projects;
6. Electricity generated is 'Green' and no carbon emission is created so the local environment is pollution free;
7. Micro Hydel generation in Northern Areas has provided the only source of energy which would not be possible without investing in very expensive transmission lines;
8. Communities control the power generation so there is less chances of line losses and theft.

Micro hydel development in Pakistan has taken a new turn after the devastating floods that hit Swat. Many international organizations including GEF, UNHCR, AKRSP and private developers are investing in micro hydel to alleviate the power shortages and floods caused damages to power supplies. The potential is immense and allows villages and communities to harness stream flows to produce electricity over which they have control.

4.7 Barrage Development

Barrages are systems that create large water bodies to serve as water ponds to store water. Pakistan has an extensive system of barrages e.g. Chasma, Khanki, Sukkur, Gudu, Jinnah, Little, Taunsa Barrage and so forth. The majority of the Barrage's were funded under the Indus Basin Treaty (1960). The irrigation system diagram Map 2 shows the location of different barrages¹⁰¹. Total water holding capacity and technical data of barrages in Pakistan is shown in table 4.

Besides formal barrages there are other wetlands that can be supported by creating artificial and temporary wetland sites. These water bodies serve temporary structures that can absorb flood waters for temporary storage and are often developed on unproductive and waste lands near river systems e.g. Lillah area off the motorway on the river Jhelum. Likewise there is a large ponding area on Chenab River which serves as a wetland during flood peaks near Pindi Bhattian.

¹⁰⁰ Details on Punjab Power Generation can be found Government of Punjab's policy document of 2006 revised in 2009. The Power Generation wing in the Irrigation and Power Department is responsible for implementing micro hydel projects

¹⁰¹ See <http://waterinfo.net.pk/cms/pdf/mbp.pdf>

New planned developments for barrages as perceived by WAPDA are shown in map 3.

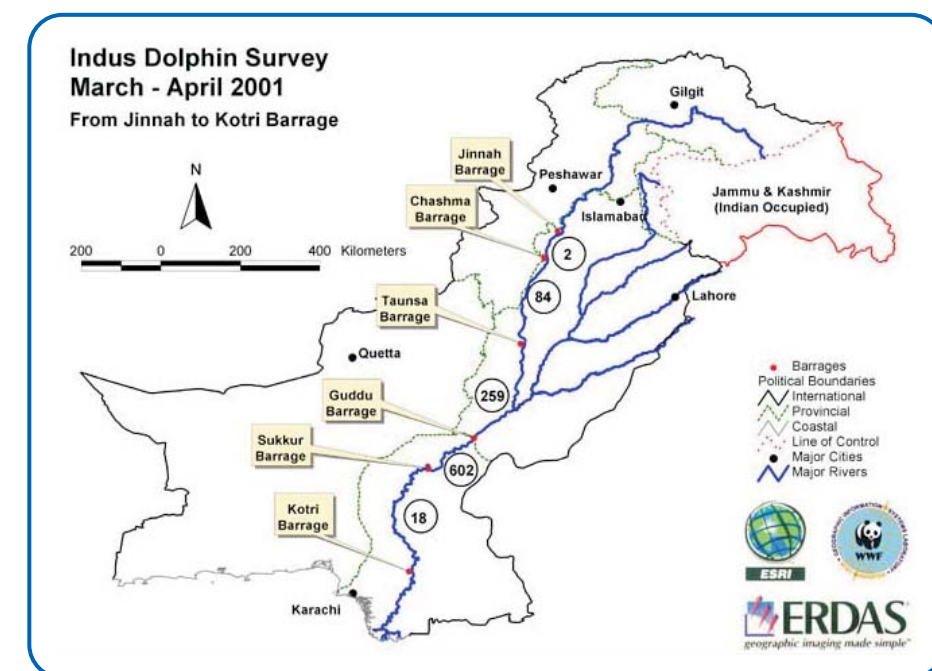
4.8 Embankment Protection/Dikes

Neglecting Embankment protection and building new dikes come into vogue only when their need is reminded by floods. For a few years after the floods there is public funding available for them which dwindles and takes lower priority as the event is forgotten. Many plans are available with the Flood Commission of Pakistan, and can become viable public participatory projects with widespread multiplier affects through distribution of social and economic benefits to a wider segment of the population. Large projects like LBOD and RBOD in Sindh have met mixed success. With large financial outlays in the form of costly loans the investments are viewed with suspicion and are open to widespread criticism and critique from civil society. Few evaluations exist on the effectiveness of such structures as currently designed to mitigate the impacts of large floods like the one witnessed in 2010.

Table 4 – Technical data of Barrages in Pakistan

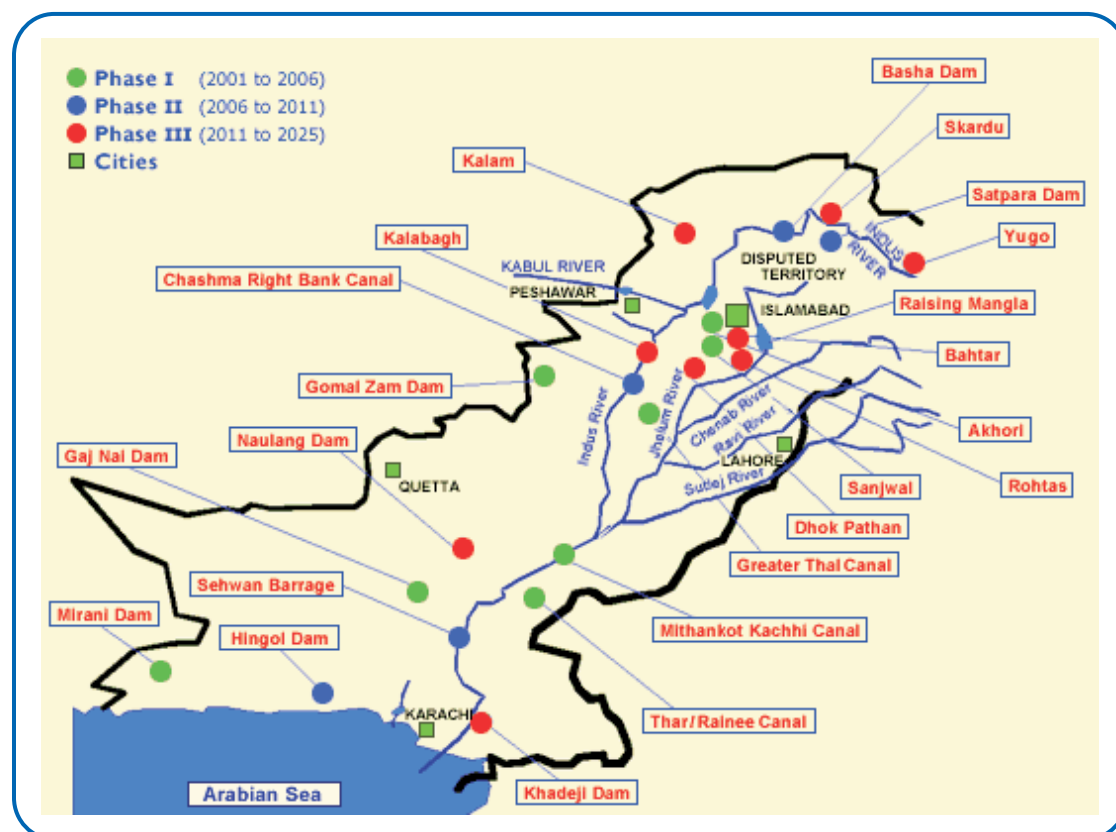
Barrage	Year of Completion	Max. Design Discharge (cusecs)	No. of Bays	Max. Flood level from floor (ft)	Total Design Withdrawals for Canal (cusecs)
Chashma	1971	1,100,000	52	37	26,700
Guddu	1962	1,200,000	64	26	-
Jinnah	1946	950,000	42	28	7,500
Kotri	1955	875,000	44	43.1	-
Sukkur	1932	1,500,000	54	30	47,530
Taunsa	1959	750,000	53	26	36,501

Map 2 – Location of Barrages in Pakistan



Source: WWF Pakistan

Map 3 – WAPDA Water Vision 2025 Proposed Projects



Source: WAPDA

4.9 Realizing the Potential of Pakistan's Large Dams

Given the protracted debate on Kalabagh dam and the entrenched positions of Sindh and Punjab, the real contribution of dams to Pakistan and their potential had become lost in too much rhetoric and politics. It is time to think of these dams as assets of Pakistan which can be used to raise financing for the repair and further development of Pakistan's irrigation infrastructure.

Box 2 Financial Dynamics of Tarbela Dam

The project was financed through Tarbela Development Fund (TDF) created in 1968 out of the remaining balance from the IBDF and additional loans and grants from friendly countries. The calculation of cost overrun is dependant on the way in which annual payments are inflated (according to local or foreign inflation rates) and which document is taken as the base cost estimate. Two approaches are used to define the possible range of cost overrun. In the first approach, the total project cost including all 12 projected power units is taken from the Lieftinck Report and inflated to 1998 prices. The original estimated capital cost, including the proposed generating capacity of 2,100 MW, was 1136.4 million (\$5875 million 1998 prices) with a foreign exchange component in the order of 60%. The actual annual disbursements for all civil and power works (3 478 MW), including resettlement and debt servicing, were converted into dollars and inflated to 1998 dollar prices. This resulted in an estimate of actual costs in 1998 terms of \$8800 million, or an increase of about 50% over the estimated capital cost. The second method makes a comparison of financial flows (in prevailing prices) related to the original cost in the SAR and supplementary loans. The final cost according to the Project Completion Report (PCR),

excluding power units (WB 1986), was \$1497 million including a foreign exchange component of \$800 million. It covered the cost reimbursed from TDF and related to: dam and associated civil works; power station civil works for four units only; design improvements; and special repairs/restoration. It did not, however, cover the cost of resettlement, additional Tunnel No. 5 and power installations (units 1 to 14) that were borne by the Government of Pakistan (GOP) and the Water and Power Development Authority (WAPDA), respectively. The original estimate for the same scope of work (excluding power etc) was \$828 million. The cost overrun in purely nominal dollar terms was therefore 81 percent. Further work is required to determine more precisely the project cost overrun which is estimated to be in the range 50-81 percent from the two methods used.

Source: Tarbela Dam Case Study, WCD 2000¹⁰²

4.10 Conclusions and Recommendations

Hydropower presents significant opportunities for the economic development of a country but on the other hand it can also bring significant social and environmental risks. In the light of the concept of sustainable development, Sustainable hydropower requires the integration of economic development, social development and environmental protection. Other than power and energy, the aims of Sustainable hydropower should be to:¹⁰³

- Ensure that the environmental and social costs are minimum, and that it benefits all the people living in the basin region;
- Incorporate the lessons learned from past unsustainable practices into current practices;
- Understand the social, cultural, socio-economic and environmental values of the basin;
- Integrate river basin planning and hydropower development management and regulatory framework.

The financial dynamics of Tarbela highlight the untapped potential of the linkage between the public and private sectors in the context of water resources development in Pakistan. There is no tangible relationship between public and private entities in the water sector. Pakistan has the world's largest contiguous irrigation infrastructure but we do not leverage our investment in water, which has huge potential as collateral to private sector investment.

Neglecting watershed management in the upper Northern Areas has a negative impact on soil erosion, and consequently contributes to reduced life of dam structures. Ignoring watershed management also has reportedly increased the damage from floods as evidenced by devastations in Swat and Malakand region. Wisely planned watershed projects that enhance tree cover and emphasize sustainable land use can contribute to reduced run-off and healthier environment conducive to water saving.

Pakistan continues to face the twin menace of water logging and salinity although at the national level problems have been curtailed. Still catchment management can directly contribute to salt load management in the Indus Basin. Addressing the salt balance problem can help improve ground water quality and also impact agriculture productivity particularly in the Sindh province where freshwater is constraining agriculture especially as river flows become highly variable due to the impact of climate change.

Over mining of the aquifer resources is a serious concern and unabated installation of tube wells without any concern for the health of the aquifer is having disastrous consequences throughout Pakistan. Even in cases where there is an adequate reserve of fresh groundwater (Punjab) exploiting the groundwater beyond normal requirements has led to a drawdown often more than 20 feet annually. This is negatively impacting agriculture and increasing the cost of pumping water. It will not be long before such reaches in which over exploitation takes place become unproductive or have to be abandoned (e.g. Balochistan apple plantations).

Although, the conjunctive use of surface and groundwater has been hailed as a giant step forward in Pakistan, now there are

¹⁰² A detailed analysis can be found in Tarbela Dam and related aspects of the Indus River Basin Pakistan, WCD 2000. available online:

<http://www.adb.org/water/topics/dams/pdf/cspkmain.pdf>

¹⁰³ Rapid Basin-Wide Hydropower Sustainability Assessment Tool (RSAT) 2010. (Joint Report By USAID,ADB,MRC,WWF)

indications that aquifer mining and long-term use of groundwater may lead to secondary salinization¹⁰⁴. Since much of the groundwater recharge in the Indus Basin is from canal seepage, an integrated approach is required for the “conjunctive” conservation of surface and groundwater. Leakages of canals, water theft and overflows primarily create moisture regimes on fields but where they are extensive these seepages can contribute to underground water recharge especially if the magnitude is high and soil porous that allows deep percolation. There are some areas where new technologies may be needed for skimming shallow lenses of sweet groundwater¹⁰⁵. In all other areas, strict groundwater monitoring and regulation are required as soon as possible¹⁰⁶.

Pakistan needs to focus on:

- Regulation and licensing, as well as close monitoring of tube well installation, depths at which boring is undertaken
- Inventory of groundwater resources and changes over time;
- Promoting of solar operated pumps that have initial large investments but the marginal cost of pumping more water is close to zero;
- Measures that provide incentive for water conservation and support alternate technologies that reduce the required amount of water required by crops;
- Policing of irregularities and action on emergency basis to avert a crisis in Balochistan;
- Developing groundwater storage as an alternative to surface storage;
- If the cost of pumping water can be reviewed in the light of *abiana* the two sources irrigation water and groundwater can be balanced close to the true cost (pumping) and value of water (opportunity in next best use);
- Proper steps to address the issues of water quality;
- Development of smaller sustainable projects that take into account environment concerns and are cognizant of upper lower riparian issues;
- Greater attention to more micro investments in village ponding structures, micro hydel projects, small dams, water harvesting for enhancing water security;
- Exploiting Pakistan's vast small dam potential with greater attention to safe design and social engineering of the benefits of these scheme;
- Revive the traditional *karez* system in Balochistan;
- Focus on developing technology and equipment to the dredge and silt of check dams to increase their longevity.

¹⁰⁴ Kamal S, Use of Water for Agriculture in Pakistan: Experiences and Challenge, Conference on the Future of Water for Food. University of Nebraska. University of Nebraska, Lincoln. 3 May 2009. Speech.

¹⁰⁵ Pakistan Water Partnership, Supplement to The Framework for Action (FFA) for Achieving the Pakistan Water Vision 2025, July 2001.

¹⁰⁶ Kamal S, Pakistan's Water Challenges: Entitlement, Access, Efficiency and Equity, Running on Empty: Pakistan's Water Crisis. Washington DC: Woodrow Wilson International Centre for Scholars Asia Programme, 2009. 28-44. Print.

This chapter focuses on environmental flows, and their importance for sustainable development. Environmental flows refer to the amount of water needed in a [watercourse](#) to maintain healthy [ecosystems](#) and directly improve livelihoods and human welfare just as agriculture, industry, hydropower and domestic users all place demands on water resources, so does nature. By supporting nature we can expect gains in terms of enhanced opportunities for inhabitants who depend on such water for sustenance. Water use is not consumptive, rather aquatic ecosystems require water to support the flora and fauna that live within them. Managing water resources effectively is about balancing water supplied to lakes and rivers by rainfall and groundwater with these competing demands. At the time of signing the Indus Waters Treaty (1960) the concept of minimum environmental flows or climate change impacts on water resources were rather unknown. Pakistan's concerns of minimum environmental flows stems from the abandonment of 3 of its rivers (Sutlej, Beas and Ravi) to India as part of the IWT. These rivers receive no flows or just tributary run-off that is generated on the Pakistani side. During high flood season in India some releases are received but these do not change the definition of “Dead Rivers”. Likewise construction of dams and barrages on the Indus River has altered flows which at times are detrimental to the ecological and environmental health of the Indus River System especially downstream in the delta areas.

In another study by the World Commission on Dams (2002) it was noted that the construction of Tarbela Dam impacted the ecological health of the river. In particular in certain instances water flows below Kotri were disturbed for upto 3 months that resulted in formation of sand and braided the channels. Likewise construction of barrages like Sukkur and Guddu have increased the cropping intensity in many surrounding districts. This altered water flows and diversion to agriculture, reduced water flows below Kotri which is the last structure to block water before it opens into the mouth of the Arabian Sea at Thatta and Badin districts. Any release between Guddu and Kotri is heavily influenced by the landed aristocracy in these reaches that control the water into the canal system, and this is determined by the political economy which tends to favour the farming community over meeting any environmental needs.

5.1 The Case for Downstream Environmental Flows for Indus Basin and Minimum Flows

A general ignorance exists about the river water based environmental and ecological systems among the policy makers, planners and managers. The water needs of these systems are even less acknowledged and accepted¹⁰⁷. This approach can be used as an indicator to evaluate the vision and potential of key organisations, like WAPDA, as basin level managers. Sensitivity on environmental issues is exceptionally high in Sindh. The province as the lower riparian has always brought in the issues of Indus delta, lakes and riverine water uses into the dialogue.

However, the sensitivity of the Lower Indus or Sindh can be justified. [The interaction between local communities and natural water bodies have been stronger in Sindh because of unusable groundwater, high aridity and dependence of communities on the aquatic and ecological goods \(fish, forest other vegetation\)](#). Sindh's insistence on water needs down stream of Kotri has been finally successful in carrying out three environmental studies.

For example 'Environmental Concerns of all provinces in Pakistan (STUDY III)¹⁰⁸'. The complete reports of these studies are still not available in the public domain but can be accessed through the Flood Commission of Pakistan, while, the government has made public recommendations of a panel of experts:

¹⁰⁷ Habib Z, see situational analysis on the water crisis including the issue of environmental flows in Pakistan. Web:

http://www.southasianmedia.net/Magazine/Journal/11_water_management.htm

¹⁰⁸ Environmental Concerns in Pakistan (Study III), FFC, GoP

- 5000 cusecs constant discharge is recommended downstream Kotri barrage in the River Indus to meet all water needs of the downstream delta;
- Below Kotri, releases will equitably share shortages of the system; these releases will be dealt like diversions to an irrigation canal. 5 MAF average flood flows should go over 5 years, i.e. 25 MAF water should go down during the flood months of five years.

While questions could be asked about the practical implementation of 5 MAF flood flows during a prolonged drought. Nevertheless, this quantification is a big achievement towards acknowledging environmental water needs.

The environmental water requirements outside the Indus Delta are still not fully acknowledged. Some of these requirements, water uses by lakes and wetland, are partially fulfilled by the existing system, but not protected through allocations. A part of water replenishment of lakes and other ponds is accounted for, as water losses or managed through the time lags. The impacts of these uses can be seen from a systematic change in time lags between different barrages. For example, after a dry period or during winter cultivation, the time lag between two last barrages of Indus (Sukkur and Kotri Barrages) increases because a higher percentage of water is consumed by the extended river cross section and riverine cultivation. An estimated summer replenishment of all water bodies on the Indus and its tributary rivers downstream Kotri is in the range of 5 MAF.

The existing water access to the riverine areas has become an “unaccounted irrigation supply”. The areas close to rivers and wetland are favorite places for the shallow well irrigation. The river seepage during summer can create a shallow water layer useable only for a small period. The riverine areas of the sweet water zone are more sustainable for groundwater use. The potential water uses of all reported riverine areas¹⁰⁹ could be more than 8 MAF¹¹⁰.

The Water Accord made provision for releasing minimum water flows to 10 MAF to sustain the health of the Indus River. However, given highly variable flow patterns and pressure on demand for drinking water, agriculture, and industrial use these minimum flows have seldom been assured. This has created a bitter controversy especially amongst the inhabitants below Kotri Barrage who complain that reduced flows below the barrage are detrimental to the ecological health of the delta region and without such fresh water flows the mangrove plantations, fish, flora and fauna all suffer. In particular sea intrusion is a consequence of not adhering to the minimum flow agreements under the Accord.

A major study (entitled “Environmental Concerns of All the Four Provinces”)¹¹¹ conducted by the Ministry of Water and Power and the Federal Flood Commission in 2005 tries to address the question of minimum flows. It provides estimates for minimum flow requirements for all the provinces. It raises serious concerns that where minimum flows are not provided to the abandoned rivers, farmers tend to continuously pump underground water with negative impacts on the underground water resources. In certain districts the annual drawdown is in excess of 20 feet. In the case of Sindh the report had estimated that wetlands in Sindh would require 1.5 MAF and environmental requirement for riverine areas was around 3.25 MAF assuming a 900 mm annual crop evapo-transpiration rate. In the case of Punjab the water requirements for riverine area cultivation forestry was estimated at 6.83 MAF and for wetlands/barrage ponds and fishery it was estimated at 1.83 MAF.

Information on environmental flows according to different basis including the Water Apportionment has been analyzed in several publications including the Asian Development Water Sector Strategy, 2002. IUCN has also taken a position on minimum environment flows¹¹² that aims at ensuring minimum flows in the river system to sustain ecological (biotic, flora and fauna) life by provision of minimum flows and addressing the major concern of dead rivers where there are no regular flows.

¹⁰⁹ Soil Survey of Pakistan 1992, Baseline Survey Sindh 2004

¹¹⁰ Study III 2005

¹¹¹ Study III-Environmental Concerns of All Four Provinces, Federal Government Commissioned by the Flood Commission of Pakistan, AAB 2005.

Another study was conducted by Mott McDonald consultants and is available through the Federal Flood Commission.

¹¹² See IUCN, The lower Indus River: balancing development and maintenance of wetland ecosystems and dependent livelihoods, http://www.iucnmed.org/web2007/cdf/flow/content/3/pdf/3_5_Pakistan_Indus.pdf

5.2 WWF's Position on Environmental Flows

WWF's stance on environmental flows is reflected in its approach that is based on science that explicitly recognizes the tradeoffs between benefits provided by dam's water and detrimental effects on biodiversity, ecosystems services and riparian livelihoods. WWF advocates for sustainable dams, hydropower and other water infrastructure and promotes the integration of environmental water needs into national laws, policies and plans while allowing equitable water allocation¹¹³.

The position of WWF on environmental flows is based on conservation concerns and by and large the authors of this report concur with the recommendations.

Requirements of environmental flows for downstream Indus:

- Principles to guide minimum environmental flows;
- An adaptive approach in which management decisions are based on the best available knowledge built on coordination amongst direct stakeholders;
- Management measures should be comprehensively monitored and successively revisited and reviewed in the light of improved understanding of the river system.

Measures for maintaining the ecological balances in the lower Indus Basin and the deltaic region on sustainable basis:

- An escapee at Kotri Barrage of 5000 cusec throughout the year is required to check sea water intrusion, accommodate the need of fisheries, environmental sustainability and to maintain the river channel;
- Sediment supply is required to maintain a stable coastline, sustain mangrove vegetation and preserve river morphology. It is recommended that a total volume of 25 MAF in any 5 year period (an annual equivalent amount of 5 MAF) be released below Kotri Barrage as flood flows (*khariif* period). The yearly releases can be adjusted so that the average of 5 MAF is maintained;
- Environmental flows should be revisited after 5 years;
- Consultative process with major stakeholders should be integral to resolving the issue of minimum environmental flows to safeguard the health of riverine ecologies¹¹⁴.

5.3 Climate Change Impacts

Climate Change is also likely to disturb the river flow patterns in the future. According to IPCC (2007) initial periods will be of rapid glacier melt and fewer but heavier bouts of precipitation. After this 25-30 year period there are projections for long prolonged periods of drought. Consequently, much reduced water resources and more pressure on possible reallocation of minimum environmental flows will occur. Unless these flows are clearly programmed into macro water allocation policies losing these flows to other uses could have a serious impact on the environmental resources of the Indus System¹¹⁵. Another important emerging dimension is the transfer of Federal Environment Ministries functions to provinces under provision of the 18th Amendment of the Constitution. Who will be responsible to follow-up on matters of environmental flows allocation, or will individual provinces settle the issue amongst themselves? As water becomes scarcer these discussions will become more intense.

5.4 Conclusions and Recommendations

The following conclusions can be made:

- Climate change is putting additional stress on ensuring minimum environmental flows as greater demands are placed on

¹¹³ See website for WWF-Pakistan's position on Environmental Flows: http://www.wfpak.org/publication/images/wwf_position_env.pdf

¹¹⁴ WWF in its bulletin entitled: WWF-Pakistan's Position on Environmental Flows, see website: http://www.wfpak.org/publication/images/wwf_position_env.pdf

¹¹⁵ For an extensive analysis of possible impacts of climate change on river flows and policy implications see study supported by the Flood Commission of Pakistan see (AAB, 2010).

water in other sectors. This situation is likely to become worse in the coming years and requires careful consideration from policy makers;

There are spin-offs from ensured minimum flows in any live and dead river system. Whereas, some of the water recharges underground resources, water that flows through riverine belts benefits the local and bed agriculture often free of cost. Rationalizing this externality and putting a value on it for recovery from those benefitting needs should be further analyzed;

Flora and fauna will be under further stress as temperatures rise and the rate of extinction of species are likely to increase, creating ecological imbalance with widespread social, economic and biophysical implications;

Engaging policy makers in constructive dialogue on the importance of minimum environmental flows is no single province's domain. It should receive central place in any water policy and the costs and benefits of supporting environmental flows as a policy should be highlighted through the media for public awareness;

Minimum flows can only be guaranteed during a lean period if there is a regulatory mechanism of storage upstream. Likewise emergency releases during drought periods will need analysis through advanced hydrology models taking advantage of current GIS and remote sensing technology to determine needs and impacts of critical reaches.

Given that IBRM calls for integration, an approach that ostensibly balances development with conservation this would be best for the Indus Basin. In this context there is a need to revisit the current divide where government is seen to develop infrastructure and NGOs seen to favor conservation. This will require long-term work on developing a continuum of linked approaches, policies and interventions that will bring together infrastructure development and conservation, water use and environmental flows into a single integrated framework.

This chapter explores the effects of the 2010 floods, in the context of flood management. In July 2010, Pakistan received the heaviest monsoon rains which continued till September 2010. This resulted in unprecedented floods affecting the entire length of the country. The damage was assessed to be the worst since 1929¹¹⁶. According to estimates, over 20 million people were affected, nearly 2000 lives were lost, and more than 4.6 million people were left shelterless. The economic damages resulting from these floods are of massive proportions. Devastation spread to nearly 100,000 km², over 2.2 million hectares of crops were destroyed and approximately 450,000 livestock was lost¹¹⁷. Further, the Flood Inquiry Commission Report appointed by the Supreme Court of Pakistan states that the gross loss from the 2010 floods amounted to 5.8 percent of the Gross Domestic Product. While civil society and private sector response to the floods was immediate and extensive, studies in the aftermath of the floods indicate that the damage and impacts of the flood worsened due to failures on the part of national crisis management and administrative authorities. Past neglect of setting aside areas earmarked for wetlands, putting in place crop zones that could take advantage of water intensive crops e.g. flood rice, jute and fish culture could partially reduce the negative consequences of floods. As climate change unfolds perhaps approaches that facilitate living with floods as opposed to fighting them may find place in addressing future similar extreme events.

6.1 Flood Management Policy and Strategy

There is no particular policy specifically dealing with flood management. Instead, a number of provincial and federal acts drive the flood policy in the country, namely: Punjab Irrigation Act 1873, Sindh Irrigation Act 1879, NWFP Act 1873, Balochistan Ordinance 1980, Punjab Soil Reclamation Act 1952, Water Users Association Ordinances 1981, Provincial Irrigation and Drainage Authority (PIDA) Acts 1997, WAPDA Act 1958, Indus River System Authority (IRSA) Act 1992 and Environment Protection Act 1997¹¹⁸.

The flood management strategy has traditionally relied heavily on the provision of structural measures for flood containment. Structural measures include construction of embankments, spurs/battery of spurs, dikes/gabion walls/flood walls, dispersion/diversion structures, bypass structures and channeling of floodwaters. Approximately 5,600 km of embankments have been constructed along major rivers and their tributaries in Pakistan along with more than 600 spurs to protect these embankments¹¹⁹.

6.2 Institutional Arrangements for Flood Management

The major floods of 1955 and 1956 in the early years of the country's history did not create enough momentum for tackling the flood problem in the country primarily due to inadequate institutional arrangements. The unstable political climate combined with limited resources of the country also played a part in sidelining the flood problem.

Up until 1976, flood protection and management was the preserve of provincial governments. However, after the devastating floods of 1973 and 1975, it was realized that the existing arrangements for flood management were inadequate and a unified countrywide approach was required to manage the flood problem. As a result, the Federal Government established the Federal

¹¹⁶ Pakistan Floods 2010: Preliminary Damage and Needs Assessment, World Bank: Pakistan. Web. 4 Mar. 2011. <http://siteresources.worldbank.org/PAKISTANEXTN/Resources/293051-1264873659180/6750579-1291656195263/PakistanFloodsDNA_December2010.pdf>.

¹¹⁷ Early Recovery Working Group Factsheet, UNDP 2011. Available online at: http://www.fao.org.pk/news/11/Floods/floods_fact_sheet.pdf

¹¹⁸ Ibid.

¹¹⁹ Rehman H and Kamal A, Indus Basin River System: Flooding and Flood Mitigation, River Symposium 2005. International Water Forum Web. 7 Mar. 2011. <<http://www.riversymposium.com/2005/index.php?element=38>>.

Flood Commission (FFC) in 1977¹²⁰.

Although FFC is the leading institution for flood disaster management in Pakistan, almost all federal and provincial ministries, divisions and departments have some responsibility in handling the crisis situation. A brief description of the responsibilities (related to flood disaster management) is given below:

6.2.1 Federal Flood Commission (FFC)

Federal Flood Commission is the lead federal agency in providing the necessary institutional framework to support the provincial flood management measures¹²¹. The Commission has been successful in modernizing the flood management policy of the country through two major projects, Flood Protection Sector Project I and II. The second project is currently underway and is expected to greatly increase the flood forecasting capabilities of the Flood Forecasting Division. In addition, further construction of embankments and spurs along major rivers will be undertaken under this project.

Responsibilities of the FFC include¹²²:

- Preparation of flood protection plans for the country;
- Approval of flood control / protection schemes prepared by provincial governments and concerned federal agencies
- Recommendations regarding principles of regulation of reservoirs for flood control;
- Review of damage to flood protection works and review of plans for restoration and reconstruction works;
- Measures for improvement of flood forecasting and warning system;
- Preparation of a research programme for flood control and protection;
- Standardization of designs and specifications for flood protection works;
- Evaluation and monitoring of progress of implementation of the National Flood Protection Plan;
- Monitoring of the provincial government's implementation of the National Flood Protection Plan.

6.2.2 National Disaster Management Authority (NDMA)

The National Disaster Management Authority (NDMA) was established in the aftermath of the 2005 earthquake and is the lead agency at the Federal level to deal with the entire gambit of national disaster management related activities¹²³. It is the executive arm of the National Disaster Management Commission, which is chaired by the Prime Minister and is the primary policymaking body in the field of Disaster Management. In the event of a disaster, the NDMA is the focal point for all stakeholders.

Responsibilities of the NDMA in relation to disaster management are:

- To coordinate the complete spectrum of disaster risk management at the national level;
- To act as Secretariat of the National Disaster Management Commission to facilitate implementation of disaster risk management strategies;
- To map all hazards in the country and conduct risk analysis regularly;
- To develop guidelines and standards for national and provincial stakeholders regarding their role in disaster risk management;
- To ensure the establishment of disaster management authorities and emergency operations centers at provincial, district and municipal levels in hazard-prone areas;
- To provide technical assistance to federal ministries, departments and provincial disaster management authorities for disaster risk management initiatives;
- To build capacity of stakeholders through awareness raising activities, especially in hazard-prone areas;
- To engage in information collection, analysis and sharing of hazards management strategies;

¹²⁰ FFC website www.ffc.gov.pk

¹²¹ FFC website www.ffc.gov.pk

¹²² A Review of Disaster Management and Policies in Pakistan, International Strategy for Disaster Reduction. United Nations. Web. 05 Mar. 2011.

<http://www.unisdr.org/eng/country-inform/reports/Pakistan-report.pdf>

¹²³ Ibid

- To serve as lead agency for liaison with NGOs and international agencies in disaster management;
- To coordinate the activities of the Federal Division, Provincial Governments, as well as governmental, semi governmental, international and national aid-giving agencies, in the conduct of operations for relief of disasters.

6.2.3 Meteorological Department

The Meteorological Department is both a scientific and a service department, and functions under the Ministry of Defence. The Flood Forecasting Division (FFD) of the Pakistan Meteorological Department plays a central role in the flood forecasting and warning in the country. The department sources hydro-meteorological data from various national and international sources including satellite data to prepare flood forecasts, which are disseminated to various flood management and relief organisations¹²⁴.

6.2.4 Emergency Relief Cell

The Emergency Relief Cell has been established in the Cabinet Division of the Federal Government¹²⁵. The relief cell plans for major disasters including floods by stockpiling basic life necessities required by the population affected by the flooding.

Responsibilities of the ERC are:

- To provide in cash as well as in kind to supplement the resources of the provincial governments in the event of major disasters;
- To coordinate the activities of the Federal Division, Provincial Governments, as well as governmental, semi governmental, international and national aid-giving agencies, in the conduct of operations for relief of disasters;
- To maintain contact with international aid-giving agencies/ voluntary organisations and donor countries for disaster relief measures;
- To administer Relief Funds, being maintained at the Federal Level;
- To stockpile certain items of basic necessity and establish central inventory of resources;
- To provide assistance to calamity stricken friendly countries.

The ERC operates an Emergency Control Room, which coordinates the situation during calamities by liaising with relevant agencies such as the Federal Flood Commission, Meteorological Department, and Provincial Governments.

6.2.5 Water and Power Development Authority

WAPDA is the custodian of Tarbela and Mangla dams and undertakes the day to day reservoir management for irrigation flow releases¹²⁶. The authority helps FFD in providing rainfall data from telemetric rain gauge stations and flood data at various locations in the Indus River system.

6.2.6 Provincial Irrigation and Drainage Authorities

The Authority in each province plays a prominent role in flood management through planning, design, construction and maintenance of flood protection works. It also undertakes flow measurements at specific rivers and irrigation canal sites.

Responsibilities include¹²⁷:

- Complete repairs of the flood protection works in the pre-flood season;
- Provide funds to the Army for replenishment of stores;

¹²⁴ Rehman H and Kamal A, Indus Basin River System: Flooding and Flood Mitigation, River Symposium 2005. International Water Forum, Web. 7 Mar. 2011.

<<http://www.riversymposium.com/2005/index.php?element=38>>.

¹²⁵ Ibid.

¹²⁶ A Review of Disaster Management and Policies in Pakistan, International Strategy for Disaster Reduction. United Nations. Web. 05 Mar. 2011.

<http://www.unisdr.org/eng/country-inform/reports/Pakistan-report.pdf>

¹²⁷ Ibid.

- Review the plan for regulation of water supply;
- Position requisite machinery and material at safe localities near vulnerable points for emergency repairs;
- Inspection of breaching sections and carrying out final surveys.

6.2.7 Provincial Relief Departments

The relief departments are headed by the Relief Commissioner who coordinates relief efforts during and after the floods. The Commissioner also undertakes flood preparatory actions such as inspections of flood protection measures and establishment of flood warning and flood relief centers at the local government level.

Responsibilities include¹²⁸:

- Provide adequate resource support to area Administration through co-ordination with;
- Provincial Government Departments/Agencies;
- Provision of necessary funds to the area administration for relief work;
- Oversee the working of area administration for relief work;
- Obtain field reports of losses and apprise the Provincial Government/Federal Government;
- Assess and evaluate losses and suggest to the Federal/Provincial Governments for providing relief to the affected persons.

6.2.8 Civil Defence Organisations

This organisation assists the local administration/Army in the rescue, evacuation and relief efforts, supplements anti-flood equipment of Army and provides personnel for flood management training in rescue and relief work¹²⁹.

In addition, the provincial departments of Health, Agriculture and Livestock, Food, Communication and Works and Planning and Development play minor but important roles in flood management in the country during floods and afterwards for rehabilitation.

6.3 Analysis of Floods Damages and its Causes

Pakistan's devastating floods that occurred in August, 2010 are a reminder of nature's force and the consequences of neglect and absence of a well integrated Flood Management system. While the death toll of 2500 is considered rather conservative, the losses exceeded US \$ 10.7¹³⁰ billion and devastation caused was of mammoth proportions. **With almost 1/5th of the country under water and more than 20 million people affected, the Pakistan 2010 floods are a stark reminder of the impacts of global warming and shifting climates¹³¹.** Later in 2011 Australia witnessed similar devastation by floods which was unprecedented in its history resulting in losses over 20.2 billion dollars¹³². Although through better flood management the death toll was much lower compared to that witnessed in Pakistan.

6.3.1 Climatic Change, Variability and High Intensity Weather Events

While there are several theories put forward on the causes of the floods of August 2010, the most acceptable view is the one suggested by the New Scientist, 2010 which states that the floods are a result of exceptional rain caused by "Freezing" of the jet stream, a phenomenon that also caused unprecedented heat waves resulting in wild fires in Russia and the 2007 floods in Britain¹³³.

¹²⁸ Ibid.

¹²⁹ A Review of Disaster Management and Policies in Pakistan, International Strategy for Disaster Reduction. United Nations. Web. 05 Mar. 2011.

<http://www.unisdr.org/eng/country-inform/reports/Pakistan-report.pdf>

¹³⁰ Pakistan Floods 2010: Preliminary Damage and Needs Assessment, World Bank: Pakistan. Web. 4 Mar. 2011.

<http://siteresources.worldbank.org/PAKISTANEXTN/Resources/293051-1264873659180/6750579-1291656195263/PakistanFloodsDNA_December2010.pdf>.

¹³¹ Also see Preliminary 2010 Flood Damage Assessment in Pakistan. Pakistan Agriculture Research Council, 2010.

¹³² www.reuters.com/.../2011/.../us-australia-floods-aon- idUSTRE7125WU20110203

¹³³ http://en.wikipedia.org/wiki/2007_United_Kingdom_floods

Other expert views suggest that changes in the strength of the monsoon caused by climate change may be to blame¹³⁴. These changes in the monsoons are a direct result of rising surface temperatures of the ocean. Experts predict that the distribution of monsoon rains will become even more uneven in the future where total rainfall may remain the same, but in more frequent and intense bursts¹³⁵.

This view is also shared by Pakistani meteorologists who think that rising Indian Ocean temperatures caused high rates of evapo-transpiration that disturbed monsoon patterns. The cloud pattern over Kashmir, which traditionally maintained heights of 3000-8000, has shifted to Gilgit- Baltistan and Swat areas since the past 5-6 years. It has also been observed that these clouds now regularly reach heights of 40,000-50,000 ft. Such shifts in cloud height and location partially explain why the downpour was so heavy in the Swat and Indus river basins. Climate variability in the past decade has seen disparate weather systems occurring at the same time: for example Westerlies over the Kabul river and the monsoons in the east. The confluence of these two extremely high flow events established the disastrous floods that generated 35 MAF of water.

According to the Pakistan Meteorological Department briefings over 200 mm of rainfall fell over a period of 24 hours in KPK and Punjab. A record breaking 274 mm fell in Peshawar alone.

In the case of Pakistan's floods of 2010 it was seen that the mismanagement of dikes and lack of investment in flood protection exacerbated the damage. Even though Pakistan has had experiences with floods in 1954, 1973 and 1975, there appeared to be complete chaos in the response mechanism to these floods during the early stages. However, as flooding progressed the administrative units established temporary relief centers.

While, Pakistan has invested in extensive flood mitigation infrastructure till 2005 much of this infrastructure is neglected, and this appeared in the massive damage that was caused as river water changed course in several areas, yet the dams and barrages withstood the onslaught¹³⁶.

6.3.2 Administrative Failure

Even though Pakistan has had experiences with floods in 1954, 1973 and 1975, there appeared to be complete chaos in the response mechanism to floods during the early stages. However, as flooding progressed the administrative units established temporary relief centers. Overall coordination of response and relief was taken over by armed forces. The civil administration appeared to be overwhelmed by the challenge with many areas inaccessible and not serviced for days after the flooding had occurred. The Punjab Government has conducted a study assessing the impacts and causes of the recent floods under the Judicial Flood Inquiry Tribunal, headed by Justice Syed Mansoor Ali Shah. However, this report is not being released by the Punjab Government at the moment.

Downstream impacts were devastating even though downstream areas had 22 days of warning. In spite of this there was no systematic mobilization on the part of the water management institutions to issue warnings and spread awareness amongst downstream communities to mitigate the amount of destruction caused.

Several institutions including the Flood Commission of Pakistan, IRSA, NDMA and district governments are supposed to be directly responsible for flood management. Yet, the Federal Flood Commission of Pakistan was seldom seen as an institution engaged or active in the 2010 floods, even though it is stipulated to be the main organization responsible for flood management. The FFC played a rather passive role and was rather dormant. A review of its recent work has shows that this institution undertakes technical assistance assignments often unrelated to matters of floods. With the induction of the National Disaster Relief Management the institution's role on flood management has become further diluted.

The National Disaster Management Authority (NDMA) was much more active in terms of providing flood management and flood relief. However, the primary role of the NDMA lies in provision of relief goods and services and not with management of floods. Therefore, it should not and cannot be solely responsible for flood management. Here, the FFC has to take charge and provide

¹³⁴ Martin Gibling, Dalhousie Univ, Halifax , Canada

¹³⁵ Source: BBC News, Professor Rajiv Sinha, Indian Institute of Technology, Kanpur

¹³⁶ Kazi A, Flood Management in Pakistan Paper No 14, World Bank Background Papers prepared for water CAS.

sound preparedness, mitigations and management strategies.

The Pakistan Meteorological Department (while earlier predicting the 2010 monsoon to be normal) stepped into action once the event had started to unfold. It provided regular updates on the rainfall predictions, forecasted floods and provided detailed meteorological briefings and flood warning that were helpful in emergency planning and action. However, while its ability to predict floods on the Indus proved helpful its complete lack of ability to understand behavior of flash floods off Indus showed up as an inherent weakness in its monitoring and tracking of floods. Several areas that did not receive such warnings paid a heavy price.

More than anything else, the absence of local government was acutely felt. The removal or abeyance of local government institutions meant that there was a vacuum in terms of local leadership and a chain of command that could have acted for warning and actions in a systematic manner.

6.3.3 The Politics of Floods Management

The politics of floods management is not yet documented in any systematic way, and is largely anecdotal. Given the propensity of corruption and political clout in the way Pakistan is governed, the floods provided another instance where pressure was applied on government employees and those struggling to deal with the problems, to act in ways that would reduce the damage to politically powerful individuals, even if that meant exposing vastly greater numbers of people to the effects of the floods.

For example, it is a widely held view amongst people of Swat and Upper Swat who witnessed the floods that illegal tree cutting and logging upstream clogged the Swat River which resulted in cutting of the embankments, and struck heavy blows to the bridges resulting in widespread destruction and overflow of the river. Illegal mafias that have emerged over past two decades have the political support and massive corruption has been reported in the press whereby upstream forest are being cut unabated without any check on these illegal activities. Government line agencies are said to participate in this crime with connivance of local political parties and influential landowners.

While adequate warning was available to the lower province of Sindh the flood damage was still extensive. There were numerous allegations that bunds were broken on several occasions to save the crops of influential and politically strong people, while the general population was forced to bear the brunt of the devastation. Inquires are still underway on these accusations¹³⁷.

6.3.4 Trust Erosion

Perhaps the greatest indicator of eroding governance and transparency came from foreign donor pledges. It is reported that Pakistan received less than 20 percent what was pledged, and the population in general refrained from giving donations to the Prime Minister's Flood Relief Fund due to a lack of trust on how the money would be spent.

6.4 Infrastructure Issues

Weaknesses in the irrigation infrastructure that enhanced flood damages include the following:

- Deferred maintenance of flood embankments;
- Insufficient reservoir/storage capacity to absorb flood peaks;
- Lack of response mechanisms to early warnings;
- Need for expanding flood early warning system (FEWS);
- Encroachment of the flood plains and riverine areas.

The breaches in flood protection embankments along the Indus River caused the main damage, and none occurred due to overtopping. There is no comprehensive inspection protocol for critically reviewing important major river training works and embankments. The ageing infrastructure and deferred maintenance is also an aspect that needs immediate attention.

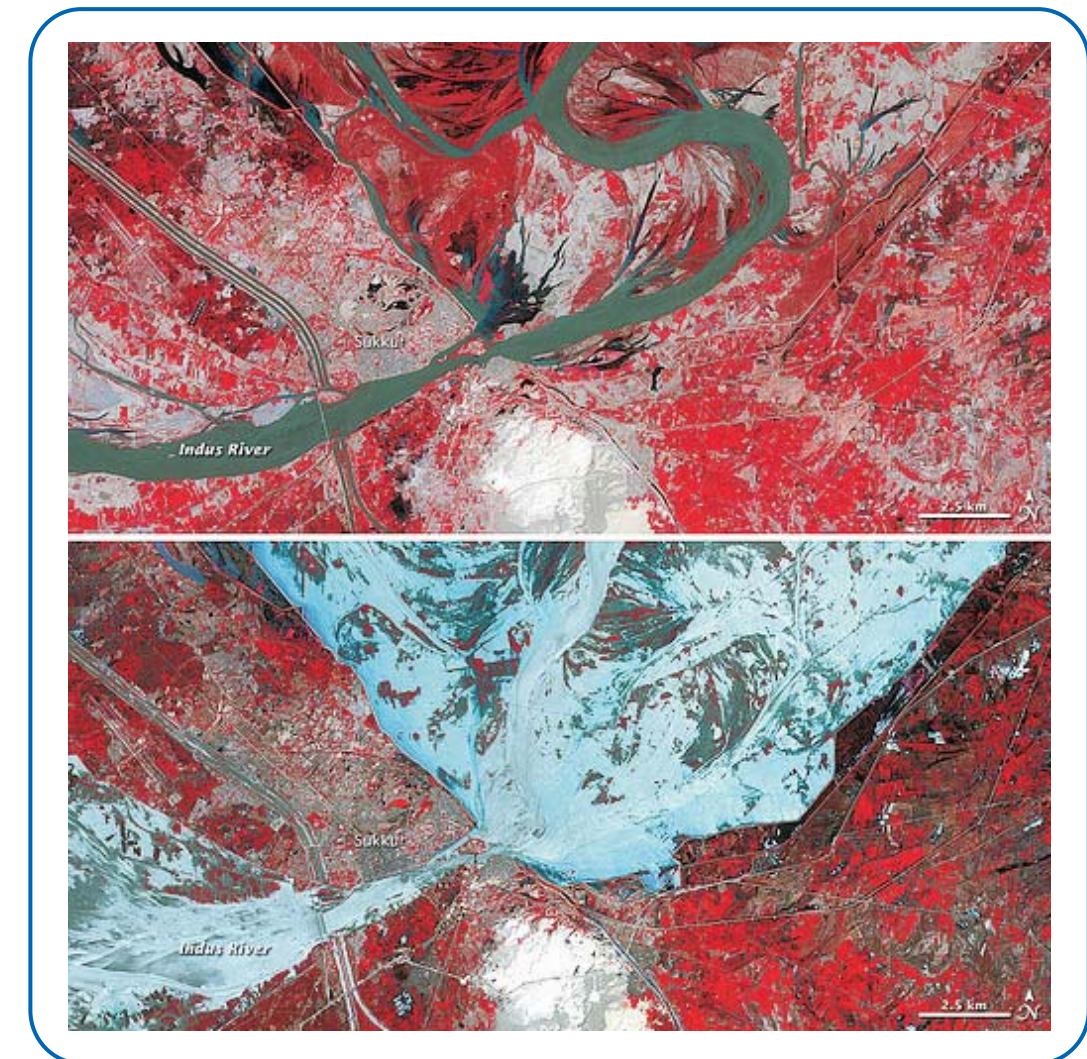
¹³⁷ See a host of articles and press coverage referring to such allegations for instance www.ipripak.org/factfiles/ff126.pdf, www.csmonitor.com/.../2010/.../Biggest-hurdle-to-Pakistan-flood-recovery-Wealthy-landowners-and-many-others

- The absorptive capacity of catchments is too low to prolong run-off concentration time;
- There are no additional reservoirs to absorb flood peaks;
- The discharge capacity of the existing barrages and river training works is too low to handle floods of this magnitude.

6.5 Impact on River Profiles

The Indus River especially at the end reaches near the mouth of the river as it opens out to the Arabian Sea has been affected. The profile of the river has changed and now closely follows the historical path near the districts of Larkana, Dadu, and Jacobabad in particular and below Kotri has changed.

Figure 2 - Before and After Flood Imagery and Impact on River Profile



Source: <http://essentialurbanism.wordpress.com/tag/water/>

Loss to biodiversity and ecologies has not been estimated. But it is clear that the vast tree damage, outflows around river embankments, carriage of pollutants to diverse areas, changes in surface and ground water quality will all have negative consequences in the long the short run and some positive impacts (ground recharge) in the long run. However, in certain water logged and saline areas there is a likelihood of salt leaching/flushing which could have positive impacts on crop productivity. The extra moisture in the kharif season helped plant the *rabi* wheat crop. It also positively impacted sugarcane which is a high delta crop.

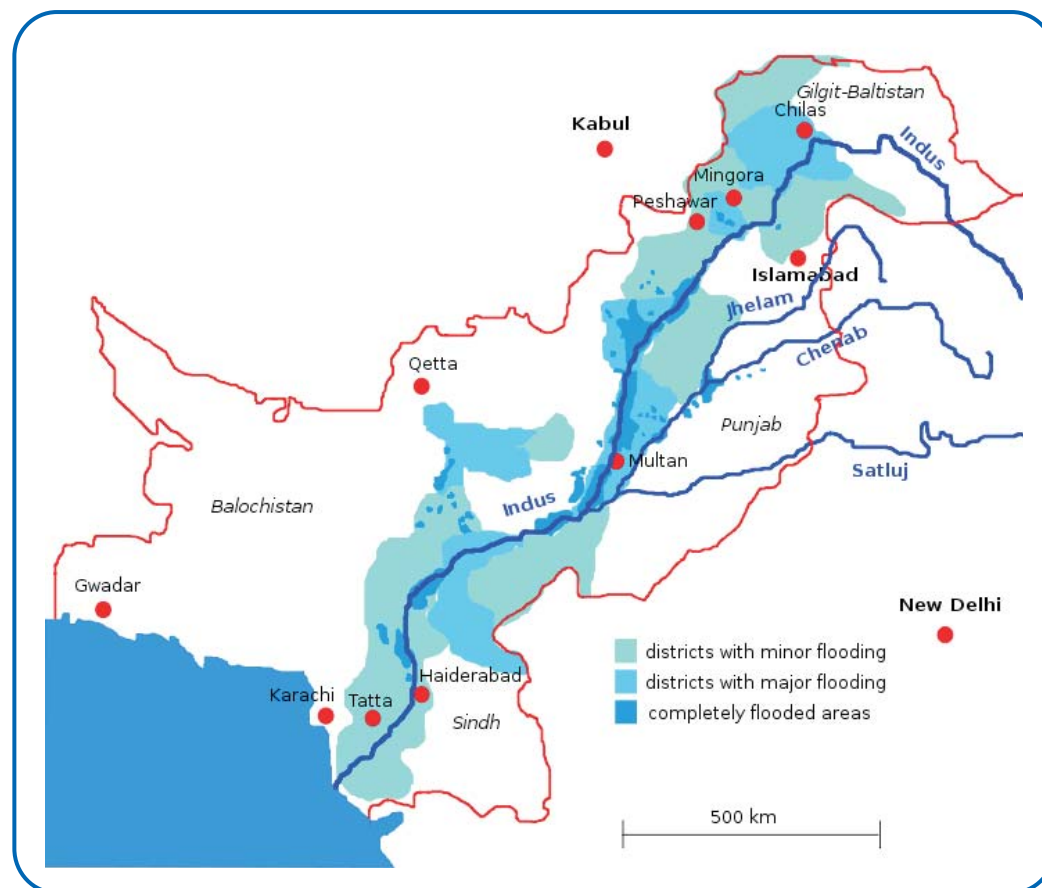
Silt load from the floods has had a positive impact on areas where this was spread. This is likely to improve fertility and

consequently crop productivity once the flood subsides completely. The high wheat yields reported in 2011 are partially being attributed to the enhanced moisture from floods as a carryover effect. The underground water recharge has increased the water table in several areas which should also help reduce the cost of pumping water thus enhance profitability in the medium run.

Changing river profile has also resulted in destruction and bunds of agriculture farm channels and also resulted in damages to drainage infrastructure. While, Pakistan is seeking out lands for infrastructure rehabilitation there are public concerns that in many cases the quality of construction of various drainage canals and channels was substandard and partly responsible for providing poor drainage during flooding peaks.

Extensive analysis has been conducted by NDRM and PARC (2010) on flood damage, river flows, land use impacts and changes in profiles of all rivers according to district level damages as shown below.

Map 4– Indus Flooding Impact 2010



Source: http://en.wikipedia.org/wiki/File:Indus_flooding_2010_en.svg

There are serious issues after a river changes its morphology. Perhaps the most serious one is the numerous litigation disputes that follow. Land once owned and cultivated becomes a part of the river while in other cases new lands are created where there is river recession. This generates disputes and conflicts when the acreages are large and traditional rights and entitlements within the river bed uncertain.

6.6 Conclusions and Recommendations

Pakistan has a long history of floods, but the 2010 floods overwhelmed the system. Yet it must be concluded that early warning systems paid off somewhat because the death toll was below 2500 despite the fact that almost one fifth of the country was under

water.

It can also be concluded that the historical neglect of investment in flood management and poor attention to O&M left much of the embankments and infrastructure prone to failure when battered by the floods. However, traditional structures and barrages withstood the onslaught very well, reinforcing confidence in some of the older barrages on the lower reaches of the Indus – the Guddu, Sukkur and Kotri barrages. Investments and systems must be planned NOW for future floods and the upgrading of capacity to handle and manage them.

The serious allegations of mismanagement in the political and administrative systems that led to poor and delayed response from the civil institutions are still being investigated, but there is little documentation as yet to determine the scope and extent of political power wielding to save lands and endanger large numbers of people.

There are some obvious overlaps and existing gaps in the current institutional arrangements for flood management in the country.

Even though water management is a provincial issue in Pakistan, the federal government must play a lead role in overall coordination, monitoring and formulation of flood management policies and strategies and to ensure implementation.

The mandates and responsibilities of each organisation dealing with flood management needs to be revisited and clarified. Each organisation should be given clear and precise mandates and responsibilities specifying their particular role in flood management efforts in the country to avoid overlaps and address obvious gaps. It is recommended that the strengthening and increasing the capacity of the Meteorological Department to address flood prediction and monitoring be undertaken immediately. The role of the Federal Flood Commission and its functions should be redefined. With the implementation of 18th Amendment interprovincial and intra provincial issues related to environmental impacts of floods should receive high priority in future action plans and policies.

The whole inter departmental coordination needs a thorough and in-depth review at all levels, where institutional experts can provide a blueprint for a workable system. Strong capability is needed for modeling and scenario building. This capacity should be enhanced with strong research backing and linkages with civil society, academia and media. Pakistan's ability to cater to multiple climate change induced threats including floods, droughts, glacier melt and GLOF need to be developed at a fast pace.

Flood cost and impact assessment is only focusing on the loss to life and property. The social costs, environmental costs and indirect costs to the economy also need to be measured.

According to the findings of the Tribunal set by government in the after math of 2010 floods:

“Encroachments in the Pond Area should not be allowed at any cost and must be immediately cleared. These environmental pockets (Pond Area) must be protected and encouraged to support the growth of biodiversity and wildlife in the country. Pond area can showcase a rich and wide range of wildlife, which needs to be encouraged. They must remain free from human settlements and must be well regulated so that their service to the Barrage for maintaining the pond level is never impaired. Ecologically friendly non structural measures for flood mitigation like afforestation of water shed and the riverine belt, developing and effectively using lakes, depression and retention pools along the river” can contribute towards better flood plain management¹³⁸.

¹³⁸ A Rude Awakening, Tribunal Flood Inquiry Report 2010

Upstream illegal logging has to be stopped immediately and the tree cover be allowed to regenerate to control flooding in the Swat River. Attention should be paid to the land disputes which will arise because of changes in river morphology across Pakistan.

Government should take cognizance of possible ecological solutions such as dedicated areas for wetlands in event of floods, inter-lake and inter-canal links to move surplus water to drylands as discussed above.

The Government of Sindh may consider the following recommendations:

- Immediate repairs and rehabilitation of embankments/bunds in all the affected districts;
- Immediate and concrete steps to strengthen all the flood protection embankments/bunds in general, on both the banks of the river;
- Removal of all privately raised bunds and illegal structures in natural course of the river, which obstruct free flow of water;
- Removal of encroachments from inside the bund walls on both the sides of the river to allow more quantity of water to flow, reducing the pressure on the old structure of barrages;
- Removal of illegal islands that have built up through siltation;
- Dredging of river and canals on a regular basis;
- Flushing of drains on a regular basis in the command areas of all the three barrages;
- Feeding of lakes on a regular basis every year making them standby escape routes and/or reservoir with appropriate outlets;
- Repairs, maintenance and rehabilitation of all irrigation infrastructures on a yearly basis by fixing targets for physical works carried out diligently;
- Reduction of pressure on all the barrages through construction of escapes/spill ways.

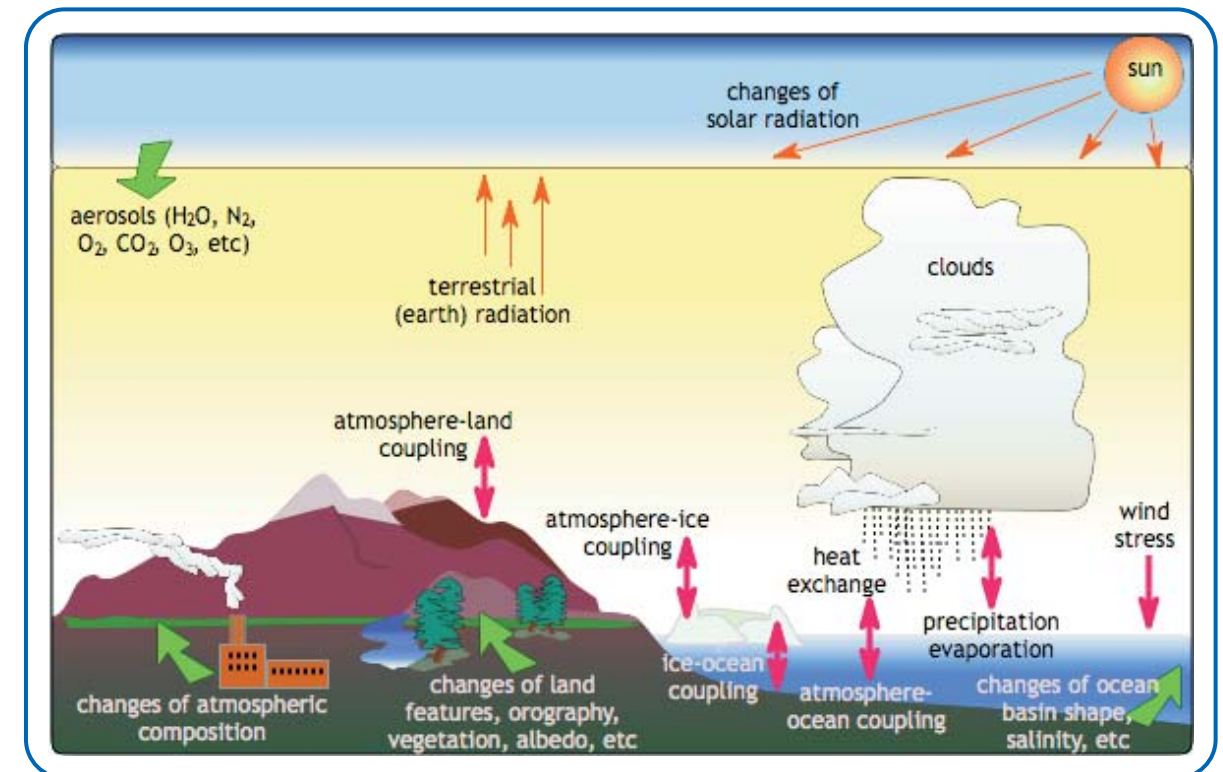
Integrated flood management (as part of IRBM for Indus Basin) calls for a paradigm shift from the traditional, fragmented and localized approach, and encourages the use of the resources of a river basin as a whole, employing strategies to maintain or augment the productivity of floodplains, while at the same time providing protective measures against losses due to flooding. Annex 2 provides information on integrated floods management concepts and guidelines.

Chapter 7 Water Economics and Agro-Ecological Zoning of Indus Basin

This chapter deals with the present status of agr- ecological zones, cropping patterns and cropping intensities within the Indus Basin with a view to identify opportunities for possible substitution in the context of water challenges. The present state of water economics is revisited for possible opportunities that help save water, and allow for a more rational allocation of this scarce resource to help improve economic welfare of the people and the state of environment in Pakistan. Agriculture contribution to GDP is around 22 percent¹³⁹ while contribution to foreign exchange earning that is attributed to agriculture is 60 percent. Thus, while the contribution to GDP may be slightly greater than 1/5, agriculture is the dominant sector in terms of foreign exchange contribution. In recent years the livestock sector has surpassed the crop sector in terms of sub sector shares to GDP, and livestock now stands at 52 percent¹⁴⁰.

Postulated changes in water availability in line with Global Climate Models (GCM's) suggest that Pakistan will face severe water shortages. This is due to extended glacier melt, global warming, mismanagement of water and lack of water storage facilities, that could help to regulate water from high flow periods (summer-monsoon months) to low flow periods (*rabi*-winter months)¹⁴¹. Volatile price fluctuations in the international market also require that crop area allocations take macro and micro realities into consideration while giving guidelines for preferred cropping patterns. This section deals with some of the critical issues with maintaining status quo in the context of changes in water regimes.

Figure 3 - Graphic Representation of a Global Climate Models (GCM)



Sources: Task Force on Climate Change, 2010

¹³⁹ Government of Pakistan, 2011

¹⁴⁰ Annual Development Plan, 2011 and Economic Survey of Pakistan, 2010, see website Planning Commission

¹⁴¹ Task Force on Climate Change, 2010

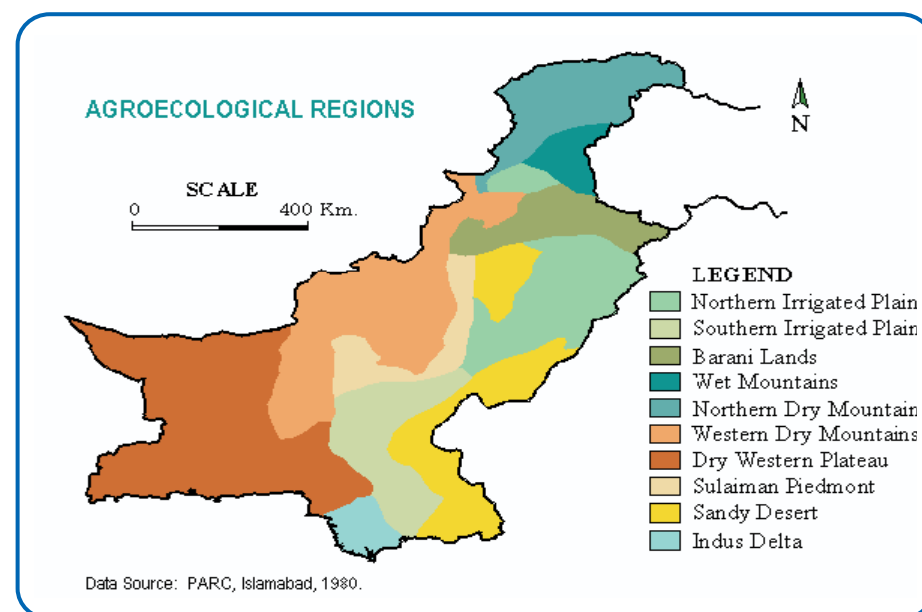
7.1 Basis for Agro-Ecological Zones in Pakistan

Pakistan has a highly varied topography and the Indus plains offer unique opportunities to exploit naturally formulated agro-ecological zones that determine what, when, how, where and in what quantities different crops can be grown. A quick look at the agro-ecological zones helps determine where interventions and substitutions may be possible and feasible.

Pakistan is very diverse in its climates, land uses, soil types, resources and human capital. This diversity especially along the Indus allows it to practice a highly varied type of agriculture at different levels of productivity. Such agriculture falls into distinct agro-ecological zones. The country is divided into 10 broad agro-ecological regions (Map 5) considering physiography as basis for characterization (PARC, 1980). Ecology and resources in these regions vary considerably. The main limitation for agriculture is water shortage because of the arid climate. Development of agriculture is; therefore, dependent mainly on development of water resources which, in turn, is more capital intensive than any other development.

Sedimentation in rivers and channels, erosion of soil, water logging and salinity, desertification and over-grazing are examples of inefficiencies and leakages in agricultural systems. This requires an ecological approach for agricultural development rather than a sectoral approach presently being followed.

Map 5 - Agro-Ecological Regions of Pakistan

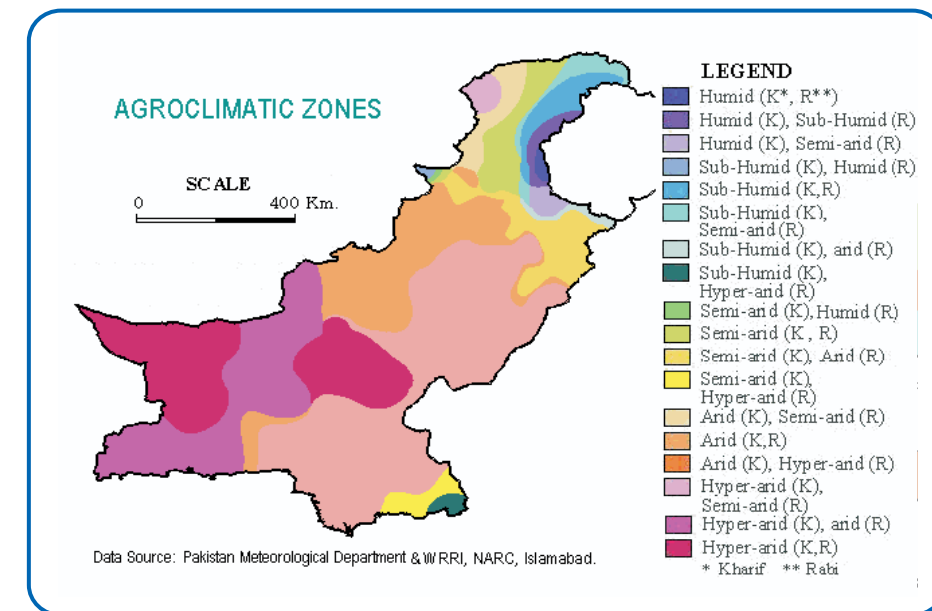


Source: PARC, Islamabad 1980

The country's cultivated area is 22.0 mha (million ha). Around 12 mha are under forage and forests (GOP 2007). This makes 34.0 mha suitable for agriculture and forestry. In addition, 8.33 mha are classified as culturable waste, which can be cultivated if water is available. The rest 37.28 mha is not suitable for agriculture and forestry within the existing framework except for rough grazing in certain places. Sustainable development of water in this area is one of the major limitations for expansion of agriculture and forestry.

Agro-climate was characterized based on the seasonal aridity index. Maps of seasonal aridity classes of *kharif* and *rabi* seasons were superimposed to prepare one map representing the seasonal aridity for both the seasons. Eighteen aridity zones were identified based on both *kharif* and *rabi* seasons (Map 6).

Map 6 – Agro Climatic Zones



Source: Pakistan Meteorological Department & WRRI, NARC, Islamabad

Humid and sub-humid *kharif* zones have 3 and 5 *rabi* zones, respectively, to illustrate the variability in *rabi* season. Variability in *rabi* season for humid *kharif* zone ranges from humid to semi-arid, whereas for sub-humid *kharif* zone it ranges from humid to hyper-arid. Semi-arid *kharif* zone shows four combinations in *rabi* season namely humid, semi-arid, arid and hyper-arid. For arid and hyper-arid *kharif* zones, *rabi* season is either arid or hyper-arid.

7.2 Current State of Water Resource Availability for Agriculture

Water conveyance efficiency of the Indus Basin irrigation system is around 55.3 percent; which is based on the canal conveyance efficiency of 79 percent and watercourse conveyance efficiency of 70 percent. Field application efficiency is around 75 percent (Ahmad 2008). Thus the overall irrigation efficiency is around 41.5 percent.

Net water availability for crop consumptive requirement is around 78.79 MAF, whereas the net water requirement for crop consumptive use for existing cropping pattern is around 95.8 MAF, considering all the crops and total irrigated cropped area. Thus the shortfall is 17.01 MAF (17.8 percent) without rainfall contribution and shortfall of 3.61 MAF (3.8 percent) considering rainfall contribution of 13.4 MAF in a mean year.

The shortfall during dry years will increase due to reduce canal water supply and less rainfall. The farmers do adapt to such conditions either by reducing their cropped area, deficit irrigation or enhanced abstractions from groundwater. The current data of water and agriculture do not indicate such adjustments so precisely. Therefore, it is difficult to establish any relationship of cropped area with availability of water. Details of Pakistan's Water Resources are provided in Annex 6.

7.3 Cropping Intensity

Historical changes in cropping intensity in Sindh and Punjab during 1980, 1990, 2000 and 2010 by province are shown to capture temporal changes. The data clearly show that cropping intensity has gradually improved in response to profitability, population food, fiber and fodder needs. Since 1980 cropping intensities show increases from 143.11 percent in Punjab to 173.19 percent in 2010 for farmers operating less than 2 HA. In Sindh there appears to be a decline in cropping intensity with much smaller variations. One important factor is that reliance on ground water which is of high quality in Punjab is increasing where ground water in Sindh is more saline and in some areas not suitable for agriculture unless mixed with fresh water. The data capture the

pre Tarbela and post Tarbela dam changes in cropping intensity. Cropping intensity shows the number of crops grown in one year, the length of time land is kept under a crop, the more intensively the land is utilized the higher its cropping intensity. Formally it is defined as the ratio of Net Area Sown to the Total Cropped Area. The following formula is commonly used (Cropping Intensity= Total Cropped Area/Net Area Sown x 100). Different cropping intensities are shown in Table 5. Table and data are also segregated by farm size using traditional definitions of small, medium and large farms.

Table 5 - Pakistan Cropping Intensity (percentages)

Comparison of Cropping Intensities by Farm Sizes during 1980, 1990, 2000 and 2010									
S#	Farm Size	Year 1980		Year 1990		Year 2000		Year 2010	
		Punjab	Sindh	Punjab	Sindh	Punjab	Sindh	Punjab	Sindh
1	Under 2 hectares	143.11	157.12	160.30	161.31	168.95	145.63	173.19	147.88
2	2-5 Hectares	130.73	140.86	148.15	150.52	159.89	140.06	167.23	138.44
3	6-10 Hectares	122.22	123.49	138.13	130.52	151.48	130.52	163.71	126.32
4	11 and above	115.40	112.13	131.25	126.07	141.22	113.63	148.95	111.37

Source: Ministry of Food, Agriculture and Livestock (Economic Wing), Government of Pakistan

Analysis of data from the Pakistan Water Courses Evaluation Study, 2011 (which is most current and utilizes data gathered during 2010) provides Cropping Intensity estimates derived from a sample survey on 1000 farmer fields where water courses were improved (or not improved) in the course of the Project. Such real time primary data are helpful in gauging cropping intensity prevalent in each province even outside the Indus Basin (See table 6).

Table 6 – Cropping Intensity by Province

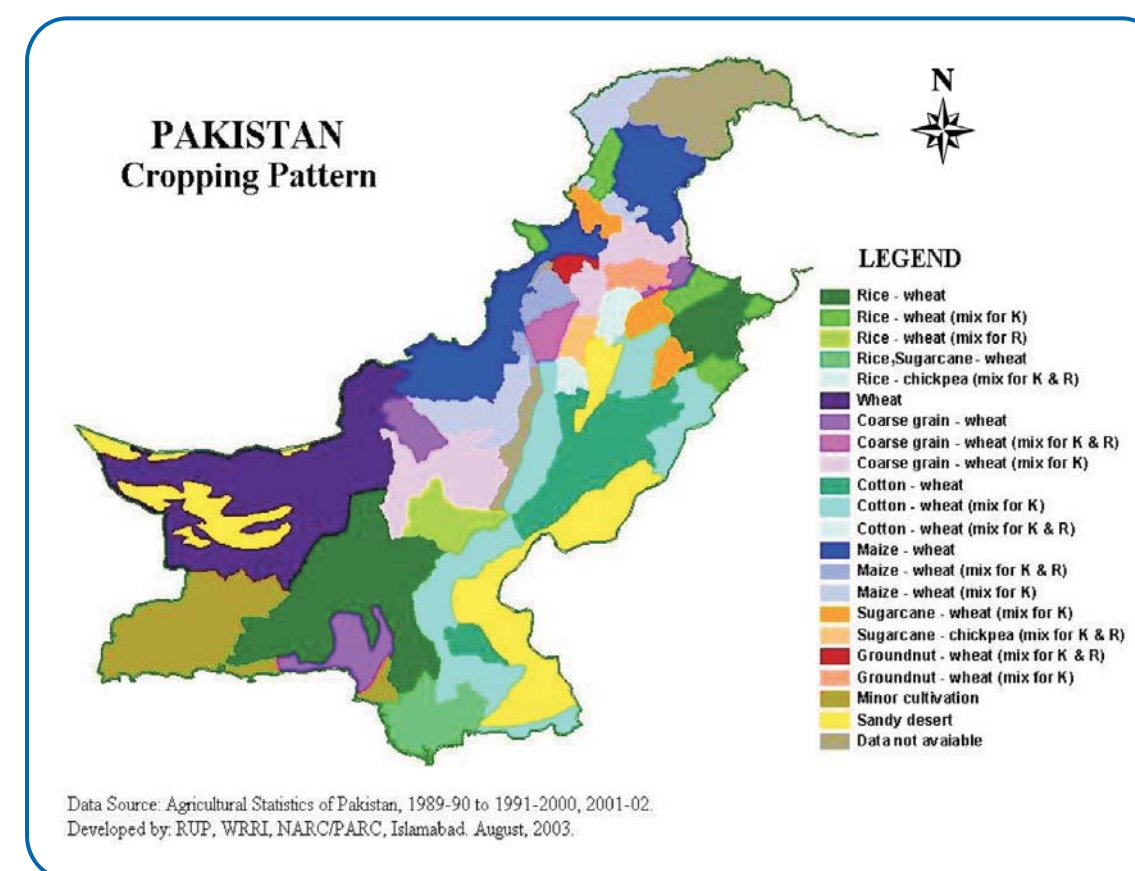
Province	Categories	Cropping Intensity (%)
Punjab	Improved	180.44
	Unimproved	177.05
	Change	3.39
Sindh	Improved	158.45
	Unimproved	153.11
	Change	5.34
KPK	Improved	169.09
	Unimproved	166.58
	Change	2.51
Balochistan	Improved	168.10
	Unimproved	163.37
	Change	4.73
AJK	Improved	200.03
	Unimproved	195.58
	Change	4.45
ICT	Improved	230.00
	Unimproved	100.00
	Change	130.00
GB	Improved	161.74
	Unimproved	160.83
	Change	0.91
FATA	Improved	168.96
	Unimproved	164.58
	Change	4.38

Source: On Farm Evaluation Report, Government of Pakistan, 2011.

7.4 Dominant Cropping Patterns in Irrigated Agriculture

Pakistan has seen stagnation in its dominant cropping patterns in the Indus River with three dominant crops *rabi*: Wheat, Sugarcane, fodder and *kharif*: Cotton, rice, *jowar* (sorghum), maize. The only changes in area allocated are in response to water availability, price response and technology shifts where they have reduced cost or encouraged crop or enterprise substitutions (e.g. livestock, fruits, vegetables etc).

Map 7 – Pakistan Cropping Patterns



Source: Agricultural Statistics of Pakistan, Developed by RUP, WRII, NARC, PARC, Islamabad, 2003

Three types of cropping pattern are dominant in the Indus System:

7.4.1 Wheat and Rice

This is the predominant cropping pattern in much of the Central Punjab especially in the Kallar Tract (Sialkot, Gujranwala, Sheikhpura, and Hafizabad) and lower parts of Sindh. The profitability of the individual crops partially dictates this traditional cropping pattern which has been in existence for the past several thousand years. Relative profitability of wheat and rice partially explains the reason why this rotation is followed. The prevalence of widespread monsoon rains support rice growing over other crops, thus providing farmers an advantage to realize the gains from rain water and otherwise highly subsidized and unregulated water.

Much dynamics has been seen in this cropping pattern with enhanced productivity. Firstly, the older *Basmati* varieties (e.g. 370) have been replaced with other HYV's like super *basmati*. Higher rates of DAP and nitrogenous fertilizer are used and some

farmers are even using bio fertilizers. In certain tehsils farmers are going for short duration varieties that allow even two rice crops followed by wheat or potatoes. Similarly, mechanization is intensive with most harvesting for wheat and rice done by combine harvesters that allows for quick turnaround time. In some soil types farmers are using the Zero tillage or *Rabi* wheat drill that allows for directly sowing wheat utilizing moisture available in the harvested rice crop. This has reduced the cost of tillage. With introduction of modern agronomic practices farmers are much more prosperous than in previous decades, despite the fact that cost of production as discussed later is also rising. In the case of wheat seed rate has increased from the traditional 100 kg/ha to around 150 kg/h and use of weedicides and insecticides for disease control are on the rise.

The production from the dominant wheat-rice systems in Punjab and Sindh are in the tune of 18.4 million tonnes in Punjab and 3.54 million tones of wheat in Sindh. In the case of rice total production in Punjab in 2009 was 3.64 million tones, and 2.54 million tones in Sindh. The value of the two important rice and wheat residues is estimated at 20 percent of the value of the wheat straw, and 10 percent value of rice straw for the two crops. Without such a strong straw residue base it is almost impossible to support the feed resources for the livestock sector that contributes 52 percent to the GDP of agriculture.

Wheat yields have steadily increased from 600 kg/ac in the 1965's to around 1600 kg/ac in 2010. This more than doubling of yield is greatly attributed to the Green Revolution technologies of HYV's, fertilizer, seed, post harvesting etc. Likewise the yields for traditional *Basmati* rice have increased and have also almost doubled from the traditional *Basmati* 370 and introduction of short stature high yielding varieties.

Fertilizer, pesticide, number of tractors and tubewells, HYV's has also increased multifold. A major contributor to Pakistan's ability to grow more wheat has come from the construction of two major reservoirs in the yield from Mangla and Tarbela. A World Commission on Dams study (WCD 2002), reported that Tarbela contributed roughly 12 BCM of water as a carryover storage dam (storing Monsoon waters July-August) for wheat production during *rabi* (November-March).

7.4.2 Cotton and Wheat

This rotation is prevalent in most of Southern Punjab (Multan, Vehari, Khanewal, Rahimyar Khan) and upper Sindh (Sukkur, Larkana, Dadu) districts. Cotton is a highly profitable commercial crop. A review of ZTBL (2010) report suggests that the prime agricultural development bank has almost 75 percent business around the cotton growing districts. Despite setback from CTV (virus name) the new trends in form of Bt cotton which is high yielding clearly establishes the superiority of cotton as a first choice of farmers. The profitability is the overwhelming reason for its dominance in Pakistan's cropping patterns along with highly suitable agro-ecological zones (see Annex 3). Wheat is also well integrated into the cropping pattern thus this is the preferred cropping pattern in terms of profitability.

Farmers have started bringing in short term crops like potato, and maize by adjusting varieties of wheat and cotton. Despite the fact that cotton is a high delta crop requiring more than 15 irrigations at a current price of Rs 800/irrigation of pumped water it still shows high levels of profitability as can be seen from the comparative cost of production table 7 shown below. While all types of cost are incorporated farmers make decisions essentially on the cash costs. The data are also only for canal irrigated areas where water costs are dismally underestimated (Rs. 300-400/acre/annum abiana rates).

Table 7 – Cost of Production of Seed Cotton in Multan District (Rs /acre) 2009

Operations	Small	Medium	Large	Overall
Cultivation cost	1600.39	1645.25	1687.68	1644.44
Sowing cost	870	879.41	915.16	888.19
Fertilizer cost	1467.02	1999.75	2458.45	1975.07
Irrigation cost (canal + tube well)	1629.07	1771.12	1833.06	1744.42
Inter-culture / hoeing cost	1855.42	1605.15	1621.77	1694.11
Plant protection cost	2841.99	3170.59	3557.26	3189.94
Labour cost	2412.51	2553.07	2886.8	2617.46
Rent	3750	3750	3750	3750
Total cost per acre.	16426.4	17374.3	18710.18	17503.6
Gross Income	20064	21596.3	26426.4	22695.5
Net Income Per Acre	3637.6	4221.91	7716.22	5191.95

Source: Imran Sharif et al, 2000 Management Vol v, Issue II, Dec 2009

Detailed Cost of production from Layyah district near the Bank of Indus River is reproduced in table 8.

There is an inherent weakness in the availability of data regarding the cost of production. No gross margin analysis is undertaken to determine cost of production and hence prices. The Prices Commission of Pakistan does not exist anymore, and the Price Policy Institute of Pakistan is also non functional. In the past, cost of production studies and analyses were data conducted by the agricultural universities of Tando Jam, Faisalabad and Peshawar but this practice has now been discontinued. Without regular and updated cost of production data which is easily accessible and verifiable, it is difficult to provide farmers any advice on relative profitability or formulate any recommendations for a given agro-ecological zone where productivity of cereal crops differs widely.

Table 8 Cost of Production Analysis of BT Cotton for Medium Farmer in Layyah (per acre basis)

Activity	Unit	Quantity	Rate	All
Land Preparation	Rs.	----	----	1815.96
➤ Rotavator	Nos.	0.23	870.59	200.00
➤ Disc Plough	Nos.	0.73	620.75	454.74
➤ Cultivator	Nos.	0.33	450.00	146.51
➤ Ploughing + Planking	Nos.	2.47	411.63	1014.71
Seed Cost	Kgs	8.09	246.28	1993.14
Seed Treatment Cost	Kgs.	8.09	41.25	333.84
Sowing Cost	Rs.	----	----	400.00
Irrigation Cost	Rs.	----	----	3771.40
➤ Canal	Nos.	2.97	----	0.00
➤ Tube Well	Nos.	5.13	735.47	3771.40
Fertilizer Cost	Rs.	----	----	4125.26
➤ DAP	Bags	0.50	2534.88	1267.44
➤ Urea	Bags	2.67	861.51	2304.04
➤ Ammonium Nitrate	Bags	0.42	706.25	295.64

➤ Micro Nutrients	No.	0.57	453.06	258.14
Inter-culture	Rs.	----	----	2733.10
➤ Inter-culture	No.	3.97	376.74	1493.83
➤ Hoeing	No.	1.77	701.16	1239.26
Weeding	Rs.	----	----	451.16
➤ Weedicide	No.	0.72	498.39	359.30
➤ Weedicide Spray	No.	0.72	127.42	91.86
Plant Protection		----	----	6069.12
➤ Sucking Pesticide	No.	5.51	731.98	4034.38
➤ Sucking Pest Spray	No.	5.51	134.19	739.58
➤ Chewing Pesticide	No.	1.83	566.05	1033.37
➤ Chewing Pest Spray	No.	1.94	135.06	261.79
Activity	Unit	Quantity	Rate	All
Picking Cost	Mds.	18.64	247.33	4609.80
Loading + Unloading Cost	Mds.	1.14	18.64	21.24
Cotton Stick Removal	Acre	9.53	60.47	576.53
Revenue	Mds.	18.64	3748.97	69875.48
Mark Up	Rs.	----	----	1355.81
Land Rent	Rs.	----	----	8500.00
Abiana	Rs.	----	----	85.00
Variable Cost	Rs.	----	----	21692.99
Total Cost	Rs.	----	----	35485.56
Gross Margin	Rs.	----	----	48182.49
Net Return	Rs.	----	----	34389.92
BCR		----	----	1.97

Source: PARC, 2010

7.4.3. Sugarcane and Fodder

Sugarcane is an annual crop grown largely as a commercial crop in Punjab, Sindh and KPK provinces portions of the Indus Basin System. Pakistan has over invested in the sugarcane industry in Punjab and Sindh which can be seen in the number of sugar mills in the two provinces. The price of sugarcane has been consistently rising as a deliberate government policy to ensure sufficient sugarcane is grown. The political economy links are strong as most of the sugarcane mills are owned by those in power (MNA's and MPA's) and efficient production or national interests in terms of prudent water allocation are subservient to the profit considerations of those in power. Given the profitability of sugar cane and despite the fact that it is the highest consumer of water, farmers prefer this crop over all other crops for profitability, multiple uses of its residues for fodder and its ability to incorporate other crops like water melons etc.

Yields of sugarcane still vary significantly with average yields of 2 tonnes/acre while some farmers in Sialkot and Gujarat are reporting yields as high as 24 tonnes /acre (ZTBI, 2010).

Table 9- Water Consumption for Major Crops in Pakistan

Rice		Cotton		Wheat		Sugarcane	
Hectares	Water m3 million	Hectares	Water m3 million	Hectares	Water m3 million	Hectares	Water m3 million
2,419,000	70,508	2,955,000	51,247	7,554,000	51,418	1,059,000	48,882

Source: WWF, 2002¹⁴²

Farmers in Punjab, Sindh and KPK also intersperse crops like mungbean, *sarsoon*, pulses, gram, tobacco, *bajra*, fodder maize, vegetables. Keeping lands fallow is the only practices in response to non availability of water or the high cost of pumping water.

7.4.4 Implications for Crop Production in Pakistan

Pakistan is a major grower of cotton and influences prices at the international level. But cotton is a new addition to the cotton production systems. However, recent rising costs despite the highly attractive cotton prices (now showing a declining trend) will still ensure that cotton remains a highly remunerative crop despite the increases in fertilizer and diesel prices. While, area allocated to cotton is directly related to how much can be brought under cultivation (in some cases land is being left fallow), still higher productivity and new ways of watering (e.g. raised bed furrow irrigation) will ensure that cotton continues as a dominate kharif crop in Sindh and Punjab parts of IBS. Growth rates in agriculture are closely tied with water availability, crop mix and weather conditions (see table 10).

Table 10- Comparison of Major Crops Sown on Area During 2000, 2005 and 2010

Sr. #	Year	Total Cropped Area (Mha)	Water Availability (BCM)			Agricultural Growth (%)
			Surface Water	Ground Water	Total	
1	Year 2000	22.12	103.73	61.55	165.28	(0.10)
2	Year 2005	23.10	124.11	61.88	185.99	7.90
3	Year 2010	23.04	140.00	66.60	206.60	2.00

Source: Ministry of Food, Agriculture and Livestock (Economic Wing), Government of Pakistan¹⁴³

7.5 Crop Farm Income in Indus Basin

A recent study evaluating the National Program for Improvement of Watercourses in Pakistan (Government of Pakistan, 2011) provides estimation of crop income and gross margins on improved versus unimproved water courses. The average farm yield for major crops in the Indus Basin are placed in Annex 4.

The most recent estimates on farm income are provided as gross margins (Gross Revenues-variable costs) for crops. As shown in table 9 below the gross margin on improved water courses in Punjab is Rs. 116910 and in the case of Sindh it is Rs. 109803 per ha. The same study also provided total farm income estimates (crops plus livestock). On average total farm income in Punjab is Rs. 123609 per HA and in the case of Sindh it is estimated at Rs. 112364.6 per HA reported in Annex 4.

¹⁴² Adapted from Khan F, Water, Governance and Corruption in Pakistan, Running on Empty, Woodrow Wilson International Centre for Scholars

¹⁴³ See also, Infopedia.com

Table 11 - Average Gross Margin of Crops (Rs. per ha)

Province	Categories	GVP	TVC	GM
Punjab	Improved	197,476	80,565.72	116,910.30
	Unimproved	181,754.70	77,909.30	103,845.40
	% Change	8.65	3.41	12.58
Sindh	Improved	170,754.90	60,951.68	109,803.20
	Unimproved	152,551.60	57,896.79	94,654.82
	% Change	11.93	5.28	16.00
KP	Improved	178,146.80	79,820.94	98,325.90
	Unimproved	150,227.80	68,988.33	81,239.48
	% Change	18.58	15.70	21.03
Balochistan	Improved	189,250.60	47,821.06	141,429.60
	Unimproved	182,306.50	44,985.36	137,321.10
	% Change	3.81	6.30	2.99
AJK	Improved	168,641.90	43,905.18	124,736.70
	Unimproved	156,049.90	42,921.31	113,128.60
	% Change	8.07	2.29	10.26
ICT	Improved	110,126.60	55,006.08	55,120.52
	Unimproved	76,397.10	36,685.68	39,711.43
	% Change	44.150	49.94	38.80
GB	Improved	166,524.10	62,831.43	103,692.70
	Unimproved	139,885.50	51,007.82	88,877.68
	% Change	19.04	23.18	16.67
FATA	Improved (Overall)	109,981.10	41,952.40	68,028.72
	Unimproved	107,956.50	40,587.76	67,368.74
	% Change	1.88	3.36	0.98
Pakistan	Improved	181,721.00	70,490.75	111,230.30
	Unimproved	162,903.20	65,919.17	96,984.00
	% Change	11.55	6.94	14.69

Source: National Program for Improvement of Watercourses in Pakistan (Government of Pakistan, 2011)

7.6 Cost of Production

Current cost of production estimates for different crops according to each dominant production zone are not available. An illustration for the wheat crop which is most important *rabi* crop in Pakistan is provided in table 12. Profitability as measured in terms of gross margins varies according to the type and size of farm, technology used, level of inputs particular seed, fertilizer, pesticide, and land quality (see Annex 5). However, recent increases in fertilizer and price of other inputs suggests a downwards trend in profitability. The steady rise in cost of pumping water (diesel price nearing Rs.100/liter, 2008 44.59, 2009 Rs 56.96) and continuous upward revision of electricity tariffs, and the long duration of unabated and unannounced load shedding are all constraints that make agriculture a difficult if not a viable proposition in the irrigated areas. It is further expected that with energy costs rising, heightened pressure from IMF for structural changes including elimination of any subsidy on electricity the farm sector is likely to come under extreme pressure.

Table 12 Costs and Returns (Rs./ha) of Wheat Production Across Cropping Zones, Farm Size and Tenancy Categories

Production practices groups	Cropping zone			Farm size groups			Tenancy status groups			Over-all
	Cot.-wheat	Rice-wheat	Mixed	Small	Medium	Large	Owners	O-C-T	Tenants	
2008-09										
Seedbed preparation (% of total cost)	7.76	10.22	8.76	8.51	8.29	10.27	8.93	8.54	10.30	8.87
Seed (% of total cost)	6.94	6.64	7.68	7.41	6.74	6.46	7.03	6.94	8.42	7.07
Manure/ fertilizer (% of total cost)	26.87	19.11	18.36	20.11	25.59	22.71	21.24	23.88	13.98	21.75
Weedicides applic. (% of total cost)	2.88	2.78	3.12	2.70	3.18	3.26	2.92	2.80	3.67	2.92
Irrigations (% of total cost)	6.40	6.90	5.81	6.64	5.91	6.14	6.50	6.04	7.11	6.38
Harvesting/ threshing (% of total cost)	17.39	20.58	20.96	20.17	18.32	18.87	19.81	18.71	21.13	19.52
Labor costs (% of total cost)	2.58	1.87	1.79	2.02	2.36	2.11	2.03	2.33	1.63	2.11
Total variable cost (% of total cost)	70.81	68.10	66.49	67.56	70.39	69.82	68.47	69.25	66.24	68.61
Total fixed cost (% of total cost)	29.19	31.90	33.51	32.44	29.61	30.18	31.53	30.75	33.76	31.39
Total cost (Rs./acre)	36940.39	32987.58	31013.03	32297.18	36253.39	35380.30	33468.04	34552.11	30726.55	33669.34
Gross Revenue (Rs./acre)	43076.00	48136.00	44121.00	44319.00	46090.00	46541.00	45925.00	43648.00	44000.00	45122.00
Net-Income (Rs./acre)	6135.61	15148.42	13107.97	12021.82	9836.61	11160.70	12456.96	9095.89	13273.45	11452.66
Return/Invest on total cost (Rs.)	0.17	0.46	0.42	0.37	0.27	0.32	0.37	0.26	0.43	0.34

Production practices groups	Cropping zone			Farm size groups			Tenancy status groups			Over-all
	Cot.-wheat	Rice-wheat	Mixed	Small	Medium	Large	Owners	O-C-T	Tenants	
Return/Invest on var. cost (Rs.)	0.65	1.14	1.14	1.03	0.81	0.88	1.00	0.82	1.16	0.95
2007-08										
Seedbed preparation (% of total cost)	7.91	10.16	8.77	8.53	8.51	10.22	9.00	8.49	10.56	8.92
Seed (% of total cost)	6.76	6.37	7.33	7.08	6.64	6.24	6.77	6.71	7.93	6.81
Manure/fertilizer (% of total cost)	23.33	16.33	14.31	16.92	21.54	19.08	17.83	20.14	11.69	18.27
Weedicides applic. (% of total cost)	4.33	3.88	4.32	3.91	4.50	4.63	4.26	3.93	4.79	4.16
Irrigations (% of total cost)	6.01	6.38	5.52	6.27	5.00	5.98	6.03	5.77	6.62	5.98
Harvesting/threshing (% of total cost)	17.54	20.94	22.37	20.73	19.14	19.42	20.33	19.56	21.29	20.13
Labor costs (% of total cost)	2.82	2.03	1.87	2.19	2.56	2.23	2.19	2.50	1.74	2.27
Total variable cost (% of total cost)	68.68	66.09	64.48	65.63	67.88	67.80	66.41	67.10	64.62	66.54
Total fixed cost (% of total cost)	31.32	33.91	35.52	34.37	32.12	32.20	33.59	32.90	35.38	33.46
Total cost (Rs./acre)	33751.26	30567.86	28866.22	30055.16	32702.99	32593.82	30921.11	31736.51	29005.63	31074.60
Gross Revenue (Rs./acre)	35217.00	41753.00	42527.00	39452.50	39828.75	40785.50	40215.75	39151.50	38700.00	39807.25
Net-Income (Rs./acre)	1465.74	11185.14	13660.78	9397.34	7125.76	8191.68	9294.64	7414.99	9694.37	8732.65
Return/Invest on total cost (Rs.)	0.04	0.37	0.47	0.31	0.22	0.25	0.30	0.23	0.33	0.28

Return/Rs. invest on var. cost (Rs.)	0.52	1.07	1.28	1.00	0.79	0.85	0.96	0.84	1.06	0.93
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Source: Wheat Production, Marketing, Harvest and Post-Harvest Losses at Farm Level in the Irrigated Punjab by Mazher Abbas, Dr. Hazoor M. Sabir, Arshed Bashir/Sajida Taj Dr. Umar Farooq. Technology Transfer Institute, PARC .Ayub Agricultural Research Institute (June 2010).

7.7 Emerging Potential of Maize and other High Value Water Efficient Crops

Maize as noted earlier is the only crop showing significant dynamics and expanding, as an emerging high value crop. This is logical and two maize crops can be incorporated into the system annually. Maize has over 50 by products besides grain and valuable residues that serve as animal feed. The US has perhaps the largest collection of germ plasm and most of its research on crops has been with maize. Pakistan could benefit from this research and hybrid technology thereby dramatically reducing the chronic malnutrition and feed resource deficiency. Genetically modified seeds can triple yields in Pakistan. A good illustration of relative cost and returns of fodder including grain cum fodder maize can be found in the FAO publication¹⁴⁴.

Pakistan has a weak research base in maize but foreign multinationals like Monsanto and Cargil are doing substantial business in the seed sector. Rapid advances in productivity can be made at relatively low cost by paying attention to this rather neglected crop. In addition to maize there are other crops especially oil seeds, pulses, condiments, fruits & summer vegetables, and dates that can be planted separately or intercropped to raise the productivity of the farm system that utilize much less water. In particular water efficiency is needed in those agro ecological zones that receive lesser rainfall during the summer season and where water availability is uncertain or cost of pumping water prohibitive. There is a whole area of research possibilities and both public and private establishments need to work jointly with farmers to explore new avenues for incorporation of crops that require lesser water (sesame, pulses, tara mera, cator oil, etc). **International best practices are emerging continuously and climate change scenarios are now focusing on crop substitutions that promote less water requiring crops, fruit and enterprises.** These strategies also push for row cropping and augmenting border crops that encourage green manuring (e.g jantar).

A detailed cost of production analysis for important oilseeds in form of canola is shown in table 13.

Table 13 Economic Analysis of Canola Production

	Farm size categories		
	Small	Medium	Large
Yield (kg/acre)	788	876	880
Gross Revenue (Rs.)	35913.10	39635.54	39868.80
Variable Cost (Rs.)	11383.51	15692.28	16577.38
Total Cost (Rs.)	14718.51	19027.28	19912.38
Gross Margin (Rs.)	24529.59	23943.26	23291.50
Net Income (Rs.)	21194.59	20608.26	19956.50
Cost-benefit ratio	1.00 : 2.44	1.00 : 2.08	1.00 : 2.00

Source: Economics of Non-Conventional Oilseed Crops in the Central Punjab By Mazher Abbas, Muhammad Waqas Akram, Ikram Saeed and Arshed Bashir, 2010 (mimeographed-PARC, Islamabad 2010).

7.8 Agriculture Water Budget

Water availability, soil and anticipated price of the crop planned for plantation are important determinants of yield and area allocated to that crop. In certain areas that specialize in a particular crop zoning of the crop, for example sugarcane mill zones also encourages production of a crop by assuring the market and provision of advanced credit.

¹⁴⁴ <http://www.fao.org/ag/AGP/AGPC/doc/pasture/dost/fodderdost.htm>

The net water availability for crop consumptive requirement is around 78.79 MAF, whereas the net water requirement for crop consumptive use for existing cropping pattern is around 95.8 MAF, considering all the crops and total irrigated cropped area. Thus the shortfall is 17.01 MAF (17.8 percent) without rainfall contribution and shortfall of 3.61 MAF (3.8 percent) considering rainfall contribution of 13.4 MAF in a mean year¹⁴⁵.

The shortfall during dry years will increase due to reduced canal water supply and less rainfall. The farmers do adapt to such conditions either by reducing their cropped area, deficit irrigation or enhanced abstractions from groundwater. The current data of water and agriculture do not indicate such adjustments so precisely. Therefore, it is difficult to establish any relationship of cropped area with availability of water.

Box 3 Budget of Agricultural Water Use in the Indus Basin (Ahmad 2008)

- Canal Diversions to the Indus basin at 50 percent probability – 99 MAF
- Water Conveyance losses – 44.25 MAF
- Canal Water Available at the Farm Head – 54.75 MAF
- Pumpage from Groundwater during 2006-07 – 50.3 MAF
- Net Water Availability at Farm Head – 105.05 MAF
- Field Application Losses – 26.26 MAF
- Net Irrigation Water Availability for Crop Consumptive Requirement – 78.79 MAF
- Rainfall Contribution – 13.4 MAF
- Assuming that rainfall is equivalent to amount required for leaching fraction to maintain salts in the basin, the net water available – 78.79 MAF
- Net Crop Water Requirement – 95.8 MAF
- Shortfall in mean year at 50% probability without rainfall contribution – 17.01 MAF
- Shortfall during mean year at 50% probability with rainfall contribution of 13.4 MAF – 3.61

Global Information System (GIS) and remote sensing applications focused on distribution of water suggests that sufficient water is available for agriculture (90 percent utilized in agriculture) and adequate but pumping ground water is expensive. This stems from the underground water resources and wasteful use of water for high delta crops. When such corrections are made and government policy encourages such substitutions there is every likelihood that Pakistan can make the necessary changes in its cropping pattern within projected water scarcity scenarios. The wider cropping patterns according to the agro-ecological zones suggest that water available is primarily used for the production of cash crops where possible.

7.9 Impact of Floods and Droughts on Cropping Pattern

The most recent flood of 2010 has questioned the viability of certain cropping patterns in the low lying reaches of Punjab and especially in key districts of Sindh. In particular, growing cotton and in some cases sugarcane in flood prone areas and revisiting possible substitutions would be worth considering. Possibilities of future flooding are real and many low lying areas will continue to face the wrath of the Indus River. Macro planners must pay heed to such eventualities and develop strategies that take into account future likelihood of floods and droughts.

A further analysis of these threats can be undertaken using the following questions as guidelines.

¹⁴⁵ Pakistan Water Resources Institute Islamabad, personal communication

Which cropping patterns and rotations within each micro agro-ecological zone are sustainable, and how will productivity decrease or increase? (Northern Areas are expected to see an increase in wheat and rice productivity by 15 percent while Southern areas in the country will see decline in wheat and rice yields by 12-14 percent). IFPRI, 2009 warns that yields of rice and wheat could decrease by 40-50 percent by 2050 in India and Pakistan. These are adequate warning signs that require carefully evaluation of micro cropping patterns.

Pakistan is already facing extreme temperature variability. 2010 witnessed the breaking of temperature records in 28 cities¹⁴⁶ and the average temperature in June was the highest recorded in World history. Such temperature extremes are taking a toll on productivity of crops, flora and fauna. Without strong capacity to collect, analyze and synthesize data for farmer recommendations, the farm community is completely unprepared to modify crop rotations or induce planned cropping intensity modifications based on rational choices. Merely, changing cropping patterns in response to price or cost of water/availability is an unwise choice as it does not factor in the macroeconomic needs, institutional constraints, markets, agribusiness plans and above all the biological ramifications of changing climates and emerging stresses.

The youth is moving out of agriculture and much of the older generation is unable to undertake the hard tasks of field crop agriculture despite the availability of modern threshing and harvesting equipment. Challenges to the farming sector in terms of labour should be rationalized with corresponding changes in cropping patterns and rotations. Designing such new systems requires a high level of expertise in crop modeling that incorporates the biology, sociology, economics and above all resource availability (water) in the future.

Pakistan now has sufficient experience with continuous crop rotations and cropping patterns in the majority of its agro ecological zones. What are the long term impacts on soil texture, structure and fertility of following a particular cropping pattern without regular flushing of fertility from rivers in the Indus Basin system?

What factors determine rigidity of sticking to a single cropping pattern besides tradition and knowledge? Can the factors be manipulated to enhance efficiency and productivity for different farm sizes, level of management available, improvements in knowledge base through extension and mass communication, market innovations etc? What will be the consequences and how will they be monitored as systems respond?

Lastly, what are the most desirable cropping pattern and rotation in the event of massive migration of labour into urban areas and gradual industrialization where contribution of crop agriculture might further decline or in the light of high levels of productivity if it were to increase?

7.10 Macro Performance and Cropping Pattern Adjustments

Pakistan is a major exporter of rice, cotton and fruits (Table 14). It has widespread potential to enhance its exports particularly for products of high value. Its fisheries sector has grown tremendously but their still remains great potential to increase productivity of inland fisheries, and integrate this into fish-crop-livestock farming systems as has been successfully done in Far Eastern countries (China, Philippines, Indonesia, and Thailand). Likewise an emphasis on high value enterprises in the area of fruits, and vegetables, medicinal plants are seldom part of intensive cropping patterns. There tend to take a peripheral place in the farming systems due to lack of knowledge and markets. Those who venture into these areas are rewarded by profits provided the production and processing systems are based on international standards and can compete in the international markets. Besides these formal exports, there is considerable cross border movement of livestock, wheat and other products to Afghanistan, Middle East and Central Asia that moves through informal sources. Similarly, the fish products from coastal areas enter lucrative markets under “ghost businesses” depriving the government of valuable revenue, but for those participating in such trade in connivance with international syndicates a profit making business. In particular, Pakistan is facing severe stress with livestock exports which are taking a heavy toll on domestic livestock prices for beef and mutton.

In terms of imports both tea and edible oil are imports of volume that burden Pakistan's exchequer. Despite a repeated demonstrated potential of oil seeds like (sunflower, safflower, palm-oil etc.) Pakistan has made negligible gains in introducing

¹⁴⁶ The News 2010

these crops into its cropping patterns. The main reasons are lack of markets, processing facilities and price support from the government. Edible oil crops are the most likely entrants into cropping patterns provided these constraints can be improved. While current cost of production information on these different enterprises is unavailable, economic analysis by Pakistan Agriculture Research Council- Agriculture Economic Research Units (AERU's) in different ecological zones had established viability of these crops as strong and profitable contenders in modified farming systems in 1990s¹⁴⁷. Likewise changing the technology (e.g. integrated pest management) can reduce reliance on imports of pesticides which enter visibly into the imports bill. In the case of sugar Pakistan should look carefully at the comparative advantage of this crop as it increases the burden on water resources. If, imports are much cheaper it is better for the economy and population's welfare to import lower priced sugar (Brazil, Cuba) and utilize the water realized for higher value products like fruits, vegetables, condiments, organic farming etc.

Table 14 – Agricultural Imports and Exports (2009-2010)

EXPORTS		IMPORTS	
ITEMS	AMOUNT (Rs. Billion)	ITEMS	AMOUNT (Rs. Billion)
Rice	185	Edible oil	106
Cotton cloth	152	Fertilizer	73
Cotton yarn	121	Sugar	24
Fruits & vegetables	30	Tea	22
Fish & fish preparations	19	Insecticides	12

Source: Federal Bureau of Statistics, Pakistan

In the absence of analytical capability, few worthwhile institutions in public, private or academic circles can support policy analysis and modeling to determine zone by zone comparative advantage. Domestic Resource Cost use (DRC) and alternate water conservation technology impacts on modifying cropping patterns. This lack of capacity for both research and analysis is further complicated by a great shortage of analytical capacity at the policy level to interpret such findings for viable policy reform. Cropping patterns are left to the whims of a farming community who try to do their best under their own circumstances. Government support or intervention only benefits them in terms of input or output supports price the two rather widely used instruments for macroeconomic intervention. Little attention to input output parity during recent years has forced farmers to make decisions solely on output prices. With import interventions unaccounted farmers have been hurt and at times announced procurement prices were not honored or the government lacked financial resources to buy the surpluses leading to a large number of frustrated and disgruntled farmers. These anomalies are partly responsible for the rigid cropping patterns which require state of the art macro management and directly engaging with farm communities to take advantage of international market, price and trading trends.

Pakistan needs to evaluate its crop sector performance in close relationship with international yields. Where it finds its yields stagnant for too long, [it should take steps to substitute these crops or enterprises for which its environment, climate, technology and national interests are best suited](#) (Tables 14 and 15). In certain cases it is tied into the over-production trap which depresses the prices it receives or it gets locked into inefficient and outmoded processing technology which forces it to continue producing crops at a low level of economic end technical efficiency just to feed its obsolete infrastructure.

¹⁴⁷ Contact with Dr. Muhammad Sharif head of the Social Sciences Division at Pakistan Agriculture Research Council confirmed that cost of production data is no longer collected. The council has launched a project to collect this information from all agro ecological zones from 2011 onwards.

Table 15 – Comparison of National Average Yields of Pakistan and other Countries

Country	Average yield (kg / hectare)				
	Wheat	Cotton	Rice	Maize	Sugarcane
World	2,720	1,788	3,916	4,343	65,802
India	2,770	754	2,915	1,705	68,049
China	3,885	3,978	6,266	5,022	66,802
Egypt	6,006	2,654	-	-	119,838
Mexico	5,151	-	-	2,437	74,746
France	7,449	-	-	9,914	-
Pakistan					
National Average	2,262	1,867	2,882	1,768	48,056
Progressive farmer	4,500	2,890	4,580	7,455	106,700

Source: ZTBL, 2010

7.11 Virtual Water

Modern water allocation correlates strongly with the amount of water it takes to produce a given unit of an agriculture output. Internationally, now countries view their outputs in terms of total water that went as an input. So, what is exported or imported is enumerated in terms of water transfers as opposed to value of the import or export only. Unfortunately, this perspective has not entered the Pakistani policy domain, or sensitivity to such accounting methods brought into a business model or promoted amongst entrepreneurs. As water becomes scarce a prime decision to produce will relate to how much output can be produced for a given amount of water. This rationale is valid since water gets allocated to the produce that will yield highest return per unit of water. Moreover, when products are traded or moved within a country, and between districts, provinces or regions, besides arguing on the basis of value of produce, producing districts or provinces can state that this produce has consumed a certain amount of water so, a specific proportion of MAF of water can be implicitly imputed into the value of the tons of grain, or livestock.

Tables 16 and 17 show the comparison of the water content to produce different agricultural products internationally, for all agro-ecological zones and cropping patterns of Pakistan which yield some interesting results. It will also answer the many questions arising as to why so many countries' e.g. Saudi Arabia, Dubai, Italy etc. are interested in Pakistan's fresh waters, and why Corporate/Multinational Farming creates intermittent hype amongst ill-informed policy makers. This is easily understood when viewed from a virtual water perspective.

Table 16 – Amount of Water Used to Grow Food (liters of water evapotranspired per kg food)

Crop	France	United State	China	India	World
Maize	500	500	1000	4500	1200
Rice	1200	1700	1200	3500	2200
Wheat	500	1200	1200	2200	1800

Source: World Bank 2006

Table 17- Virtual Water Content for Selected Products

Product	Water content (m3 /ton)
Beef	13,500
Poultry	4,100
Soybean	2,750
Eggs	2,700
Rice	1,400
Wheat	1,160
Milk	790

Source: World Bank 2006

7.12 Crop Water Requirements

The *rabi* and *kharif* are the two main cropping seasons followed in the country.

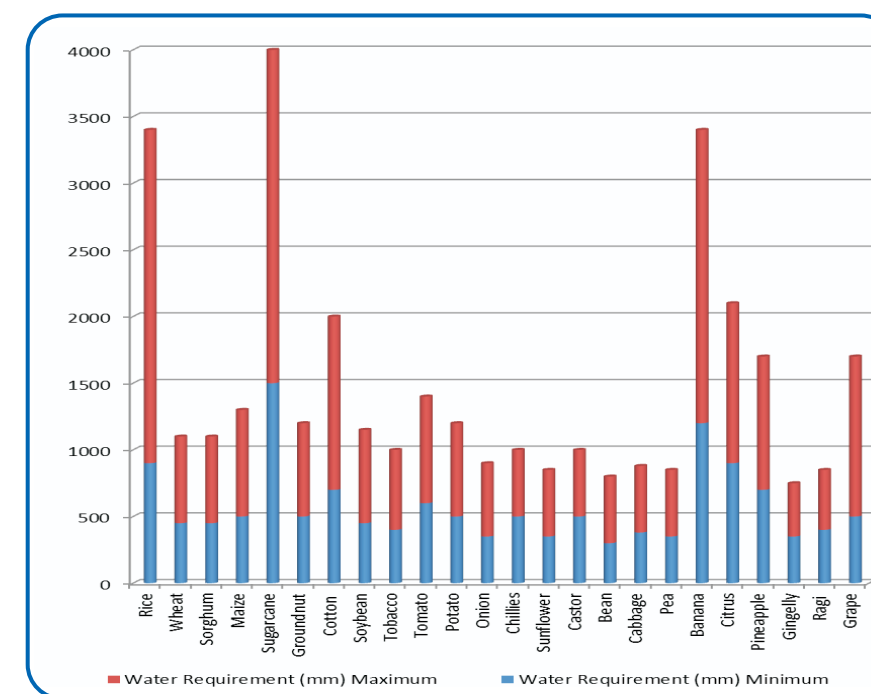
The main *rabi* crops are wheat, rapeseed, and chickpeas, while the *kharif* crops are rice, cotton, sugarcane, maize, and sorghum. The *kharif* season in Sindh of Lower Indus Plains starts earlier than Punjab or in the Northern Indus Plains by about 20-30 days due to early onset of summer. Season-wise crop water requirements at some locations of the country are given in Table 18. It can be observed that the annual water requirements are slightly more in the lower Indus region than in the upper Indus region. This is due to higher aridity and climatic conditions in the Lower Indus Plains.

Table 18- Seasonal Crop Water Requirements

Area	Crop Water Requirements (mm)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Bhakkar	732	566	1298
D.G. Khan	852	568	1420
Faisalabad	755	525	1280
Jhelum	588	435	1023
Lahore	606	441	1047
Multan	691	510	1201
Average over Northern Indus	704	508	1,212
Hyderabad	697	675	1372
Mirpur Khas	715	683	1398
Nawabshah	511	536	1047
Sukkur	797	660	1457
Thatta	715	689	1404
Average over Southern Indus	687	649	1,336
Quetta	699	413	1112
Jacobabad	837	650	1487
Kalat	588	435	1023
Bela	470	557	1027
D.I. Khan	750	504	1254
Peshawar	732	463	1195
Chitral	728	452	1180
Parachinar	567	357	924

Source: FAO Rome, Statistical Division

Figure 4 – Minimum and Maximum Water Requirements by Crop



Source: FAO Rome, Statistical Division

7.13 Conclusions and Recommendations

Climate change is likely to affect the crop enterprise sector. Present cropping patterns and intensities will face water challenges that will force some substitution and adjustment in rotations even though the system has shown remarkable rigidity and stability over centuries.

Within the Indus Basin there is dynamics in use of inputs, choice crop varieties, timing of sowing and harvesting but yields have stagnated over the past decade, and growth rates show wide variance from 2-7 percent which is likely to be further widened as water and energy crisis is aggravated.

Cropping intensities in Punjab, KPK, and Balochistan are high and Sindh tends to display lowest cropping intensities (partly due to mismanaged water and growing high delta crops in abundance e.g. sugarcane, wheat-rice, wheat-cotton, and sugarcane-fodder are dominant crop rotations in the Indus Basin. The support price for some of the major crops partially determines the rotation farmers are likely to follow. Although in recent years with support prices announced primarily for wheat, and other governments para-statal like (rice export corporation) taking a back seat farmers have relied more heavily on marketing mechanism which have often been exploited. Thus farmers face hard choices in continuing with certain crops especially in zones where other more traditional or new crops remain untested on a large scale. Lack of marketing infrastructure for the other crops like maize, *jowar*, pulses, oilseeds, etc discourages their widespread commercial production.

Water in Pakistan is becoming scarce. While almost 90 percent water is utilized in agriculture, the cost of pumping water with rising diesel and electricity prices and persistent load-shedding is increasing the cost of water. Whereas, *abiana* rates (water charges) for canal water are dismally low (Rs. 200-400/annum) those with access to a canal have a clear production advantage. Cropping patterns will continue with rigidity as long as water is highly subsidized and high delta crops will remain attractive. However, when true water costs are factored in dynamics in cropping patterns is a highly probable outcome.

In the absence of storage and capacity to regulate there can be no option for water on demand. Thus water pricing without water on demand is an unrealistic concept. For markets to work water has to be available when, where, in whatever quantities demanded and free from interruptions.

The study found yields to be in the reasonable range but rather stagnant over the last decade. There is marked difference between

Pakistani field crop yields and those obtained at the international level. Likewise a major difference was noted between yields of, a progressive farmer and an average farmer pointing to the marked potential to improve yields within local circumstance by better system management.

Food security is a valid concern for Pakistan and it will continue to produce wheat in most of its cropping systems where water is available or even where not available (*barani* areas). However, by bridging yield gaps considerable areas can be released from *rabi* wheat production and put to higher value enterprises orchards, oilseeds, maize etc.

Pakistan needs to rationalize its crop water use based on crop physiology. Scientific advance in metrology and GIS can help guide where and when water is needed the most.

It seems that such information is not available to farmers despite the availability of technology to the meteorological and research departments e.g. SUPARCO. Even input fertilizer and pesticide use could be tied to observations validated through GIS and remote sensing.

The high import bill of oilseeds and tea in Pakistan is largely due to a strong political economy that wishes to maintain status quo. Indus Basin can easily be geared to relieve this heavy burden on the national exchequer by substituting crops in the relevant agro ecological zones in favor of oilseeds (both winter and summer) and by taking out low value maize and planting tea in Manshera, Abbottabad and other upper reaches of the Indus in northern areas along the Indus.

Evaluation of water resources within changing climate circumstances was found deficit. The missing link between crop systems modeling and water resources at macro and micro level undermines innovation in cropping patterns that can lead to a major turnaround in the Indus Basin System.

For long term sustainable development for Pakistan, economic surpluses in the agricultural sector must be created. There is water, a hard working farmer, but no science and no management. We have to put the best minds into agriculture and ensure that maximum returns are realized for each and every acre water is utilized. There are ample opportunities for substituting high delta crops with crops that require less water and divert this water into more intensification and introduction of high value crops and enterprises like vegetables, flowers, fruit and livestock.

Given that Pakistan is an agricultural country, thinking in terms of agro-ecological zones (rather than eco-zones) is more appropriate for the Indus Basin, and the following actions are required for making integrated approaches for the Indus Basin more effective:

- Carry out modeling and analytical studies at agro ecological zone level to understand productivity, substitution potential, constraints and opportunities;
- Advocate potential of maize to transform agricultural economy;
- Advocate crop-livestock integrated agriculture that makes best use of land-water-labor-technology and market opportunities;
- Advocate processing, transportation, refrigeration, marketing and allied functions of the agribusiness sector for handling high value products;
- Establish an effective Prices Commission or institution at Federal and Provincial levels which generate and share data on production, farm systems, cropping patterns etc;
- Use emerging technology tools in media, telephony, and the internet to provide daily information to farmers to make decisions on what to plant, when and how, and in what quantities to produce and where to market the crops.

Best Practices in Integrated River Basin Management (IRBM)

IRBM is part of the Integrated Water Resource Management (IWRM) concept and approach, which involves the coordinated management of land and water resources for multiple purposes and across different sectors for conservation of the river basin in a participative and integrated way, consistent with relevant international conventions and national laws, policies, objectives, goals and institutions¹⁴⁸. A fundamental tenet of IRBM is that the entire river basin ecosystem is the source of freshwater including groundwater and wetland systems connected to the river. *Therefore, the sustainability of the river basin inherently depends on protecting the functioning of the entire system.*

Box 4: Key Elements to a Successful IRBM Approach

- A long term vision for the river basin, agreed to by all stakeholders;
- Investment, capacity building and knowledge generation on the part of stakeholders for river basin planning and participation processes;
- Clear and strong institutional arrangements;
- Solid foundation of knowledge of the river basin and good water related data, information, systems and models for easy application;
- A complete set of basin wide policies, procedures and strategies (legislative framework);
- An appropriate forum for participation, communication and involvement for all stakeholders and partners;
- Sustainability performance indicators and a consolidated approach to monitor and report on how the basin is being managed and the resources being utilized protected.

IRBM provides a set of guiding principles for water managers, there is a need to translate those principles to practical improvements in water management that help to deliver tangible outcomes.

There are several successful examples of IRBM approaches around the world that highlight some or many of these elements even if the term IRBM is not used. A closer look at some of these will help us glean some “best practices” that could serve as the foundation of future projects.

8.1 Murray-Darling Basin Initiative

The Murray - Darling Basin is located in the southeast of Australia and covers about 1 million square kilometers of the country's total area¹⁴⁹. The catchment area of the Murray and Darling rivers and their tributaries includes 23 river valleys¹⁵⁰. The basin covers four states (New South Wales, Victoria, South Australia and Queensland)¹⁵¹ and also covers the Australian Capital Territory. Approximately two million people live in the basin and another million outside it are dependent on its water¹⁵². The

¹⁴⁸ Lenton E R and Muller M, Global Water Partnership. Integrated Water Resources Management in Practice, Earthscan, 2009. Print.

¹⁴⁹ Elfithri R et. Al, Perspectives and Initiatives on IRBM in Malaysia: A Review, The Social Sciences Jan. 2011: 169-176. Medwell Journals. <http://docsdrive.com/pdfs/medwelljournals/sscience/2011/169-176.pdf>

¹⁵⁰ Murray Darling Basin Authority website. See online: http://www.mdba.gov.au/about/governance/ministerial_council

¹⁵¹ Elfithri R et. Al, Perspectives and Initiatives on IRBM in Malaysia: A Review, The Social Sciences Jan. 2011: 169-176. Medwell Journals.

<http://docsdrive.com/pdfs/medwelljournals/sscience/2011/169-176.pdf>

¹⁵² Ibid.

MDB is also Australia's most important agricultural area, comprising 65 percent of Australia's irrigated agricultural land and producing over one third of Australia's food supply.

8.1.1 History of Basin Management

The first instance of cooperation over the MDB waters can be dated back to 1914 with the River Murray Waters Agreement 1914 between the governments of New South Wales, Victoria, South Australia and the Commonwealth. This was a classic case of upstream versus downstream riparian issues where interests for irrigation were competing with interests for river water use for navigation purposes. The 1914 Agreement established a framework for cooperative management of the river water whilst safeguarding the states' sovereign right of water use. The salient features of this Agreement were: (1) water sharing – it specified share and distribution of water between the riparian states; (2) joint works – it provided for a series of structures to be constructed along the Murray river and its tributaries for expansion of irrigation and preservation of navigation; (3) cost sharing – it mandated that the cost of the infrastructure development be divided between the riparian states; (4) implementation – it made provisions for the establishment of the River Murray Commission to ensure that the Agreement is implemented by all states¹⁵³.

The 1914 Agreement, however, contributed to increased environmental degradation because of its heavy focus on infrastructure development along the Murray river. As a result the MDB community raised concerns as a whole regarding the future state of the basin. This led to the signing of another Agreement in 1987 which pertained to the entire Murray – Darling Basin, however this was also inadequate in addressing environmental concerns. Therefore, the Murray-Darling Basin Agreement 1987 was replaced by the Murray-Darling Basin Agreement 1992¹⁵⁴.

The 1992 Agreement also created a new institutional framework, built on the principles of IRBM, for the management of the MDB. The fundamental premise of the Australian government's Murray Darling Basin Initiative (MDBI) of the Australian government is the protection and integrated management of all water, land, and environmental resources of the whole basin. The Murray Darling Basin Initiative provides the institutional structures for cooperative management and planning of the whole basin in partnership with the basin community and signatory governments. The MDBI also acts as an “umbrella” organisation under which a multi-jurisdictional river basin authority functions as the decision-making and implementing agencies¹⁵⁵.

8.1.2 Capping Withdrawals and Ensuring Environmental Flows

As a part of its approach, the MDB Commission placed a 'cap' on total water withdrawals at the river basin level and set up a process to negotiate environmental flows for each tributary and the main river. The cap does not affect the shares of water from the transboundary Murray River for the three states in the Murray-Darling basin. Allocation to individual water users and between consumption and in-stream uses remains a matter for the State concerned. What the cap does is to reinforce the responsibility of the states to exercise controls over actual extractions of water in accord with the cap rules. The cap, by sending a powerful signal that water is finite, is intended to improve water use efficiencies¹⁵⁶.

A limitation of this approach is that the cap works only on annual flows, ignores the major extraction or intervention caused by the operation of storage dams, and allows maximum extractions in dry years (which may be contrary to the actual ecological needs of the rivers at that time). Nonetheless the cap has demonstrated through strict implementation that managing the health of rivers is important¹⁵⁷.

8.1.3 Water Entitlements

The cap has also reinforced the status of water entitlements as an important instrument of management. While the concept of water entitlements or rights has been inherent in Australian water policies, it takes on particular significance in the new

¹⁵³ Lenton R E and Muller M, From Water to Wine, in Global Water Partnership. Integrated Water Resources Management in Practice, Earthscan, 2009. Print.

¹⁵⁴ Shahjahan M. IRBM for the Ganges: Lessons from the Murray Darling and Mekong River Basins (A Bangladesh Perspective), Adelaide, Australia: University of Adelaide, 2008. <http://digital.library.adelaide.edu.au/dspace/bitstream/2440/49983/1/02whole.pdf>

¹⁵⁵ Haisman, 2004: 64

¹⁵⁶ Lenton E R and Muller M, Global Water Partnership. Integrated Water Resources Management in Practice, Earthscan, 2009. Print.

¹⁵⁷ Haisman, 2004: 64

dispensation. This is highlighted by the objectives of the National Water Initiative, which, as explained by the National Water Commission, signifies:

- A commitment to identifying over-allocated water systems, and restoring those systems to sustainable levels;
- The expansion of the trade in water resulting in more profitable use of water and more cost-effective and flexible recovery of water to achieve environmental outcomes;
- More confidence for those investing in the water industry due to more secure water access entitlements, better registry arrangements, monitoring, reporting and accounting of water use, and improved public access to information;
- More sophisticated, transparent and comprehensive water planning.

8.1.4 Murray Darling Basin Committee

There are a series of committees to manage the basin:

Murray Darling Basin Ministerial Council

- Supreme authority in relation to policies and policy implementation;
- Political forum comprising of three Ministers (land, water, environment) from each signatory government and a representative of the Commonwealth;
- Decision can only be passed with the unanimous vote of all the Ministers present, thus representing a consensus of the participating governments.

Basin Officials Committee

- Executive arm of the MDBA plays an advisory role to the Ministerial Council;
- Role is to develop a basin-wide framework for the sustainable management of the basin's resources;
- Role is to participate and promote MDBI by managing policy planning and knowledge generation activities across the basin;
- Commission comprises of an Independent President, two commissioners and deputy commissioners (land, water, environment) from each government, non-voting representative of Australian Capital Territory.

Basin Community Committee

- Consultative body that provides two-way communication between council and the basin community;
- CAC communicates directly with the ministerial council, without any bureaucratic interference and is in regular coordination with the commission.

8.1.5 Recent Changes

Most recently, there has been a shift in the institutional arrangements of the MDB where the decision-making and policy power has been shifted to the Commonwealth. With the Water Act 2007, the Murray Darling Basin Commission was replaced by the Murray Darling Basin Authority which in addition to taking over of all Commission responsibilities is also in charge of drafting a Basin Plan by 2011. This plan is to be all inclusive and deal with all issues that threaten environmental conditions and resource security, using a basin-wide approach and ignoring all state borders¹⁵⁸.

Therefore, the MDB example shows us that a neutral “apex” body, albeit with some interests and stake in the river basin should be responsible for designing basin related policies in conjunction with stakeholder participation.

8.2 Mekong River Basin

The Mekong River rises in the Tibetan Plateau at an elevation of 5000 meters and flows for 4800 km through six countries before running into the South China Sea. From its source in the Himalayas, the Mekong flows in a southerly direction through Southern

¹⁵⁸ Experiences with integrated river basin management, international and Murray Darling Basin: a lesson for northern Australia, North Australia Land and Water Science Review Oct. 2009: 1 - 33. See online: http://www.nalwt.gov.au/files/Chapter_22-International_experience-lessons_for_northern_Australia.pdf

China. It then forms the boundaries between Myanmar and Laos and between Laos and Thailand. Flowing further through Laos, it also crosses through Cambodia. Before finally entering the South China Sea, it forms a complex delta system in Vietnam¹⁵⁹.

The Mekong River Basin is generally regarded as the eighth largest river basin in the world in terms of annual flow (475,000 million cubic meters) and the twelfth largest with a drainage area of 795,000 square km.

8.2.1 History of Basin Management

The story of cooperation in the Mekong region starts with the end of the Cold War and the signing of the Geneva Accords. The newly independent states of Laos, Cambodia and Vietnam along with Thailand (lower Mekong countries) supported by the United Nations Economic Commission for Asia and Far East (ECAFE) and the US Bureau for Reclamation established the Mekong Committee and embarked upon the “Mekong Project” to undertake large infrastructural development works along the Mekong river. Instability in the region, however, led to the failure of the Mekong Committee with Cambodia leaving the agreement. Cambodia's request for readmission into the Committee in 1991 sparked off lengthy discussion which finally resulted in the 1995 Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin¹⁶⁰.

The 1995 Agreement also led to the dissolution of the former Mekong River Committee and transferred its powers to the newly established Mekong River Commission. The focus of the Commission changed from the development of large scale projects to management of natural resources and the preservation of the Mekong River Basin holistically¹⁶¹. The premise of the 1995 Agreement was “a common interest in jointly managing their shared water resources and developing the economic potential of the river” with a mandate of “cooperation in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin¹⁶². Since then, member countries have signed sub-agreements on data, information sharing and exchange, flood management and mitigation strategy, and a formal agreement with China on the exchange of hydrological and other data.

It is noteworthy to mention here that although the Mekong River Commission actually comprises of only the four lower Mekong countries (Laos, Cambodia, Thailand and Vietnam), the two other riparian countries of the Mekong River - China and Myanmar - are dialogue partners of the Mekong River Commission. Thus, the Commission is an all-inclusive regulatory body representing the interests of all the stakeholders.

8.2.2 Structure of MRC

The structure of the Mekong River Commission consists of three permanent bodies: The Council, Joint Committee and the Secretariat. These permanent regulatory bodies are assisted by National Mekong Committees in each country.

MRC Council¹⁶³

The Council meets once a year and consists of one member from each country at the ministerial or cabinet level. The Council makes policy decisions and provides other necessary guidance concerning the promotion, support, co-operation and co-ordination of joint activities and programmes in order to implement the 1995 Agreement. The Council has overall governance of the Mekong River Commission.

MRC Joint Committee¹⁶⁴

The Joint Committee (JC) consists of one member from each country at no less than Head of Department level. The Joint Committee is responsible for the implementation of the policies and decisions of the Council and supervises the activities of the Mekong River Commission Secretariat. This body functions as a board of management.

¹⁵⁹ Shahjahan M, IRBM for the Ganges: Lessons from the Murray Darling and Mekong River Basins (A Bangladesh Perspective), Adelaide, Australia: University of Adelaide, 2008. <http://digital.library.adelaide.edu.au/dspace/bitstream/2440/49983/1/02whole.pdf>

¹⁶⁰ Mekong River Commission website. See online: http://www.mrcmekong.org/about_mrc.htm#nmc

¹⁶¹ Ibid.

¹⁶² Ibid.

¹⁶³ Ibid.

¹⁶⁴ Ibid.

MRC Secretariat¹⁶⁵

The MRC Secretariat is the operational arm of the MRC. It provides technical and administrative services to the Joint Committee and the Council, is under the direction of a Chief Executive Officer (CEO) who is appointed by the Council. Under the supervision of the Joint Committee, the Chief Executive Officer (CEO) is responsible for the day-to-day operations of around 155 professional and general support staff. The main counterparts for MRC activities in the four member countries are the National Mekong Committees (NMCs).

The United Nations and the US Bureau for Reclamation were key players in catalyzing the cooperation amongst the Mekong riparian states. Financial and administrative support on the part of the US and the UN enabled the newly independent states to enter into the agreement of developing the potential of the Mekong River. Political will manifested by the four member countries in the lower Mekong region to engage the upper Mekong countries to become dialogue partners of the Mekong River Commission truly makes this Commission enabled to engage in holistic integrated river basin management.

8.3 Lake Biwa, Yodo River Basin

This sub session is based largely on best practices in Integrated River Basin Management (IRBM).

While the history of water resources development interventions in Lake Biwa goes back to the 1950s and before, the conflicts around water use began to be critically articulated in the 1970s. From this time onwards there were a number of processes with IRBM and Integrated Lake management characteristics that were tried and that led to a cascade of results over three decades.

Achieving a balance between development and conservation in Lake Biwa required an 'integration' of economic concerns with environmental sustainability. It also entailed adapting to the changing social priorities of groups in the upstream and downstream areas. This process involved several instruments, which are considered classic tools of IWRM, IRMM and ILBM.

Formed about four million years ago, Lake Biwa is an ancient lake of great historical and cultural significance. With a surface area of 670 km², Lake Biwa is the largest lake in Japan. It lies in the upper reaches of the relatively small (8,240 km²) Yodo River Basin, above one of the most urbanized and developed regions in the world¹⁶⁶.

While more than 400 tributaries flow into the lake, only one natural watercourse, the Seta River, flows out of Lake Biwa. The Seta River is joined by the Kizu and the Katsura Rivers to become the Yodo River, which flows into Osaka Bay and eventually to the Pacific Ocean.

8.3.1 Planned Management over a Century

The history of Lake Biwa's planned management goes back more than a century to an episode of severe flooding in 1896, which caused substantial damage in the region. This led to the dredging of the Seta River at the outlet of the lake and, soon after, the construction of the Seta Weir, the lake's first artificial water-flow control facility.

Half a century later, Lake Biwa became an important focus of development to support the programme of industrialization and urbanization that was initiated after World War II. It was the main source of water to meet increased demands from the burgeoning industries and urban areas of the Kinki region (including the cities of Osaka and Kobe).

By the 1960s, it became apparent that the explosive industrial and population growth in the region was leading to wide-scale pollution and the destruction of important habitats around the lake.

During the 1970s, pollution became so bad that it began to threaten both human and ecosystem health. Chemicals from agricultural runoff, untreated sewage and wastewater, and industrial effluents, including heavy metals, combined to degrade soil and water quality and contaminate fish and shellfish. Excessive levels of nutrients such as nitrogen and phosphorous caused

¹⁶⁵ Mekong River Commission website. See online: http://www.mrcmekong.org/about_mrc.htm#nmc

¹⁶⁶ Nakamura, 2007: 34

massive algal blooms and red tides in the lake in 1977. The eutrophication - the reduction of dissolved oxygen in the water due to overgrowth of algae and other plants - encouraged invasive species to flourish in one of the most biologically diverse areas of Japan¹⁶⁷.

In addition, the regional Shiga Prefecture government actively promoted the construction of infrastructure along a substantial portion of the lake - much of which was designed to support tourism.

8.3.2 How the Challenges were Addressed

Over six decades a series of laws and regulations were promulgated and successive institutions formed, leading up to a renaissance plan and stewardships. As can be seen from Table 19, this development reflects thinking and actions around water management and conservation as it has evolved.

Table 19 - Lake Biwa Water Resources Development and Conservation Milestones

Year	Laws, Regulations, Institutions
1950s	Water resources development interventions in Lake Biwa
1961	The Water Resources Development Promotion Law
1963	Kinki Improvement Law (KRIL)
1967	The Basic Law for Environmental Pollution Control
1969	Pollution Control Ordinance of Shiga Prefecture
1970s	Heavy contamination in Lake Biwa
1970	Environmental Standards for Water Quality
1970	Start of the citizens' movement in Shiga Prefecture
1971	Water Pollution Control Law
1971	Pollution Control Ordinance, Shiga Prefecture
1972	Law for Lake Biwa Comprehensive Development (LLBCD)
1972	Lake Biwa Comprehensive Development Project (LBCDP)
1976	Start of litigation by citizens of Osaka and Kobe
1977	Red tides in Lake Biwa
1977	Citizens Movement focuses on water quality issues
1978	Citizens Forum for Conservation of the Aquatic Environment around Lake Biwa (Biwa-ko Forum) formed
1980s	Continuation of litigation and public outcry
1981	Shiga Environment Conservation Association formed
1989	Court rules against litigants
1990s	Dams built around the Lake Biwa
1990s	Environmental Cooperatives formed
1992	Reed Belt Conservation Ordinance, Shiga Prefecture
1993	Lake Biwa designated a Ramsar site
1996	Basic Environment Ordinance
1997	The LBCDR increases water flow to 40 metric tons per second
2000s	The concept of the 'mother lake' takes root
2005	Lake Biwa Renaissance Plan using stewardship concepts

8.3.3 Infrastructure Interventions

Infrastructure development was undertaken in incremental water to address both flooding and water shortages. Floods provoked the earliest interventions and the construction of the Seta weir to enable outflows and lake levels to be controlled. But too much water was only one aspect of the problem. In drought years, downstream communities dependent on flows from the lake also faced water shortages when there was not enough outflow. In 1978, water restrictions were in place for 161 days of the year - with

¹⁶⁷ Kira, 2005

serious economic and social impacts for downstream communities. In addition, navigability of the river, at that stage still important for fishing boats, was impeded by shallow water during dry periods¹⁶⁸.

To address these issues, a further series of infrastructure interventions was initiated in 1972 which can be said to have addressed the water challenges of the basin in an integrated manner.

The most important infrastructure work under the LBCDP allowed navigation and water abstraction to be maintained even when the lake levels fell. Extensive flood protection works were built and new drainage pumps were installed to lift flood water over the new flood levees and prevent inundation in the area around the lake.

8.3.4 Lobbying for Water Quality and Environmental Protection – Public Participations and Citizen's Action

Increasing water pollution heavy metal contamination and algal growths made it difficult to produce drinking water with acceptable taste and smell. Detergents and fertilizer used by rice farmers upstream, untreated sewage and industrial discharges were all contributing to the problem of eutrophication in the lake.

People were alarmed and there were two noteworthy citizens' actions in the 1970s - a people's movement in the upstream areas and one of Japan's first environmental lawsuits to be brought by citizens, in this case by downstream water users.

The citizens' movement had its base in the Soap Movement, which started in the early 1970s in the area around Lake Biwa as a campaign by homemakers who were concerned about babies' nappy rash and housewives' eczema caused by synthetic detergents. In 1977, however, after the red tides in the lake, the movement changed its focus to the conservation of lake water quality and became one of the most successful and celebrated citizens' movements in Japan. This movement is especially significant because it was led by women, who highlighted that citizens were also responsible for the degradation of lake water quality.

The movement successfully put pressure on the local government to pass the Lake Biwa Ordinance to regulate the use of phosphorus-containing detergents. This presaged a worldwide trend to reduce the use of phosphorus based detergents in catchment areas vulnerable to eutrophication.

The second citizen's action was lead by residents of downstream Osaka who filed a lawsuit 1976 against the central government and the Shiga Prefecture government for supplying them with polluted water. While the case was lost, it established the fundamental argument for the quality of water and water conservation.

A Citizens Forum for Conservation of the Aquatic Environment around Lake Biwa (Biwa-ko Forum) was established in 1978 and remains relevant today as an established institutional outcome of citizens' action. Another outcome of this movement was the establishment of Environmental Cooperatives in 1990, which specialized in the promotion of environmentally sound commercial products, especially those that end up in the drainage system after use.

8.3.5 Development and Implementation of the Water Resources Knowledge Base

The development of the water resources knowledge base and the capacity to use it was a key early intervention needed to guide other interventions. Lake Biwa is reputed to be one of the most researched areas in Japan, with a rich scientific and social database related to water resources.

In addition capacity has been developed across many disciplines with a whole cadre of trained researchers, scientists and field staff now working in the area. The Lake Biwa Environmental Research Institute was established in 1993 as a mechanism for gathering, exchanging, and distributing research information and technologies which reflect the needs of society and challenges of the government. The Centre for Ecological Research (Kyoto University), the UNEP-supported International Environmental Technology Centre and the Lake Biwa Museum are also centres of research. The outcome is a permanent system of close linkages between research institutions and citizens' groups, private businesses, industries and government institutions, such that the water resources knowledge base continuously feeds into management decisions.

¹⁶⁸ IAAJWA Lake Biwa Development Integrated Operation & Maintenance Office, 2003

8.3.6 Private initiatives and Stewardship

In the context of Lake Biwa, there was a unique instance of private initiative when in 1981 the Shiga Environment Conservation Association was formed. It consisted of more than four hundred local companies at that time and originated from an information exchange group of personnel in charge of industrial wastewater treatment. This association has remained an active participant in the conservation and reuse of water. Other private organisations serving Lake Biwa include the Citizen Forum for the Conservation of the Aquatic Environment around Lake Biwa (Lake Biwa Citizen Forum), Friends of Lake Biwa, Water and Culture Study Group, Akanoi-Biwako Environment Citizens' Initiative, Lake Biwa-Yodo River Water Purification Organisation and Environmental Co-op Union Shiga. By adopting codes of practices these organisations have directly contributed to the outcome of improved water quality.

8.3.7 Building Effective Institutions and Administrative Systems

The challenge of addressing water quality and environmental conservation required substantial organisational changes in the Shiga Prefecture government to reflect the changing focus and priorities towards environmental conservation. The evolution of the organisations involved in environmental protection in Lake Biwa between 1970 and 1996 is shown in Table 20. This evolution demonstrates the slow shift from a focus on antipollution measures in 1970 to a more comprehensive menu in 1996, where 'ecological lifestyle promotion' is also a function.

Table 20 - Changes in Environmental Administration System of the Local Government

Year	Departments and Divisions in Charge of Lake Biwa and its Catchments Area
1970	Department of Welfare (Antipollution Measure Office)
1972	Department of Planning, Life Environment Bureau (Antipollution Division, Drinking Water and Waste Management Division, Nature Conservation Division, Prefecture Life Division)
1974	Department of Life Environment (Antipollution Division, Environmental Policy and Waste Management Division, Nature Conservation Division, Prefecture Life Division)
1979	Department of Life Environment (Environment Office, Waste Management Division, Nature Conservation Division, Prefecture Life Division)
1996	Department of Lake Biwa and the Environment (Water Policy Administration Division, Environmental Policy Division, Waste Management Division, Ecological Lifestyle Promotion Division, Nature Conservation Division, Forest Conservation Division, Forestry Administration Division, Sewerage Planning Division)

Source: <http://www.pref.shiga.jp/b/kokusai/siryousoshikimeii/index.html#03>, 2008

8.4 Water Framework Directive, European Union

October 2000 marked the formal adoption of the EU Water Framework Directive, an ambitious undertaking of the European Commission to jointly and sustainably manage Europe's 40 international river basins. Under the Water Framework Directive (WFD), each member country is responsible for implementation in the portion of the international river lying within its territory but in consultation and coordination with other countries of the same river district¹⁶⁹.

8.4.1 Clear Objectives

Through the WFD, the European Commission aims to achieve the following¹⁷⁰:

- Expanding the scope of water protection to all waters, surface waters and groundwater;

¹⁶⁹ EU WFD Water note 1 http://ec.europa.eu/environment/water/participation/pdf/waternotes/water_note1

¹⁷⁰ European Commission Environment website. http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

- Achieving "good status" for all waters by a set deadline;
- Water management based on river basins;
- "Combined approach" of emission limit values and quality standards;
- Getting the prices right;
- Getting the citizen involved more closely;
- Streamlining legislation.

8.4.2 Comprehensive Approach

The WFD establishes a basin-wide approach for management of river basins keeping in view that the best model for a single system of water management is by river basin – the natural hydrological and geographical unit of shared waters and sets specific deadlines for Member States to achieve ambitious environmental objectives for aquatic ecosystems. The directive addresses inland surface waters, transitional waters, coastal waters and groundwater. The essence of the WFD is to develop and implement a river basin management plan for each river basin that would be established and updated every six years in consultation with all those member countries sharing that particular river basin¹⁷¹.

The plan is a detailed account of how the objectives set for the river basin (ecological status, quantitative status, chemical status and protected area objectives) are to be reached within the timescale required. The plan includes all the results of the above analysis: the river basin's characteristics, a review of the impact of human activity on the status of waters in the basin, estimation of the effect of existing legislation and the remaining "gap" to meeting these objectives; and a set of measures designed to fill the gap. One additional component is that an economic analysis of water use within the river basin must be carried out. This is to enable there to be a rational discussion on the cost-effectiveness of the various possible measures. It is essential that all interested parties are fully involved in this discussion, and indeed in the preparation of the river basin management plan as a whole¹⁷².

8.4.3 Close Cooperation with Stakeholders

The success of the Water Framework Directive relies on close cooperation with the public and stakeholders at local level and their involvement in key decisions. Participation is especially important for the development of river basin management plans (RBMPs), which are at the heart of the WFD's implementation. To ensure the participation of the public and stakeholders in establishing and updating river basin management plans, the directive recognizes that it is necessary to provide proper information to the public of planned measures before final decisions on the measures are adopted. In addition, the directive makes provisions for giving the public access to all background documents and information used for the development of the management plan. Once a plan is in place, the WFD directs the authorities to report on the progress of its implementation to the public and stakeholders.

In this case, public participation extends to all water users, to non-governmental organisations, such as local and national environmental groups, and to other stakeholders¹⁷³.

8.5 Conclusions and Recommendations

From the Murray Darling examples it can be concluded that good governance and effective water systems take time and patience, that there needs to be a limit to what can be withdrawn from river systems, so that environmental flows can be maintained and rivers remain alive. The example also shows that neutral apex bodies can sometimes work better than 'participative' bodies, who might hesitate from taking vital decisions because the right decision may affect their own interests. It can be seen that when benefit-sharing was obvious, states became more amenable to negotiation and agreement. Lastly it can be concluded that IRBM is a dynamic process - the MDB Commission become an authority and the system evolved and, in fact, continues to evolve.

From Lake Biwa's case it can be concluded that citizens' actions helped to promote better water resource management. As a direct result of citizens' actions the lake biodiversity was protected and eventually restored. While the original infrastructure

¹⁷¹ EU WFD Water note 1 http://ec.europa.eu/environment/water/participation/pdf/waternotes/water_note1

¹⁷² European Commission Environment website. http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

¹⁷³ Ibid.

development focused on resolving the water supply problems of downstream users, the scope of the project eventually expanded to include flood control, water level control, irrigation and agricultural development, forestry, fisheries and nature conservation.

Dialogue between water users, politicians, administrative authorities and water managers triggered change in tune with Japanese traditions, reflecting local priorities as well as regional and national preoccupations. This stakeholder participation, both from within 'the system' (academic, research and political groups) and from the outside (citizens' movements, protests and litigation) made a crucial contribution to achieving a balance between the various uses of water and the needs of the resource itself.

From the Lake Biwa experience it can also be concluded that the rights and entitlements of all populations relying on or benefiting from a water source have to be addressed and safeguarded with equal interest and vigour, if not with equal and similar measures. It has also shown clear benefits of enhanced local sovereignty, local autonomy and local economy, once stakeholders were brought on board.

From the European example it can be concluded that clear objectives and common interest can be the glue to hold a range of nations together, and that these can be principles to glue together the provinces of Pakistan when sharing and caring for water.

The examples mentioned above highlight certain key aspects of Integrated River Basin Management (IRBM) that are crucial to a successful IRBM approach:

- Political will on the part of the federal and provincial government is crucial. The relevant government authorities need to commit themselves to IRBM philosophies in a clear, transparent and tangible manner;
- IRBM practices rely on local knowledge as a foundation for sustainable water management and consumption practices; Local knowledge should be encouraged and applied within the process of IWRM and combined with new knowledge for the sustainable development of the river basin in question;
- Community involvement is the foundation for all management practices of natural resources;
- Effective partnership on the part of all stakeholders is the single most important aspect of a successful IRBM initiative; Active dialogue between stakeholders with confidence and willingness to cooperate with one another is a crucial element of IRBM;
- Effective partnership is based on the following criteria:
 - A common vision for the river basin and its long term development shared and agreed to by all stakeholders;
 - IWRM agreed to and adopted as the approach for water resources management by all stakeholders;
 - Commitments of all stakeholders including participation and provision of inputs and decision-making;
 - Agreed modality for building a strong participatory approach for decision making.
- **Basin development goals should include healthy river basin, improved water security, economic development, livelihoods and welfare of communities;**
- Shared benefits should be the cornerstone of the approach.

What should be the elements of a water policy for sustainable development in the 21st century for Pakistan? This is the question that has intrigued and engaged water practitioners and professionals in the past two decades. WWF has been interested in this question from both productivity and conservation perspectives. As a fresh start what are the essential elements of a Water policy that Pakistan should follow, that provides sufficient incorporation of various perspectives especially those of civil society and a broad range of stakeholders from different reaches of Pakistan? Likewise, a water policy which takes into consideration a few important steps that can make a major contribution to addressing water issues in Pakistan within each identified area. However, the latter does not imply an action plan but merely suggests bringing in some degree of specificity to undertake detailed policy formulation in the future that can be implemented within a reasonable time frame.

The proposed elements of Pakistan's National Water Policy, as presented below, are firmly anchored in developing a balance between productivity and conservation, between utilizing water/land assets and infrastructure and protecting the environment. It needs to be stated here that unless the land and water resources of Pakistan are adequately conserved, the basis for economic and social development will be severally compromised.

Land and water are Pakistan's main natural resources endowments, for which there is substantial infrastructure available and also where a very large segment of the population are provided livelihood opportunities. The best option for sustainable economic growth given the present level of development, including institutional capacity, is to make the needed investments to generate economic surpluses for investment in other sectors, while conserving the vital water, land and environmental resources. Of these resources, water is greatly limited by its variable availability and existing usage. Therefore, it is necessary to first have in place a succinct sound water policy that will allow for the optimal development and management of Pakistan's water resources and assets, while maintaining balance with the equally vital conservation needs Pakistan's water policy therefore, should include key elements that all relevant stakeholders can agree upon, or at least find the elements widely endorsed for further positioning.

Given that such a water policy is still not in place in Pakistan, the proposed elements of a succinct National Water Policy for Pakistan are given below with actions in bolded italics:

1. **Climate Change and Water Adaptation**

Rapidly changing water regimes suggest that climate change will have an impact on water resources and water availability in Pakistan's agro ecological zones. Keeping abreast of these changes and developing appropriate planning strategies should need to be the cornerstone of Pakistan's future water policy, so that appropriate and adequate measures for securing and sustaining water and environmental resources can be in place.

Ensure that all water and development projects approved for funding are carefully screened for their resilience to climate change and appropriate measures are included to enable both mitigation and adaptation perspectives as appropriate.

2. **Environmental Flows**

In addition to waterlogging and salinity, the most devastating result of system inefficiency of Indus waters has been the destruction of the Indus delta. The drying up of the River Indus downstream from Kotri Barrage has permanently damaged the eco system and affected livelihoods, limiting access of local inhabitants to water sources and made them the direct victims of infrastructure – both irrigation and drainage.

Although the Water Accord suggests a fixed quantum of environmental flows, these are not released in a consistent way each year, and the inconsistency is justified on the grounds that there is an 'average' over time (when flood flows even out the dry years).

According to the National South African Water Act, water shall be allocated to all the stakeholders after securing the allocation for

basic human needs and the environment. Environmental flows in the present draft policy have been discussed in Section 14- Under Ecology, however realizing its importance under the Water Accord 1991, it shall be discussed in a different section as per consultation with the major stakeholders.

This policy should ensure a regular, controlled environmental flow each year, to be guaranteed through strict regulation and implementation and a GIS based monitoring system.

3. Groundwater, Quality and Salt Balance

There should be regular monitoring of the quality of surface water and groundwater. The quality of water is deteriorating and we are rapidly losing the water bodies. Clean water is essential for flora, fauna, humans, and to prevent water related deaths and disease. Water pollution needs to be checked at all levels. In terms of groundwater unregulated development (tube- well installation) has led to adverse gradients of salt to fresh water. It is essential to revisit the hydrology of both surface and groundwater systems of the Indus Basin.

Regulation of groundwater should receive high priority and practical steps that are environmentally sound, socially acceptable and which can be legally enforced and economically feasible will be put in place to rapidly reduce over exploitation of groundwater resources.

Monitoring of water quality should be carried out for both surface and groundwater. Environmentally sound emergency measures should be designed and undertaken to ensure that large and small urban centers facing acute underground water shortages are checked and populations are protected from acute water shortages forecasted in the long run.

Measures should be taken to achieve salt balance in the Indus Basin through a phased programme to introduce appropriate conservation methods (which may be different for different areas), improve water quality, improve drainage and monitor and manage salt balance. Gains already made by addressing water logging and salinity contribute directly to improving the environment and conserving water and land resources, and should be continued.

4. Conservation of Water

The decline in freshwater availability to surface water bodies is increasingly affecting water quality, both for drinking and agricultural use. Greater awareness of water as a scarce resource and also its efficient utilization will be improved. Water savings will be promoted through greater awareness, regulation and incentive schemes at all levels. New technology in terms of water conservation will be used to take advantage of increasing education and awareness of water management by promoting technology, knowledge and awareness that helps save water. Techniques that facilitate water harvesting at all levels will be encouraged to ensure that natural water sources help preserve water during periods of rainfall for use during lean periods. Traditional water harvesting systems such as Rod Kohi agriculture and the karez system will be preserved as they help conserve water in dry lands and harsh ecologies.

Steps should be taken at all levels through widespread media campaigns by encouraging public private sector partnerships to raise awareness about conserving water at all levels and places through appropriate incentives and penalties by influencing demand and supply of water on a need basis.

5. Integrated Flood Control and Drought Management

Since the 1970's Pakistan has experienced an increase in floods and extreme weather events. Such events have basin-wide implications, therefore, their assessments, responses, and planning should be carried out at the national level while implementation of programmes can be done by the provinces in line with Constitutional provisions.

Flood and drought management should be a high priority, with a national body coordinating assessments, responses and planning. An Integrated Flood and Drought Control Management system at appropriate levels, that includes clear actions and steps for mitigating the effects of these events on water and land resources, should also be considered.

6. Inter-Seasonal Transfer Facility to Regulate Flows

The nature of occurrence of surface water in the Indus system is highly variable with 75 to 80 percent of water being available in three months of the year and only a trickle in the remaining nine months of the year. Carryover capacity of the system is markedly deficient Adequate facilities are, therefore, needed to store water to move it from one season to the other, and also to store water in water surplus years. Without these facilities Pakistan will not be able to harness the full potential of its water resources.

Pakistan should create and expand water storage facilities at all levels from local ponds to multi-purpose dams and embark on a sustained path of building a cascade of infrastructure on its Indus River Basin system to meet its irrigation and power needs and also to mitigate the negative impacts of floods and droughts. However these must be undertaken after extensive environmental assessment to mitigate the impact on biodiversity and the environment.

The tradeoffs between the benefits provided by dams water and their detrimental effects on biodiversity, ecosystem services, and riparian livelihoods should be assessed. A comprehensive assessment of institutions, and their capacities should be undertaken to reorient all institutions to participate in addressing Pakistan's water infrastructure and water conservation needs with clear recognition of sharing both productive and environmental benefits with upper and lower riparian in a fair and just manner.

7. Drinking Water and Sanitation Needs

The water allocation in urban areas should first ensure that drinking water and sanitation needs are met since both drinking water and sanitation are social goods.

The access to clean and sufficient drinking water is recognized as a human right that will be ensured through investments focusing on both urban and rural areas to remove disparities in price and availability.

8. Irrigation water

The protection and sustainability of the Indus River Basin infrastructure is paramount. Advantage will be taken of possible substitutions in use and allocations amongst different sectors to remove inefficiencies, and adjustments will be made in historical rights and entitlements in the national interest. In certain instances, existing cropping patterns will be readjusted in line with changing water availability and emerging opportunities. Such changes will take place in a manner that takes cognizance of ground realities, market trends and trade opportunities.

Irrigation water efficiency will be enhanced by improving delivery systems, establishing benchmarks for minimum crop water requirements, promoting efficient irrigation practices (bed and furrows, trench plantation, land-leveling, etc) and adopting new conservation technologies (e.g. rainwater harvesting, drip irrigation etc.) that help save water.

9. Water Zoning

All economic development activities should be reviewed according to agro-ecological zones, water dynamics and conservation imperatives. This zoning will take advantage of knowledge, farmer goals and food security considerations, as well as local and regional conservation needs. Diversity of hydro zones across the country should also be taken into account for emerging opportunities and related conservation requirements. Attempts should be made to exploit the important link between water and economic development as harnessed elsewhere (e.g. India, Jordan, and China), but with a clear vision for concomitant action to conserve the water resources. Accelerated involvement of professional water managers and water conservation specialists should be encouraged and best technology options explored.

The existing cropping pattern should be reviewed. Zoning land according to water productivity and water conservation potential should be undertaken at macro and micro level through widespread technical, environmental, social and economic consultations with relevant stakeholders. This way a framework can be developed that will identify the yield gaps to be bridged in each zone, to ensure that optimal annual productivity of the systems bring marked improvements in the farming sector, while also conserving the basis of these improved yields.

10. Institutional and Legislative Framework

Institutional and legislative framework for water management will be revisited in the light of changing scenarios to develop greater coordination between land, water and other natural resources, human development, and human capital formation policies. Where there are disparities, steps and measures will be taken to correct anomalies in the system through suitable modifications in legislation.

[Institutional and legislative framework for water management revisited to rationalize roles of all stakeholders and improve laws.](#)

[A comprehensive set of water laws will be developed that are relevant to Pakistan's circumstances and define rights, uses, value, principles of pricing, subsidies, licenses, polluter penalties and incentives.](#)

11. Water Rates

Water rates should reflect the scarcity and value of the resource to the users to provide incentives and bring about efficiency within the economy regarding water-use, and protect the environment. Today the value of water is taken for granted and the common perception does not include awareness that irrigation water, and water for other uses is being provided far below its economic value.

[Water rates will be evaluated in line with economic and social realities to bring it close to the “true” value of water. All explicit and implicit subsidies on water to be recognized and rationalized with sufficient attention to service delivery and accountability.](#)

12. Water and Energy Nexus

To capture the full potential of Pakistan's water resources, the linkage between water and energy needs to be recognized. For example, integrated development and use of surface and groundwater is only possible when affordable energy is available, which is primarily achievable through better conserving of water resources and their sustained availability for harnessing hydropower.

[Development and conservation of water and power resources on rivers, canals, on channel and off channel will be ensured in an integrated manner.](#)

13. Participation of Farmers

Farmers should be an integral part of participatory processes in management, planning and implementation of water distribution, collection of water rates and the management of tertiary irrigation systems. Farmers should also be educated in efficient use and management of water and processes that support, strengthen, and enhanced farmer participation should be encouraged.

[A paradigm shift is recognized as fundamental in the irrigation and agricultural production process. This change in perspective will be encouraged across the board by developing suitable linkages between agriculture and irrigation at all levels and support systems.](#)

14. Research, Science and Technology

Linkages should be developed between research and practice. Research universities and facilities must engage effectively with water users, and farmers. Research institutions need to be linked to actual applications in the field. Funding and support for linking research with practice should be encouraged, covering water and land resources, their use and conservation.

Research efforts should focus on emerging needs and will include but not be limited to following areas:

- Telemetry and hydrometeorology;
- Assessment of water resources and measurements;
- High altitude glacier, snow and ice hydrology;
- Groundwater hydrology and recharge;
- Management of waterlogging and salinity;
- Water – harvesting;

- Multiple cropping systems under water scarcity regimes;
- Sedimentation of reservoirs and the safety of water related structures;
- Soil and materials research;
- Recycling and re-use;
- Use of sea/marine water resources;
- Social and economic engineering aspects;
- Capturing advances in allocative and technical efficiency in water;
- Utilization of indigenous water knowledge and systems.

Other areas may emerge according to threats, opportunities, basin-wide changes, local needs and conservation requirements.

15. Institutional Strengthening and Capacity Building

To counter the tremendous erosion of competence that has rendered water institutions to become non-responsive to current needs at all levels, a reassessment of the capacity of water and power institutions will be urgently undertaken. Eroded capacity will be checked on a priority basis to ensure that Pakistan maintains its competitive position within a regional context.

[Gaps and weaknesses should be addressed through appropriate long-term and short-term training and capacity building programmes.](#)

The study of Pakistan's challenges, the elements of a sound national water policy and global examples highlight certain key components for developing an Integrated River Basin Management (IRBM) approach.

10.1 Components of IRBM for Indus Basin

First, it is important to understand and incorporate the policy determinants that would drive the IRBM approach. For example, preparing a plan for basin management without looking at the population and poverty issues or the financial crisis would be unrealistic. In the case of Pakistan, these would be climate change impending emergencies, population and poverty, energy crisis, the financial crunch and the security situation in the country. Basin development then, would place equal emphasis on healthy and alive rivers, ecological conservation and improved water security, as well as economic development, livelihoods, creation of assets/wellbeing and quality of life.

Secondly, political will on the part of the federal and provincial government is crucial. The relevant government authorities need to be completely committed to IRBM approaches in a clear, transparent and tangible manner. This will be difficult, in an environment when successive governments dismantle what the previous government initiated in programmatic terms. The answer is advocacy, advocacy and advocacy with different levels of government.

Thirdly, this advocacy must lead to changes in the policy, legal and institutional framework to look at water holistically, rationalize approaches, regulate its use effectively and implement penalties for non-compliance.

Fourthly, science and knowledge (from universities to local levels) must become the foundation for sustainable water management and consumption practices. Local knowledge should be encouraged, applied and combined with new knowledge for the sustainable development of the river basin in question.

Fifth, community involvement and effective partnerships must be the foundation for all management practices of natural resource and active dialogue between stakeholders with confidence and willingness to cooperate with one another is a crucial element of IRBM.

Sixth, investments need to be made for managing the effects of climate change, as rhetoric will no longer be possible. This means reform of institutions and building capacity must be combined with physical infrastructure programmes.

Seventh, we need to work with existing infrastructure. The Indus Basin in Pakistan has a huge irrigation infrastructure. This current infrastructure should be repaired and maintenance should take precedence over creating new irrigation infrastructure.

'Sub-basins' should be defined and smaller hydrological units for management and conservation, coupled with existing institutional reforms, where they have been successful should be considered. There should be someone who is responsible for all the units in totality. There should be also a person to monitor all aspects of the units. IRSA is the only institution but it does not own the Basin. IRSA should be strengthened and its mandate increased. It needs to be placed under the CCI, and the Cabinet Division. IRSA needs to develop technical capacity as well. There must be an institution that takes responsibility of the Basin. This organisation should have a water audit and authority to take action. IRSA is best left to allocate water. It is not designed to address broader issues of river basin management. We can strengthen IRSA, but the base is so weak perhaps it would need to be completely revamped and restructured. There must be an organisation that takes responsibility of the Basin and overlooks the Basin as a whole.

The Indus Basin is already bifurcated between India and Pakistan, so IRBM in Pakistan for the Indus Basin is already 'compromised' because we do not have the whole Basin to work with.

Ninth, let us address both rural and urban issues within an IRBM approach.

And lastly, and most important, developing and delivering shared benefits should be the cornerstone of the IRBM approach. In particular greater attention should be paid to inter-provincial benefit sharing to serve as a conflict resolution mechanism. The IRBM approach will be bought if this can be demonstrated, especially if it is across provincial and administrative boundaries.

10.2 Theoretical Basis for IRBM

These components can be incorporated into a more theoretical basis of IRBM, to develop a particular stance and IRBM possibilities for Pakistan.

1. Manage Water Flow within Basins

- Manage both rural and urban water flows within basins, and subdivide the Basin into smaller unit in pragmatic ways;
- Any flood management plans in a basin should include drought management, and should take measures to maximize the positive aspects of floods such as retaining part of flood flows for use in crop production;
- Develop linkages among relevant institutions.

2. Integrate Land and Water Management

- Land-use planning and water management should be combined and synthesized to enable the sharing of information between land-use planning and water management authorities;
- Flood management needs to recognize, understand and account for linkages between upstream and downstream in order to realize synergies in improving river basin performance.

3. Manage Risk and Uncertainty

- Water-related risks are related to hydrological uncertainties which are subordinate to social, economic and political uncertainties: the biggest and most unpredictable changes are expected to result from population growth and economic activity;
- Management of risks of floods and droughts consists of systematic actions in a cycle of preparedness, response and recovery, and should form a part of IRBM;
- Risk management calls for identification, assessment, and minimization of risk, or elimination of unacceptable risks through appropriate policies and practices.

4. Adopt a Mix of Strategies

- IRBM strategies must not propose single solutions – different parts of the Basin warrant different approaches. Agro-ecological or hydrology-based strategies are more likely to succeed;
- While the Basin must be approached holistically, the strategies need to be grounded in reality – comparison of the available options and selecting a strategy or a combination of strategies that is most appropriate to a particular situation are required;
- Both long-term and short-term interventions need to be designed.

5. Ensure a Participatory Approach

- IRBM should encourage the participation of users, planners and policy-makers at all levels and should be open, transparent, inclusive and communicative; this requires the decentralization of decision-making, and includes public consultation and the involvement of stakeholders in planning and implementation;
- IRBM must keep gender perspectives in mind and should include all marginalized groups of people;
- It is important to make use of the strengths of both a "bottom-up" approach and "top-down" approach in determining the appropriate mix;
- River Basin committees or organisations, at basin or sub-basin levels, can provide appropriate forums for such

coordination and cooperation across functional and administrative boundaries.

10.3 Policy Determinants

Based on the analysis of the study five main policy determinants have emerged.

1. Climate Change Crisis

Climate change has a direct impact on the hydrological cycle and it appears to be having serious consequences on surface and ground water resources in the Indus Basin. With rising population water uses are projected to shift dramatically, including water requirements for crops, livestock and municipal uses. According to the latest IPCC 2012 report for Policy Makers, the recent floods are consistent with the types of events that have been projected from human induced climate change and such extreme events are occurring with more frequency and intensity¹⁷⁴.

2. Financial Crisis

Pakistan is facing severe financial stress which is likely to continue and progressively reduce its ability to undertake vital investments in the water sector. The international financial crisis has meant reductions in development assistance flows. With rising inflation, agriculture is facing a difficult time. Negative impacts on agricultural productivity are likely.

3. Energy Crisis

The demand for energy in the future is likely to rise steeply. Present peak load demand deficit exceeds 5000 MW and is undermining economic growth. While hydropower is the cheapest source of power in the country its development has been stunted while alternative sources like solar, wind, thermal and biogas are in an infancy stage. Pakistan relies heavily on oil and gas which is linked to a circular debt. Pakistan therefore, needs investments upto almost US \$ 50 billion to partially realize its hydropower potential of 60,000 MW in the next two decades.

4. Security Outlook

The last decade has seen deteriorating security in the country due to terrorism, extremism and the War on Terror. Rural to urban migration is likely to result in culmination of large mega cities that would require further investments in water infrastructure.

5. The Crisis of Population Growth and Poverty

Pakistan's population is predicted to be 265 million by the year 2030 (Planning Commission of Pakistan, 2010). Economic growth rates in Pakistan are tied to the performance of the agriculture sector, where land ownership and access to land, water and environmental resources directly impact equity, distribution of wealth and welfare. Water is the most crucial input here and its management means direct impact on economic growth and stabilization of growth rates.

10.4 Larger National Objectives that IRBM of Indus Basin would Address

In addition to the policy determinants it must be understood that an appropriate IRBM initiative for the Indus basin must respond to larger national objectives relating to a balance between water conservation and water resources development:

- Creation of wealth and well being through generation of economic surpluses from land and water resources
- Distribution of wealth and well being in equitable manner;
- Correction of historical 'kinks' in land ownership, water rights and entitlements keeping in view water quality and availability;
- Rationalizing the historical resource allocation of water and revisiting the basis of the allocation;

¹⁷⁴ IPCC,2012: Summary for Policy Makers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

- Protection and securing of the water resources of the Indus Basin;
- Protection of environmental rights, access to water and ecological zones.

10.5 Policy, Institutional and legal Framework for Water Resource Development, Allocation and Management

The analysis of Indus Waters Treaty 1961, Water Accord 1991, Indus River System Authority (IRSA) document, Provincial Irrigation and Drainage Authority (PIDA) documents, Water Vision 2025, draft Water Policy, Pakistan Country Water Resources Assistance Strategy (CAS) 2005, and Benefit Sharing in Hydropower 2011 have shown that water reforms for IRBM of Indus Basin imply change in policy, governance, institutions, laws, regulations and processes in the way water is used, shared, conserved and valued. While there are laws to govern water distribution, Pakistan needs the following measures to strengthen the Indus River Basin System:

- Shift from management of water supply to management of water demand;
- Effective regulations for abstracting, using and disposing water, must be a check on groundwater. Like India, groundwater is a public good and belongs to the state;
- Effective water pricing and recovery: Whatever are the charges for *abiana* or water prices, they must be collected. This covers other prices as well. Even if we recover all *abiana* charges at such dismally low rates we cannot maintain our irrigation system. Water charges have to be reviewed in the light of alternate sources of pumping water e.g. diesel and electricity. To this must be added the value of water;
- Penalties for non-compliance: It covers implementation of collecting water charges as well. This would require identification of groups who do not pay. But what are the incentives in terms of rebate to those who pay on time;
- Conservation guidelines;
- National regulatory framework for water use ;
- Rationalization of *abiana* and other water rates to near cost of what developing, abstracting, storing and distributing water
- Information services for farmers;
- Focus on water quality.

There is no need to create new institutions, but rationalization of their roles is needed to define clear roles and functions, remove overlapping and provide human, technical and financial resources to allow these institutions to deliver their mandate. Perhaps consolidation of water institutions to bring them under a single banner would result in greater efficiency and focused outputs that can help turn around the water scenario in Pakistan. There is already a well established system of water entitlements within the irrigated areas of the Indus Basin, 1991 accord warabandi all exist, as well as options for increasing water efficiently and productivity. There may also be an advantage in paying greater attention to water governance and revisiting IRSA and the Indus Commission for certain aspects of Indus Basin System improvements. Let the accord be our good starting point for macro allocations. When we figure in climate change perhaps things will change significantly in terms of micro allocations that are meaningful when Pakistan makes adjustments to its cropping patterns, and many options for increasing water supply by repairing and priming the canal system and there is tremendous scope for increasing water productivity.

In the case of further water infrastructure development in the Indus Basin, dams and storages should be developed as per need, cost and economic feasibility (from small local check dams to larger multipurpose infrastructure). Storage through which flood water can be stored, regulated and used during lean periods should receive priority. There is need to strengthening traditional village level ponds and structures that provide permanence, recharge and environmental entitlements. Micro-hydel, micro-irrigation and low-cost turbine technology potential should be harnessed. Home water storage should also be encouraged, and rain harvesting promoted on a national level both for urban and rural water storage with local designs suited for each agro ecological zone. For equity purposes, new irrigation schemes and programmes should be especially designed to benefit the poor by putting in specific conditions for investments, repairs and rehabilitation of water infrastructure.

10.6 Managing the Effects of Climate Variability and Change

Investments and systems must be planned NOW for future climatic events, and the upgrading of capacity of Meteorological Department and other infrastructure to address flood prediction management and monitoring should be undertaken as a priority. The role of the Federal Flood Commission and its functions should be redefined. With the implementation of 18th amendment

interprovincial and intra provincial issues related to environmental impacts of floods should receive high priority in future action plans and policies. Review management of existing flood management organisations and infrastructure along with their upgradation.

The whole inter-departmental coordination needs a reviewed at all levels with strong capability for modeling and scenario building. This capacity should be enhanced with research backing and linkages with civil society, academia and media. Flood cost and impact assessment is only focusing on the loss to life and property. [The social costs, environmental costs and indirect costs to economy also need to be measured.](#)

10.7 Water Economics and Agro-Ecological Zones in Indus Basin

[Thinking in terms of agro-ecological zones \(rather than eco-zones\) is more appropriate for the Indus Basin](#) as it produces the bulk of Pakistan's food output and supports the bulk of its population. The following actions will make integrated approaches for the Indus Basin more effective:

- Modeling and analytical studies at agro ecological zone level to understand productivity, substitution potential, constraints and opportunities., such that maximum productivity can be derived within the potential of the , by maintaining balance with environmental conservation;
- Advocating potential of high-productivity and high value crops such as maize oil seeds, fruits, vegetables, flowers, ornamentals, and condiments, to enhance returns to farmers and encourage them to use water judiciously;
- Advocating crop-livestock integrated agriculture that makes best use of land-water-labour-technology, conserves water, enhances environmental sustainability and market opportunities;
- Advocating processing, transportation, refrigeration, marketing and allied functions of the agribusiness sector for handling high value products;
- Setting up of an effective Prices Commission or institution at Federal and Provincial levels which generates and shares data on production, farm systems, cropping patterns, water usage and conservation and environmental sustainability;
- Using emerging technology tools in media, telephony and internet to provide daily information to farmers to take decisions on what, when, how, and in what quantities to produce, what amounts of water to use and where to market the crops.

10.8 Measures for 'Moving Towards Integrated River Basin Management' for Indus Basin

When we speak of Integrated River Basin Management, we ask the question 'what is being integrated? Experience has shown that to manage a river basin to an optimal level, we need to integrate not only water supplies, water allocations, water use and water infrastructure, but also the land, policy, institutional and legal frameworks, conservation and protection imperatives, economic activities and returns, financial and incentive structures, access and use profiles (who can get what in terms of water and related resources for agriculture, industries, urban usages and environmental flows), preparedness for and handling of emergencies and most of all what people want for productive and fulfilling lives. To achieve this integration, changes are needed in the way water saving can be affected in agricultural water. But here the system is driven by political interests and is very rigid, so we must recognize that any proposed policy changes will elicit very strong opposition.

[We must, however, accept that for long term sustainable development of Pakistan we must create both economic surpluses from land and water sectors and ensure water conservation and environmental sustainability. Therefore we must focus on agriculture as well as improved water conservation and environmental management in terms of IRBM in the Indus Basin.](#) We have water, we have land, we have the hard working farmer, but we have inadequate science, low valuation, low level of water conservation, less awareness and programming for environmental sustainability, few incentives for conservation and poor management. If we are unable to conserve and ensure longevity and health of our water resources, our eco systems and our environment, it will be hard to improve on the agro-ecological zones and increase the productivity of the Indus Basin.

The following measures are suggested as essential for the revitalization of the Indus Basin and for its IRBM framework:

- Make water conservation and environmental sustainability the bedrock of revitalization of the Indus River System
- Strategically adopt water, energy, economic and food security as an interwoven and integrated nexus, so that the overriding determinant is the preservation, conservation and prudent use of scare water resources.
- Develop agriculture business structures in line with stated national goals and vision (storage, processing, air-conditioning, transportation, international trade) to encourage improved production, water management and water

resource conservation.

- All water infrastructures proposed for the future should be based on benefit-sharing approaches and mechanisms and prepared in consultation with all stakeholders;
- Bring science, technology and information on conservation and production to the forefront and make it available to farmers;
- Determine value and price of water;
- Change the basis of providing business loans for agriculture, so medium and small farmers can access credit;
- Introduce agriculture tax and remove constitutional and other legal flaws that prevent progressive agriculture taxation (so that the big farmers that are largely out of the tax net can be brought in and the revenues raised for improving government irrigation infrastructure and services);
- Move to planning based on agro-ecological zones in order to get the most appropriate combination of land, water climate, soil and crops, while focusing on water conservation;
- Design incentivized reforms to urge farmers to plant according to best conditions and use appropriate water and environmental conservation methods in specific agro-agricultural zones;
- Rationalize subsidization for water and agriculture (for both inputs and outputs) to encourage conservation and improved agricultural processes and methods;
- Remove anomalies in tariffs, quotas and VATs;
- Develop international trade links to market products of the Indus Basin, and highlight that products use water and environmental conservation;
- Leverage water and power infrastructure assets to raise water-sector financing for the future. – to repair systems, build new ones and maintain them;
- Reduce dependence on foreign resources through innovative re-structuring and local financing, including financing for water conservation methods (such as rip and micro-irrigation);
- Promote entrepreneurship led growth and a transformation model (which includes water conservation and environmental sustainability) as a prerequisite to see Pakistan achieve a sustained growth rate;
- Develop an accessibility framework for water and agriculture to counter the negative influence of political economy and interest groups;
- Make the irrigation department accountable for providing allocated water on time, to control illegal tapping of aquifers and preventing water for the environment being used for agriculture;
- Make the irrigation, agriculture and environment departments set targets for productivity and water conservation in each agro-ecological zone and prepare connective paths;
- Overhaul and re-systemize the Revenue Department, including computerization of all revenue and productivity records and make this information available to the public;
- Apply GIS and remote sensing technology as regular tools in appraisal, monitoring and evaluation of all land, agriculture and water activities, including water conservation and environmental protection activities.

IRBM calls for integration an approach that ostensibly balances development with conservation that would be best for the Indus Basin and for the people of Pakistan. In this context there is a [need to revisit the current divide where government is seen to develop infrastructure and NGOs seen to favor conservation](#). This will require long-term work on developing a continuum of linked approaches, policies and interventions that will bring together infrastructure development and conservation, water use and environmental flows into a single integrated framework.

WWF has already worked extensively for water conservation, water quality, living rivers and related programmes and initiatives. In the light of this report and especially in the light of chapters 9 and 10, the following next steps are suggested for WWF - Pakistan:

Step 1 Set-up a Think Tank on IRBM

- Think Tank should have about 10 people from across Pakistan (with one or two international experts, if possible);
- Meet once a quarter, with a special focus on implementation and follow up on all projects;
- Work on the theme of balancing development with conservation as the main pillar of IRBM in Pakistan and take up the challenge of working on rationalizing water resource allocation on river basin basis for all of Pakistan (covering irrigated, rain-fed and arid areas);
- Interact with government on many levels to promote IRBM;
- Include people who can actually implement the plan with a multidisciplinary problem solving focus.

Step 2 Evolve WWF's Objectives and Approach

- Realign its work on the basis of 'sharing and caring' of rivers;
- Identify its niche based on a Strengths-Weaknesses Analysis;
- Use this or similar theme to engage with all stakeholders, including provincial governments to soften their current entrenched positions;
- Work out a schedule of advocacy on the priorities outlined in Chapter 10.

Step 3 Programmes for Advocating Agro-Ecological Zones

- Carry out modeling and analytical studies for identified zones by focusing on priority issues through twinning arrangements with relevant institutions located in the studied zones;
- Advocate these zones;
- Work with government to develop packages of support for these zones;
- Work with government to develop information system for farmers (media, telephony, internet).

Step 4 Programme on Climate Variability and Change

- Build research opportunities and linkages with academia, private sector and government on climate change data and reporting specifically for Pakistan;
- Set up hubs in selected universities;
- Support modeling and scenario generation through these hubs. (We need to tap the opportunities of research and scholarship from local universities. We need to establish the link with these universities. Financial incentive for research that can be used for practical use. Results of research can be used).

Step 5 Programme for Promoting Environment- Friendly Infrastructure

- Share new technologies;

- Help revive old sustainable systems;
- Promote successful models.

Step 6 Engage with Government on Policies and Legislation

- Bring international best practices to government and use them in such a way that they are relevant to Pakistan and can be owned by the people;
- Provide concrete inputs for new laws and policies;
- Assist in improving institutions and departments with tangible inputs;
- Become a partner in developing an evaluation and monitoring mechanism that provides sustained and regular feedback on how things are improving in the water sector.

Step 7 Involve Local Resources Use the Research from Local Universities

- Faisalabad University;
- Tandojam University;
- National University of Science and Technology (NUST), Islamabad;
- University of Engineering and Technology, Lahore;
- FAST, Islamabad;
- NED University, Karachi.

Background

WWF – Pakistan in collaboration with WWF – UK has been working on the Project “Indus Basin Water Security”. The vision behind this advocacy driven approach is to ensure that Environmental flows are protected in the Indus River system securing sustainable freshwater resources, which are available to support people, the ecosystem functions and services upon which they depend and to increase the adaptive capacity of the local people (droughts/floods) in wake of future water fluctuations.

The recent flood has played havoc in Pakistan. It is the worst flood in the hundred years recorded history and the devastation is beyond government's ability and capacity. Precious lives were lost while over 20 million have been displaced, with all their life supporting assets lost. The direct losses are estimated over US \$ 20 billion and rising. It is highly unlikely that Pakistan can maintain the required growth rate or implement reforms conditional under the IMF US \$ 10 Billion bailout implemented at the height of the global financial crisis.

In wake of the rapidly changing circumstances and prevailing water management crisis there is hue and cry from all quarters that ask for a critical analysis of the water management in Pakistan. WWF – Pakistan very strongly believes that there is a need for scientifically assessing the causes that have exacerbated the current crisis along with determining the loopholes in the overall administrative and response setup that has contributed to the present situation besides the natural calamity. The analysis shall further give pragmatic solutions that will help counter any such future eventualities with greater preparedness.

Water usage especially in the agriculture sector is almost 90 percent of the total freshwater, this needs a critical relook in the light of changing circumstances and climate change. A relook will be based upon analysis of the water situation in different irrigated agro zones and then seeing it through the lens of economics and availability of water for the best macro actions in each zone. Moreover to question the rationale of the existing cropping pattern and to check whether it needs modification or complete revamping within a pragmatic setting.

In this context, WWF - Pakistan requires technical support to assist in the development and refinement of a report that reflects on the above stated issues. It is recognized that this represents a broad policy area within the limited framework of these terms of reference. It is intended, however, that the programme of work will build on the existing analysis of all the components. Moreover in absence of a water policy, it is pertinent to have a document that voices the concerns of the major stakeholders in water management and further lobby that raises awareness and sets actions into motion at the earliest.

The overall management and compilation of draft report rests with Raasta Development (Ms.Simi Kamal) , however the input on Tasks as agreed is stated in front of activities

- Khalid Mohtadullah
- Dr Pervaiz Amir
- Simi Kamal

Activities:

Objective 1: Review of the present institutional and legal framework for water resources, allocation and management.

- 1) Analysis of all the current available documents (IBWT 1960, Water Accord 1991, IRSA, PIDA Acts ,Water Vision 2025, Draft Water Policy, The World Bank, ADB reports, etc);
- 2) Analysis of the watershed/catchment management and the reservoir enhancement/management issues;
- 3) Analyse/ check viability for decentralized storage such as (upper-catchment) small(er) dams, on-farm storage, micro-

- hydels, localized self help dams, capacity of headworks, barrages, embankment protection;
- 4) Review the existing administrative set up and analyzing the role of IRSA, FFC .PIDAs, LGs, etc and suggest legislative and institutional arrangements;
 - 5) Review the best international/regional practices with special reference to Integrated River Basin Management (IRBM);
 - 6) Provision and Implementation of environmental flows in the review of (1,2,3,4,5) for sustained development.

Objective 2: Critical analysis of management of 2010 floods

- 1) Review existing floods management policy and roles of different departments;
- 2) Analyse the natural, scientific, technical, social, administrative, and political reasons for the flood damages;
- 3) Review the role of Met Deptt, IRSA, FFC, PIDAs, NDMA, Distt Govts for better coordination in light of the lessons learnt from the 1954,1973,1975 and present floods and setting up a response mechanism protocol between departments;
- 4) Analyse the impacts on rivers profiles.

Recommendations considering climate change impacts and future preparedness.

Objective 3: Water Economics And Re-Zoning Of Areas On Basis Of Cropping Patterns With Special Focus On Irrigated Eco Zones Of River Indus

- 1) To analyse the existing cropping pattern in wake of the water availability/water economics /food security in Pakistan and global international trade trends;
- 2) Current survey of the existing cropping patterns , analysis of basic layers through GIS surveys and review of historical availability of water and existing crop water requirement of the area;
- 3) To determine that how much of the available water is being used based upon the low and high value crops keeping in mind the food security debate;
- 4) Analysing the current water footprint (in terms of virtual water exports);
- 5) Alternatives for the existing cropping patterns (if viable) be given on basis of economic viability/marketability of the new crops suggested in light of food security debate.

Objective 4: Recommendations for an improved framework as an alternate National Water Policy

- 1) Under objectives (1,2,3) recommend a Framework of IBRM in light of best international/regional practices bearing semblance with Pakistan in form of a draft report covering aspects of :
 - a) Legislation and Institutional Arrangement;
 - b) Stakeholder and Public participation;
 - c) Economic measures and Financial Incentives.
- 2) Produce preliminary workshop documentation in light of the report. This will include briefing notes, technical brochures on relevant reform processes, and preparation and design of workshop agendas and presentations;
- 3) Delivery of a workshop for WWF Pakistan by inviting key stakeholders from government, civil society, international organisation and having their opinion on the draft report;
- 4) Review of the study/report by incorporating the view collected through the workshop and submitting a final report to WWF - Pakistan.

Time Frame:

Draft Report to be prepared by end May 2011, followed by a Workshop in first week of June (before 15th June) 2011. Final Report (alternate National Water Policy) by third week of June, 2011.

Elements of Integrated Flood Management

1. Manage the Water Cycle as a Whole

- Flood management plans should include drought management, and should take measures to maximize the positive aspects of floods such as by retaining part of flood flows for use in crop production;
- IFM recognizes the need to manage all floods and not just those floods up to some design standard of protection. Flood plans must consider what will happen when a flood more extreme than the design standard flood occurs, and must foresee how such a flood will be managed;
- Urban flood plans must manage both storm water quantity and the effects of storm water on water quality.

2. Integrate Land and Water Management

- Land-use planning and water management should be combined in one synthesized plan with a certain common field, such as the mapping of flood hazards and risks, to enable the sharing of information between land-use planning and water management authorities;
- Flood management needs to recognize, understand and account for linkages between upstream and downstream in order to realize synergies in improving river basin performance.

3. Manage Risk and Uncertainty

- Flood risks are related to hydrological uncertainties which are subordinate to social, economic and political uncertainties: the biggest and most unpredictable changes are expected to result from population growth and economic activity;
- Flood risk management consists of systematic actions in a cycle of preparedness, response and recovery, and should form a part of IWRM;
- Risk management calls for identification, assessment, and minimization of risk, or elimination of unacceptable risks through appropriate policies and practices.

4. Adopt a Best-Mix of Strategies

- Flood management plans should adopt strategies that are flexible, resilient and adaptable to changing conditions.
- Successful IFM looks at the situation as a whole, compares the available options and selects a strategy or a combination of strategies that is most appropriate to a particular situation;
- Flood management plans need to include both long-term and short-term interventions.

5. Ensure a Participatory Approach

- IFM should encourage the participation of users, planners and policy-makers at all levels and should be open, transparent, inclusive and communicative; this requires the decentralization of decision-making, and includes public consultation and the involvement of stakeholders in planning and implementation;
- IFM has to keep gender, religious and culture differences in perspective;
- It is important to make use of strengths of both "bottom-up" approach and "top-down" approach in determining the appropriate mix;
- River basin committees or organisations, at basin or sub-basin levels, can provide appropriate forums for such coordination and cooperation across functional and administrative boundaries.

6. Adopt Integrated Hazard Management Approaches

- A holistic approach to emergency planning and management is preferable to a hazard-specific approach, and IFM should be part of a wider risk management system;
- Integrated Hazard Management Approach consequently ensures consistency in approaches to natural hazard management in all relevant national or local plans;
- Early warnings and forecasts are key links to the series of steps required to reduce the social and economic impact of all natural hazards, including floods.

Suggested improvements in flood management

Flood management involves a two pronged approach: mitigating flood damages and managing flood damages. The first of these two approaches, that is, mitigating flood damages is concerned with reducing the impact of the floods, while the second approach of managing flood damages concerns reconstruction efforts after the floods have occurred. For the relevance of this report, only the first approach - Flood Mitigation - will be considered in detail here.

Traditional Flood Management Measures

The deficiencies of traditional flood management approaches can be characterized as follows as they:

1. Address only negative aspects of flooding: Most of the time runoff constitutes an essential part of the available water resource and only poses a problem under extreme conditions;
2. Focus on reducing flooding and reducing the susceptibility to flood damage: Such measures often reduce the socio-economic development potential of floodplains;
3. Provide ad hoc reactions and are carried out in isolation: Specifying an issue in terms of a problem can lead to the implicit exclusion of other feasible options. The adverse impacts of a particular solution on downstream and upstream areas, on other elements of the hydrological cycle and on riverine ecosystems tend to be ignored;
4. Express the risk of flooding simply as the "Exceedance probability of a flood of a given magnitude on a particular stretch of river" leading to the setting of design standards for protection: Uncertainties related to the frequency and magnitude of extreme events, possibly caused by climate change challenge the concept of a design standard for protection.

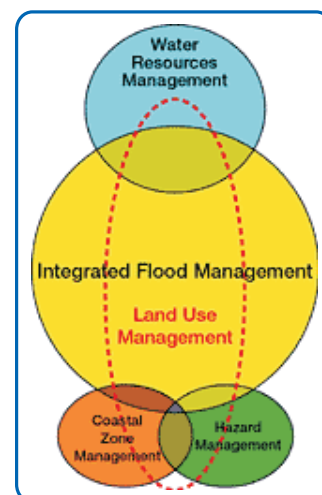
Challenges of Flood Management

Key challenges of flood management that need to be addressed in an integrated approach include:

- Population growth and economic growth exert considerable pressure on the natural resources system;
- Increased population and enhanced economic activities in floodplains further increase the risk of flooding;
- Designing for large floods must account of the likelihood of failure in cases of floods of magnitude below the notional design standard;
- Riverine aquatic ecosystems provide such benefits as clean drinking water, food, materials, water purification, flood mitigation and recreational opportunities;
- The magnitude and variability of the flow regime needed within a basin to maximize the benefits to society and to maintain a healthy riverine ecosystem must strike a balance between competing interests in the river basin;
- Intensity and duration of precipitation events are likely to increase due to climate change, resulting in an increase of the frequency of major floods in many regions.

Integrated Flood Management (IFM)

IFM is a process that promotes an integrated, rather than fragmented, approach to flood management. It integrates land and water resources development in a river basin, within the context of Integrated Water Resources Management (IWRM), with a view to maximizing the efficient use of floodplains and to minimizing loss of life.



Source: WMO

Comparison of Major Crops Sown on Area during 2000, 2005 and 2010

Crops	Area '000' hectares					
	Year 2000		Year 2005		Year 2010	
	Punjab	Sindh	Punjab	Sindh	Punjab	Sindh
Wheat	6255.5	810.7	5921.5	887.4	6,836.2	1,031.4
R.Chickpea	780.1	51.9	934.5	50.9	969.1	32.4
Rapeseed	128.9	74.2	130.9	53.1	142.8	47.6
Rice	1,627.2	685.6	1,754.3	543.9	1,977.7	733.5
Cotton	2,386.4	523.6	2,518.3	635.1	2,223.7	561.5
Sugarcane	615.5	238.8	644.7	214.9	666.5	263.9
Maize	1,883.0	571.0	475.0	3.0	4,916.0	630.0
Sorghum	238.4	87.2	216.7	61.4	182.7	43.9
Millets	303.1	80.5	331.7	5.7	386.6	75.9
Barley	32.0	16.3	34.8	6.5	33.0	6.5
Groundnut	66.4	2.2	94.7	1.6	82.8	2.2
Jute	21.0	-	-	-	-	-
Tobacco	17.7	0.2	17.7	0.1	16.3	0.4
Guarseed	116.1	12.1	109.1	16.5	93.2	51.4
Total	14,471.3	3,154.3	13,183.9	2,480.1	18,526.6	3,480.6

Source: Ministry of Food, Agriculture and Livestock (Economic Wing), Government of Pakistan

Crop Farm Income in Indus Basin

Average Farm Yield of Major Crops (kg per ha)

Province	Categories	Wheat yield	Rice yield	Cotton yield	Sugarcane yield	Maize yield
Punjab	Improved	3,882.59	3,753.79	2,691.51	69,915.45	5,527.53
	Unimproved	3,556.41	3,482.11	2,398.43	67,546.33	4,538.36
	% Change	9.17	7.8	12.22	3.51	21.8
Sindh	Improved	2,915.49	4,910.83	2,747.82	73,039.17	2,939.30
	Unimproved	2,757.22	4,625.79	2,437.54	72,447.00	2,321.80
	% Change	5.74	6.16	12.73	0.82	26.60
KPK	Improved	3,374.79	3,735.48		68,116.69	3,095.10
	Unimproved	2,886.19	3,608.18		67,184.00	2,738.98
	% Change	16.93	3.53		1.39	13.00
Balochistan	Improved	2,594.46	5054	1,761.93		2,439.26
	Unimproved	2,043.49	3,507.40	1,416.13		2,003.44
	% Change	26.96	44.1	24.42		21.75
AJK	Improved	3,214.29	5,159.56			3,183.56
	Unimproved	2,017.17	2,354.73			2,129.69
	% Change	59.35	119.11			49.48
ICT	Improved	2,568.80				
	Unimproved	2,272.40				
	% Change	13.04				
GB	Improved	3,322.15				3,705.00
	Unimproved	2461.77				2,486.47
	% Change	34.95				49.01
FATA	Improved	1,842.21	1,786.63			1,706.93
	Unimproved	1,823.68	2,410.72			1,616.73
	% Change	1.02	-25.89			5.58
Pakistan	Improved	3,370.24	4,317.11	2,706.27	70,537.31	3,163.81
	Unimproved	3,041.20	4,075.18	2,407.71	69,080.62	2,741.53
	% Change	10.82	5.94	12.40	2.11	15.40

Source: National Program for Improvement of Watercourses in Pakistan (Government of Pakistan, 2011)

Average Gross Margin of Crops (Rs per ha)

Province	Categories	GVP	TVC	GM
Punjab	Improved	197,476	80,565.72	116,910.30
	Unimproved	181,754.70	77,909.30	103,845.40
	% Change	8.65	3.41	12.58
Sindh	Improved	170,754.90	60,951.68	109,803.20
	Unimproved	152,551.60	57,896.79	94,654.82
	% Change	11.93	5.28	16.00
KP	Improved	178,146.80	79,820.94	98,325.90
	Unimproved	150,227.80	68,988.33	81,239.48
	% Change	18.58	15.70	21.03
Balochistan	Improved	189,250.60	47,821.06	141,429.60
	Unimproved	182,306.50	44,985.36	137,321.10
	% Change	3.81	6.30	2.99
AJK	Improved	168,641.90	43,905.18	124,736.70
	Unimproved	156,049.90	42,921.31	113,128.60
	% Change	8.07	2.29	10.26
ICT	Improved	110,126.60	55,006.08	55,120.52
	Unimproved	76,397.10	36,685.68	39,711.43
	% Change	44.150	49.94	38.80
GB	Improved	166,524.10	62,831.43	103,692.70
	Unimproved	139,885.50	51,007.82	88,877.68
	% Change	19.04	23.18	16.67
FATA	Improved	109,981.10	41,952.40	68,028.72
	Unimproved	107,956.50	40,587.76	67,368.74
	% Change	1.88	3.36	0.98
Pakistan	Improved	181,721.00	70,490.75	111,230.30
	Unimproved	162,903.20	65,919.17	96,984.00
	% Change	11.55	6.94	14.69

Source: National Program for Improvement of Watercourses in Pakistan (Government of Pakistan, 2011)

Average Farm Income from Crops and Livestock (Rs. per ha)

Province	Categories	Gross Margin from Crops (Rs/Ha)	Gross Margin from Livestock (Rs/Ha)	Farm Income (Rs/Ha)
Punjab	Improved	116,910.31	7,928.55	123,609.90
	Unimproved	103,845.43	9,750.60	111,970.90
	% Change	12.58	-18.69	10.39
Sindh	Improved	109,803.24	5,178.90	112,364.50
	Unimproved	94,654.82	8,610.48	98,565.69
	% Change	16.00	-39.85	14.00
KP	Improved	98,325.90	33,232.82	122,212.00
	Unimproved	81,239.48	25,880.15	98,227.42
	% Change	21.03	28.41	24.42
Balochistan	Improved	141,429.58	1,774.57	142,842.20
	Unimproved	137,321.11	1,990.26	138,709.10
	% Change	2.99	-10.84	2.98
AJK	Improved	124,736.72	77,611.55	187,565.10
	Unimproved	113,128.59	70,382.93	153,347.40
	% Change	10.26	10.27	22.31
ICT	Improved	55,120.52	44,377.67	72,871.59
	Unimproved	39,711.43	-	39,711.43
	% Change	38.80	-	83.50
GB	Improved	103,692.70	-1,777.65	102,877.90
	Unimproved	88,877.68	43,225.00	92,479.76
	% Change	16.67	-104.11	11.24
FATA	Improved	68,028.72	6,081.61	73,350.12
	Unimproved	67,368.74	1,922.05	69,050.53
	% Change	0.98	216.41	6.23
Pakistan	Improved	111,230.30	13,633.51	120,701.10
	Unimproved	96,984.00	13,092.04	105,396.10
	% Change	14.69	4.14	14.52

Source: National Program for Improvement of Watercourses in Pakistan (Government of Pakistan, 2011)

Crops Gross Margin and Existing Water Rates (Rupees/Acres)

CROPS	Rice Wheat Zone			Cotton Wheat Zone			Sugar Wheat Zone			Wheat Mixed Zone		
	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin
Rice Fine	1651	32.09	1.94	1393	30.652.20		1280	31.37	2.45	959	29.11	3.04
Rice Coarse	872	32.09	3.68	721	30.654.25		723	31.37	4.34	964	29.11	3.02
Cotton	567	33.73	5.95	1822	33.631.85		2023	33.6	1.66	958	33.6	3.51
Maize	1365	18.99	1.39	1364	17.991.32		1490	19.2	1.29	914	16.8	1.84
Kharif Fodder	1025	14.76	1.44	1025	14.791.44		1306	14.8	1.13	1025	14.8	1.44
Wheat	967	21.55	2.23	508	21.584.25		472	21.6	4.58	312	21.6	6.92
Gram	284	15.94	5.61	284	15.985.63		284	16	5.63	284	16	5.63
Rabi Fodder	3874	13.59	0.35	2824		13	3714	13.6	0.37	8872	13.6	0.15
Vegetable	6590	11.2	0.17	5933		11	6820	11.2	0.16	5512	11.2	0.20
Oil Seeds	1494	23.42	1.57	1494	23.251.56		1494	23.2	1.55	1494	23.2	1.55
Sugarcane	2371	62.17	2.62	1833	59.663.25		2746	62.78		2.291847	59.51	3.22
Ochards	5250	41.66	0.79	8821	36.230.41		2153	41.13		1.911761	41.34	2.35

Small Farms

Medium Farms												
CROPS	Rice Wheat Zone			Cotton Wheat Zone			Sugar Wheat Zone			Wheat Mixed Zone		
	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin
Rice Fine	1740	32.09	1.84	1467	30.65	2.09	1303	31.37	2.41	1290	29.11	2.26
Rice Coarse	901	32.09	3.56	811	30.65	3.78	692	31.37	4.53	830	29.11	3.51
Cotton	748	33.73	4.51	2026	33.63	1.66	1930	33.6	1.74773		33.6	4.35
Maize	1205	18.99	1.58	1477	17.99	1.22	1366	19.2	1.41	1044	16.8	1.61
<i>Kharif Fodder</i>	1065	14.76	1.39	1088	14.79	1.36	1346	14.8	1.10	1065	14.8	1.39
Wheat	790	21.55	2.73	655	21.58	3.29	573	21.6	3.77	398	21.6	5.43
Gram	490	15.94	3.25	388	15.98	4.12388		16	4.12	529	16	3.02
<i>Rabi Fodder</i>	4094	13.59	0.33	4399	13.6	0.31	4040	13.6	0.34	3869	13.6	0.35
Vegetable	6787	11.2	0.17	5572	11.2	0.20	6219	11.2	0.18	5445	11.2	0.21
Oil Seeds	1630	23.42	1.44	1661	23.25	1.40	1661	23.2	1.40	1723	23.2	1.35
Sugarcane	2490	62.17	2.50	2116	59.66	2.82	2910	62.78	2.16	2108	59.51	2.82
Ochards	5639	41.66	0.74	9676	36.23	0.37	2351	41.13	1.75	1799	41.34	2.30

Large Farms												
CROPS	Rice Wheat Zone			Cotton Wheat Zone			Sugar Wheat Zone			Wheat Mixed Zone		
	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin	Gross Margin	Water Rate	Water Rate as percentage of gross margin
Rice Fine	1314	32.09	2.44	1532	30.65	2.00	1150	31.37	2.73	1250	29.11	2.33
Rice Coarse	523	32.09	6.14	642	30.65	4.77	509	31.37	6.16	1017	29.11	2.86
Cotton	635	33.73	5.31	2110	33.63	1.59	1958	33.6	1.72	1041	33.6	3.23
Maize	993	18.99	1.91	1378	17.99	1.31	1351	19.2	1.42	1081	16.8	1.55
<i>Kharif Fodder</i>	1136	14.76	1.30	1136	14.79	1.30	1417	14.8	1.04	1207	14.8	1.23
Wheat	815	21.55	2.64	644	21.58	3.35	491	21.6	4.40544		21.6	3.97
Gram	617	15.94	2.58	531	15.98	3.01	531	16	3.01	531	16	3.01
<i>Rabi Fodder</i>	3740	13.59	0.36	4565	13.6	0.30	4310	13.6		0.323883	13.6	0.35
Vegetable	6784	11.2	0.17	5954	11.2	0.19	6798	11.2		0.165525	11.2	0.20
Oil Seeds	1533	23.42	1.53	1773	23.25	1.31	1773	23.2		1.311773	23.2	1.31
Sugarcane	2645	62.17	2.35	2225	59.66	2.68	2993	62.78		2.102095	59.51	2.84
Ochards	6278	41.66	0.66	11215	36.23	0.32	3081	41.13		1.332436	41.34	1.70

Source: Salman M and Martini, 2000. Illustrations in the use of the Policy Analysis Matrix. Policy Paper (WP 00-27 LUMS), Lahore, Pakistan

Water Resources of Pakistan

This section draws on a policy study entitled Impact of Global Warming on Availability of Water in Pakistan's rivers and Response Strategy, Government of Pakistan (2010) conducted by AAB Pvt. Pakistan for the Government of Pakistan.

Rainfall

Rainfall in Pakistan is markedly erratic in magnitude, time of occurrence and aerial distribution and is vulnerable to further impacts due to Global Climate Change. However, almost two-thirds of the rainfall is concentrated in the three summer months from July to September. The mean annual precipitation ranges from less than 100 mm in parts of the Lower Indus Plain to over 750 mm near the foothills in the Upper Indus Plain. Kharif crop season extends from April to September and Rabi from October to March. The entire Indus Plain (canal commanded areas) receives an average seasonal rainfall of 212 mm in the Kharif and Rabi seasons. 75 percent of the area receives rainfall less than 250mm annually and 25 percent of it less than 125 mm. The total landmass of Pakistan i.e. 79.6 Mha can be further classified as under:

- Hyper arid – 10 Mha average rainfall 50 mm produces 4.3 MAF of rain water.
- Arid – 30.3 Mha average rainfall 100 mm produces 24.57 MAF of rain water.
- Semi-arid – 29.3 Mha average rainfall 400 mm produced 95.05 MAF of rain water.
- Upper Indus massive glacier covered area and area outside the influence of monsoon 4.4 Mha @ 600 mm produces 21.41 MAF.

Pakistan so far has not developed the capacity to fully utilize rain water. Rainwater can be harvested in areas receiving rainfall as little as 50 – 80 mm of average rainfall. Presently it is estimated that not more than 20-25 percent of rain water is harvested with current practices. Modern harvesting techniques followed in different parts of the world can enable Pakistan to capture almost upto 90% of the total rainfall. This potential needs to be exploited on more scientific basis to meet the future food and fodder requirements.

Presently the population and economy are heavily dependent on an annual influx into Indus River System of about 154.1 MAF of water mostly derived from snow and glacier melt. Table 17 indicates the contribution of snow, rain and glaciers in the Upper Indus catchment.

Snowfall and Glacier

Pakistan receives snow fall only in the northern areas during winter. Frozen reservoirs in the up-country release large amounts of ice-melt water to many of the major rivers. The glaciers, as given in Table 16, consist of huge layers of ice that also create glacial lakes. During the last few decades there has been a rapid retreat of glaciers that has created additional glacial lakes in the Hindu Kush-Himalayan region of Pakistan. This is attributed to the effect of global warming that is rising unabated as temperatures projected over next 3-8 decades rise.

Famous Glaciers of Pakistan

Glacier	Region	Length in Km	Area in Sq. Km
Siachin	Karakoram (Baltistan)	75	1,180
Biafo	Karakoram (Shingar)	68	625
Baltoro	Karakoram (K-2)	62	755
Batura	Karakoram (Hunza)	58	290
Hisper	Karakoram (Nagar)	53	620

Source: Impact of Global Warming on Availability of Water in Pakistan's rivers and Response Strategy, Government of Pakistan (2010)

Water Availability at Farm-Gate

Average Annual Canal Diversion (Gross)	104.5 MAF
Water at Farm Gate	58.3 MAF
Groundwater Abstraction (Average Annual)	46.0 MAF
Total at Farm Gate	100.3 MAF

Source: Impact of Global Warming on Availability of Water in Pakistan's rivers and Response Strategy, Government of Pakistan (2010)

Surface Water Resources

The various water resources including surface and groundwater along with escapages to sea and drainage losses are described below:

Western Rivers Contribution

Pakistan is now dependent on three western rivers i.e. Indus (including Kabul), Jhelum and Chenab. Annual average western river rim station flows (Indus at Kalabagh, Jhelum at Mangla and Chenab at Marala) from 1958-59 to 2007-08 are 149.14 Million Acre Feet (MAF) with *Kharif* inflows as 122.99 MAF (82 percent) and *Rabi* as 26.15 MAF (18 percent), while post-Tarbela (1976-2008) are 146.64 MAF with *Kharif* 119.83 MAF (81.7 percent) and *Rabi* 26.81 MAF (18.3 percent).

Eastern Rivers Contribution

The three eastern tributaries of the Indus, Ravi, Sutlej and Beas had been allocated to India for its exclusive use. India has constructed Bhakra Nangal Dam on Sutlej, Pong Dam on Beas and Thein dam for harnessing on the Ravi. The spills from these dams and unutilized flows enter Pakistan at Madhopur on the Ravi and below Ferozpur on the Sutlej. At present there is about 4.60 MAF of water which flows from India to Pakistan through eastern rivers. In addition, there is 3.33 MAF of run-off generated in eastern rivers catchments within Pakistan, particularly on the Ravi where a number of streams (Deg, Basanter and Bein Nullahs) join the Ravi upstream at Balloki. However, the river health of these eastern rivers paints a pitiful picture-best termed as dead rivers of the Pakistan Punjab.

Groundwater Resources

It is an important resource but no firm policy is in place for regulation of groundwater. It is causing groundwater level to fall rapidly in many fresh groundwater areas. Mining of groundwater is leading to intrusions of saline groundwater into fresh groundwater and increasing deterioration of groundwater quality in many areas. In addition, pumping cost of groundwater increases as the water table goes down. This implies that more expensive and poor quality groundwater will now be drawn for agriculture, domestic and industrial use. The fresh water volume is 43 MAF and saline water volume is 3 MAF.

This also results in lateral or vertical movement of saline interface which limits its use primarily due to unsystematic and unplanned exploitation. Site specific and in-depth analysis of data is required for further or on-going exploitation of groundwater resources and its use has to be based on a very scientific formula for sustainability of this valuable resource.

As in India, where ground water abstraction is leading to rapidly declining water tables reinforced by the production high delta crops like rice, sugarcane and cotton Pakistan is also seeing rapid recession of its ground water. In several area of central Punjab water tables are going down by 15-20 feet annually requiring deeper and deeper aquifer mining to maintain crop productivity.

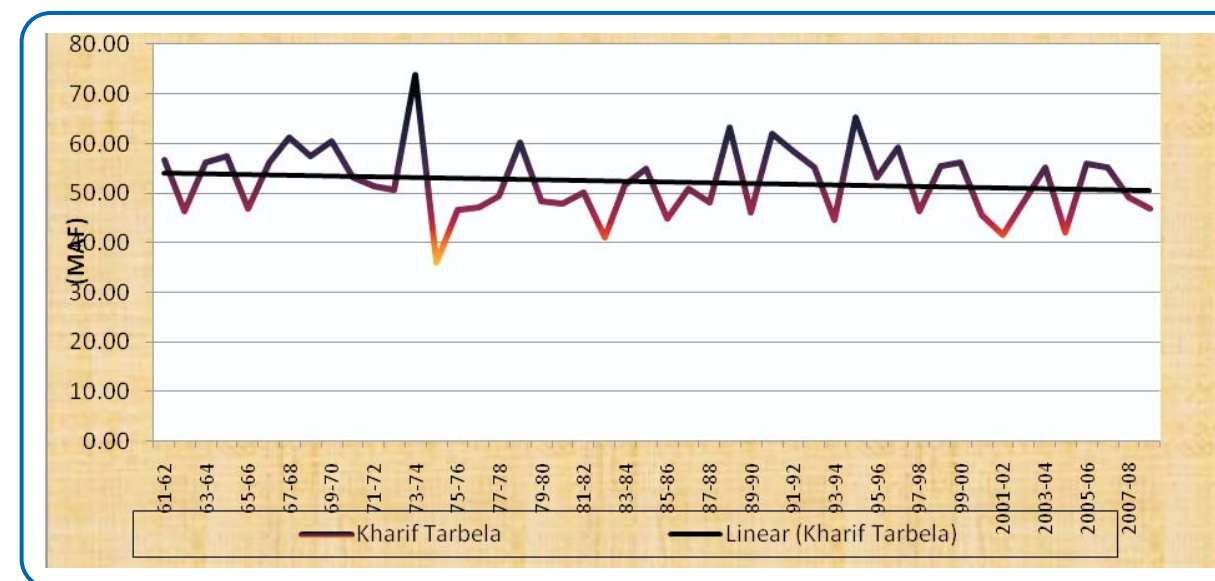
Declining Flows in River Jhelum largely attributed to diversions upstream Escapages to Sea

Despite acute water shortage in the system, it continues to allow substantial amount of water escapes below Kotri to sea. The data shows that post-Tarbela (1976-2008) average annual escapages below Kotri are 32.3 MAF, with a maximum of 91.83 MAF in 1994-95 and minimum of 0.77 MAF in 2000-01. Most of the flows to the sea occur during *Kharif* season and minimize during *Rabi* season. In recent years there has been considerable variability in these flows causing heightened tensions between the upper and lower riparian areas in Pakistan.

Long Term Flow Pattern of Western Rivers

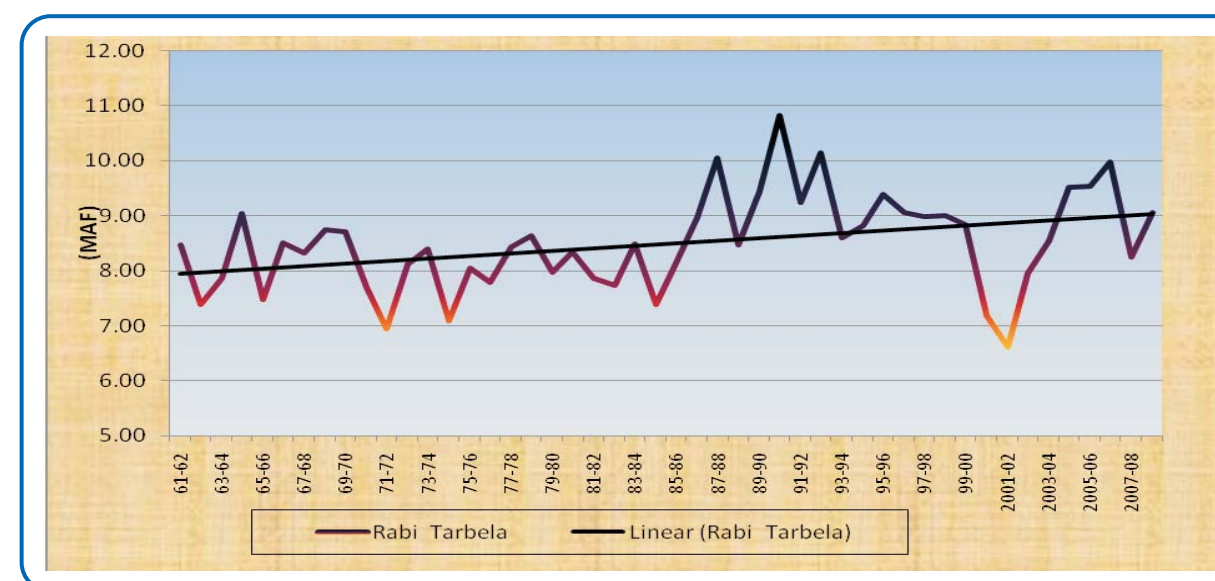
The following figures for Tarbela show *Kharif*, *rabi* and total flows from 1960 onwards, while for the other two rivers flows at Mangla are from 1922-2008. It is important to review the total flow pattern and then focus on the past 20 years to see variation in flows. As heightened climate changes (temperature and rainfall) have set in and glaciers are melting at the fast rate difference should be visible, provided excess water is not being stored elsewhere (glacial lakes, across the border).

Indus River inflows (Kharif) at Tarbela rim station (2002-09)



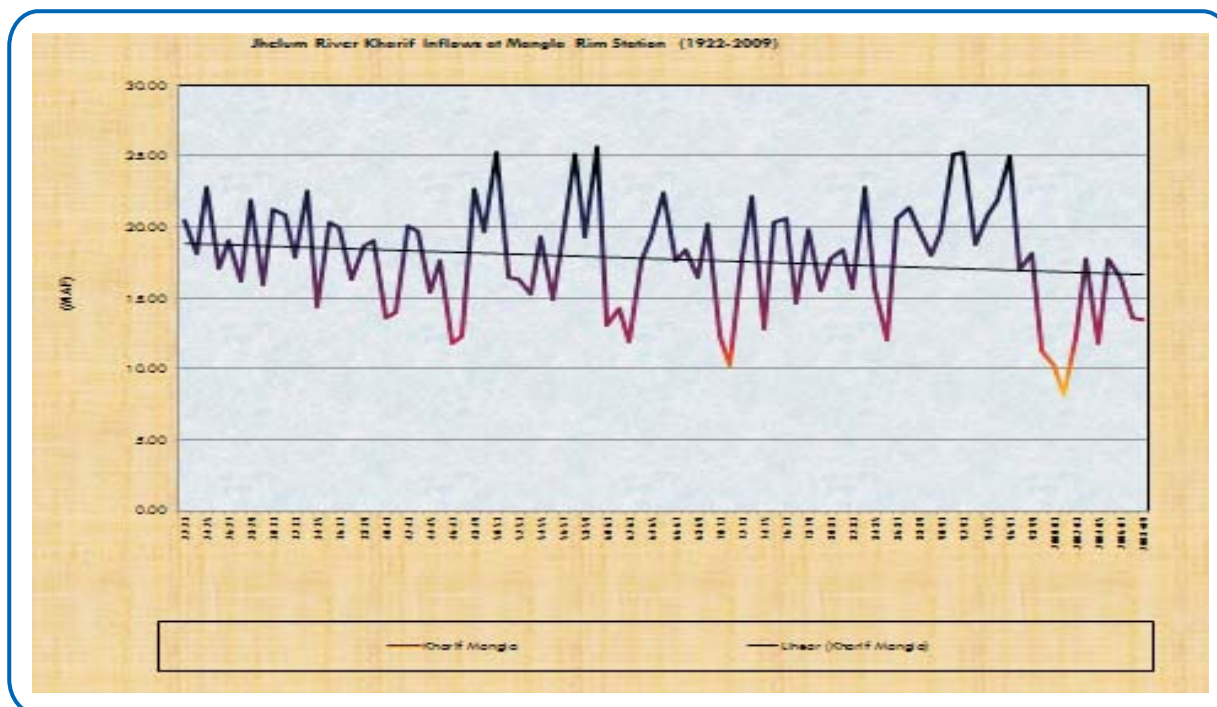
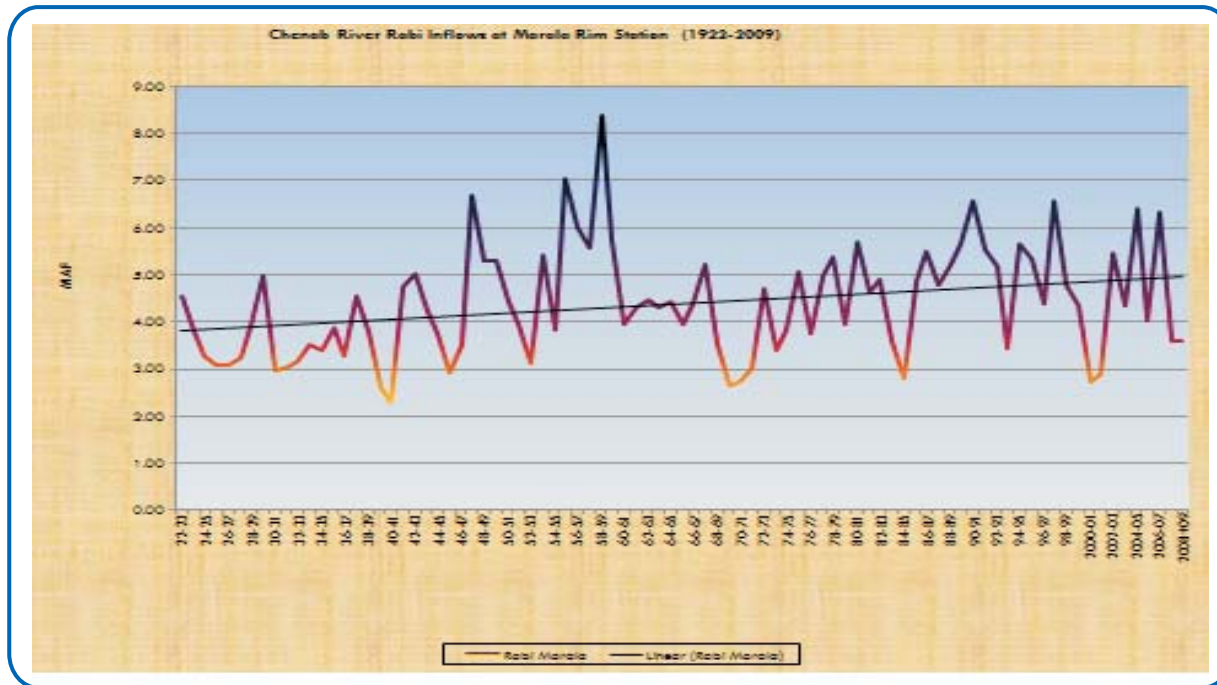
Source: Developed by study team based on IRSA (2009 Distribution of water resources within the Indus Basin System are shown in the GIS images (courtesy, IUCN, 2011)

Indus River inflows (Rabi) at Tarbela rim station (2002-09)

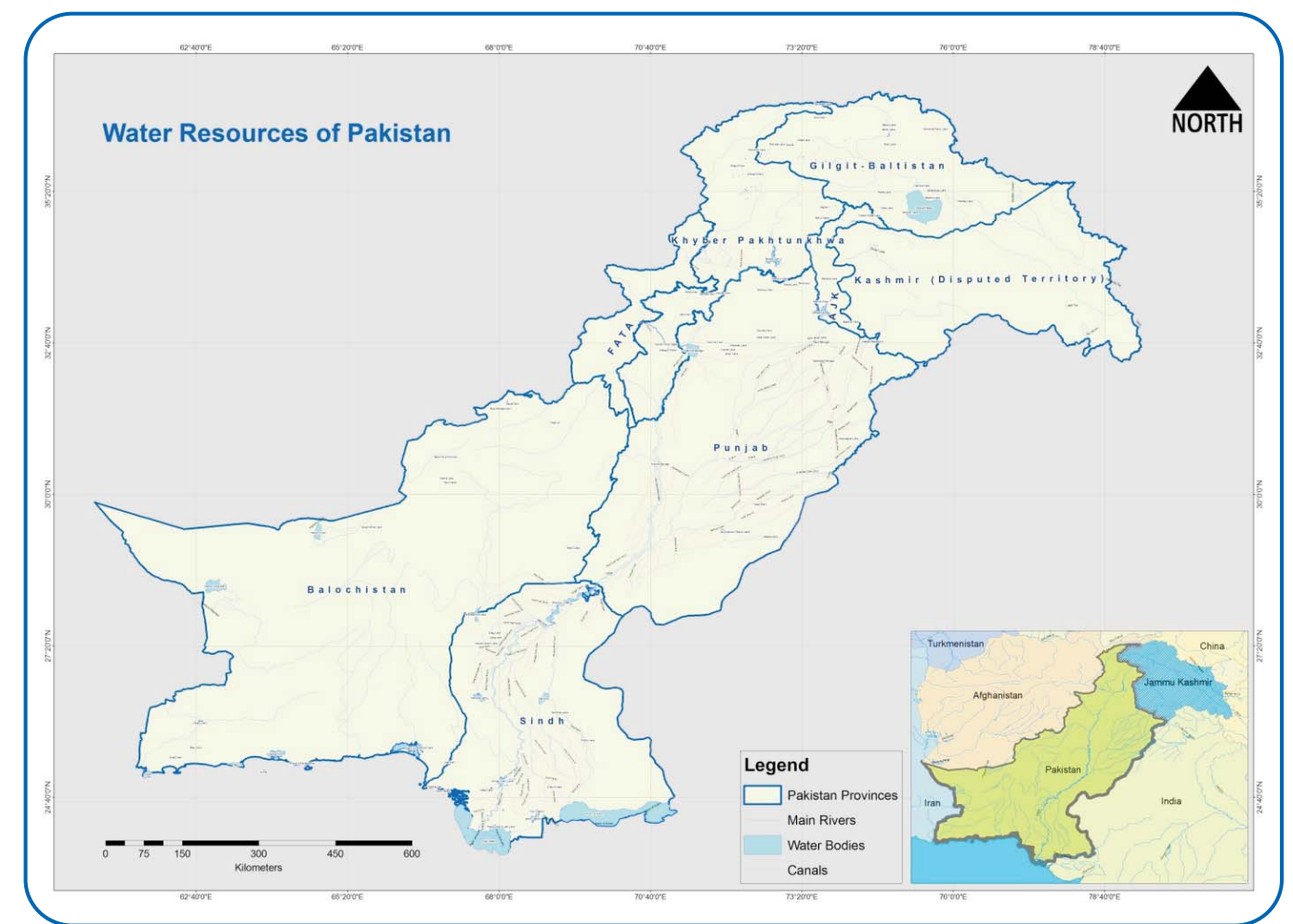


Source: Developed by study team based on IRSA (2009 Distribution of water resources within the Indus Basin System are shown in the GIS images (courtesy, IUCN, 2011)

Chenab River Inflows at Mangla Rim Station



Water Resources of Pakistan



Source: Courtesy of IUCN GIS Lab, Quetta, April 2011

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