SINDH IRRIGATION AND DRAINAGE AUTHORITY
Sindh Water Sector Improvement Project Phase-I (WSIP-I)

PREPARATION OF REGIONAL PLAN FOR THE LEFT BANK OF INDUS, DELTA AND COASTAL ZONE

Phase - I Final Report

Preparation of Inventory, Assessment of Existing Conditions, Identification of Issues, and Methodology and Plan for Consultations and Stakeholder Participation


Weir at DPOD

LBOD Spinal Bifurcation Point


Disposal of Sewage Water in Phuleli Canal


Consultation with Women

MAIN REPORT

Volume – I

The Louis Berger Group Inc.
In Association with
Indus Associated Consultants (Pvt.) Ltd.

JUNE 2011

Phase-I Final Report

The Sindh Irrigation and Drainage Authority on behalf of the Government of Sindh on the 5th of March 2010 signed a contract with The Louis Berger Group Inc., in alliance with Indus Associated Consultants (Pvt) to prepare the Regional Master Plan for the Left Bank of Indus, Delta and Coastal Zone under the Sindh Water Sector Improvement Project Phase-I (WSIP-I).

On 23rd December 2011, the Consultants submitted the draft report of Phase-I. The same was made available on the SIDA Web Page and sent out to the Panel of Experts for comments. On 03rd March 2011 the Panel of Experts met for the first time to review and comment on the Consultants draft report Phase-I.

On 30th April, 2011 the Consultants submitted a revised Final Report of Phase-I. On 18th May the Panel of Experts met to analyze and assess the revised report. After the Consultants presentations and the comments of the different members of the Panel, the Final Report Phase-I was formally accepted by the Panel of Experts.

The Final Report Phase-I May 2011 version was distributed among the stakeholders invited to attend the National Workshop in Karachi. The comments of the workshop participants have been incorporated in the present version.

June, 2011

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ACKNOWLEDGEMENTS

Contract agreement was signed on March 5, 2010 between Sindh Irrigation and Drainage Authority (SIDA) and The Louis Berger Group Inc. in Association with Indus Associated Consultants (Pvt.) Ltd. for preparation of Regional Plan for the Left Bank of Indus, Delta and Coastal Zone, addressing the flooding issues and providing proper drainage through appropriate structural and non structural measures.

The studies are planned to be carried out in consultation with the stakeholders starting from beginning to end covering identification of issues, analysis and design of solutions in four phases. The phase-I study cover inventory and assessment of existing conditions and identification of issues and problems. The Final Phase-I report has been prepared as per terms of the agreement

We feel great pleasure in extending our cordial thanks to SIDA management, Project Coordination & Monitoring Unit Staff and Panel of Experts (POE) who reviewed draft Phase-I report for their valuable guidance and support in preparing this report.

We are greatly indebted to Mr. Muhammad Ehsan Leghari Managing Director SIDA and Dr.Ylli Dedja FAO Project Management Consultant/ Agent (PMC/A) Team Leader for kind assistance and guidance extended during various interactive meetings for monitoring progress of the study.

Acronyms, Measures and Units

Acronyms and Abbreviations

ACE	Associated Consulting Engineers
ADB	Asian Development Bank
ADF	Assistant Director Fisheries
ADP	Annual Development Program
ALI	Adult Literacy Index
APHA	American Public Health Association
AWB	Area Water Board
AWWA	American Water Works Association
BDG	Beneficiary Drainage Group
BDN	Badin
BHU	Basic Health Unit
BOD	Biochemical Oxygen Demand
CBO	Community Based Organization
CCA	Cultivable Command Area
CCB	Citizen Community Board
CHW	Community Health Worker
COD	Chemical Oxygen Demand
CS	Case Study
CWR	Crop Water Requirement
DCO	District Coordination Officer
DDMA	District Disaster Management Authority
DERA	Drought Emergency Relief Assistance
DO	Dissolved Oxygen
DOF	Department of Fisheries
DPOD	Dhoro Puran Outfall Drain
DRIP	Drainage Reclamation Institute of Pakistan
DSEA	Drainage Sector Environment Assessment
E. Coli	*Escherica Coli* Forms
EI	Educational Index
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
ERC	Emergency Relief Cell
ETo	Evapotranspiration
FAO	Food and Agriculture Organization of the United Nations
FD	Finance Department
FFC	Federal Flood Commission
FGD	Focus Group Discussion
FGW	Fresh Ground Water
FO	Farmers organization
FP	Family Planning
GCA	Gross Command Area
GD	Government Dispensary
GDP	Gross Domestic Product
GEI	Gross Enrollment Index

GER	Gross Enrollment Ratio
GFCS	Ghotki Feeder Canal System
GIS	Geographic Information System
GoP	Government of Pakistan
GoS	Government of Sindh
Govt	Government
HDA	Hyderabad Development Authority
HDI	Human Development Index
HH	House Hold
HYD	Hyderabad
IAC	Indus Associated Consultants
IBRD	International Bank for Reconstruction and Development
ICID	International Commission on Irrigation and Drainage
IMR	Infant Mortality Rate
IPD	Irrigation and Power Department
IPOE	International Panel of Experts
IUCN	International Union For Conservation Of Nature
IWASRI	International Water- Logging, and Salinity Research Institute
IWMI	International Water Management Institute
KPOD	Kadhan Pateji Outfall Drain
KVA	Kilo Volt Ampere
LANDSAT	Land Observation Satellite
LBG	The Louis Berger Group Inc.
LBOD	Left Bank Outfall Drain
LGO	Local Government Ordinance
LIG	Lahmeyer International Germany
LIP	Lower Indus Project
M&E	Monitoring and Evaluation
MA	Million Areas
MAF	Million Acre Feet
MDG	Millennium Development Goal
MGD	Million Gallons per Day
Milch	Milking Producing Animals
MINFAL	Ministry of Food Agriculture And Livestock
MMR	Maternal Mortality Rate
MMP	Mott McDonald Pakistan, Consultants
MPK	Mirpurkhas
NA	Northern Areas
NCMC	National Crisis Management Cell
NCS	National Conservation Strategy
NDMA	National Disaster Management Authority
NDMF	National Disaster Management Framework
NDMO	National Disaster Management Ordinance of 2007
NDP	National Drainage Project
NEAP	National Environmental Action Plan
NEC	National Economic Council
NEQS	National Environmental Quality Standards

NESPAK	National Engineering Services Pakistan
NFFB	National Flood Forecasting Bureau
NGO	Non-Governmental Organization
NRM	Natural Resources Management
NWFP	North Western Frontier Province
O&M	Operation and Maintenance
OFWM	On Farm Water Management
OM&M	Operation, Maintenance and Management
P&D	Planning & Development
PARC	Pakistan Agriculture Research Council
PCBs	Polychlorinated Biphenyles
PCMC	Provincial Crisis Management Cell
PCRWR	Pakistan Council of Research in Water Resources
PDMA	Provincial Disaster Management Authority
PHC	Primary Health Care
PID	Project Information Document
PoE	Panel of Experts who reviewed the first draft of the Phase I report
PPA	Participatory Poverty Assessment
PPAF	Pakistan Poverty Alleviation Fund
PPM	Parts per Million
PPT	Parts per Thousand
PSDP	Public Sector Development Program
PSQCA	Pakistan Standards Quality Control Authority
RBOD	Right Bank Outfall Drain
RD	Reduced Distance
SAR	Sodium Adsorption Ratio
SCARP	Salinity Control and Reclamation Project
SFD	Sindh Forest Department
SGW	Saline Ground Water
SIDA	Sindh Irrigation & Drainage Authority
SITE	Sindh Industrial Trading Estate
SMO	SCARP Monitoring Organization
SOFWMP	Sindh On-Farm Water Management Project
SS	Suspended Solids
SUPARCO	Space and Upper Atmosphere Research Commission
SWMO	Sindh Water Management Ordinance, 2002
TAY	Tando Allahayar
TB	Tuberculosis
TBA	Traditional Birth Attendants
TDS	Total Dissolved Solids
THT	Thatta
TMA	Tehsil Municipal Administration
TMK	Tando Mohammad Khan
TOR	Terms of Reference
TPK	Tharparkar
TSS	Total Suspended Solids
UAF	University of Agriculture, Faisalabad

UC	Union council
UCDO	United Community Development Organization
UMK	Umerkot
UNDP	United Nations Development Programme
UNO	United Nation Organization
UWP	Urban Works Program
VC	Village Council
VDO	Village Development Organization
WAPDA	Water and Power Department Authority
WASA	Water and Sanitation Authority
WB	World Bank
WCA	Water Course Association
WHO	World Health Organization
WMO	World Meteorological Organization
WPCF	Water Pollution Control Federation
WSIP	Water Sector Improvement Project
WWF	World Wide Fund For Nature
WWF-P	World Wide Fund for Nature- Pakistan
ZTBL	Zarai Tariqiati Bank Ltd

Units/Measures

BCM	Billion Cubic Meters
BTU	British Thermal Unit
Cu.m	Cubic Meter
Cumecs	Cubic Meters per Second
Cusec	Cubic Foot Per Second
EC	Electrical Conductivity
Ha	Hectare
MAUND	40 Kg Weight
Kc	Crop Coefficient
Kg	Kilogram
MHA	Million Hectares
mm	Millimeters
Mt	Metric Ton
PAISA	100 Paisa = 1 Rupee
ft^{-3} sec^{-1}	Cubic feet per second
ft	Feet
Sec	Second
m	Meter

Glossary and Definitions of Terms

Abadgar	Farmer
Abiana	Tax for using Irrigation Water
Abkalani	Flood season
Arhtis	Commission Agents
Bt	*Bacillus thuringiensis* is a bacterium, commonly used in cotton varieties
Bachao bund	Flood protection bund
Baraaj	Barrage
Beldar	Lower level employee of the Irrigation Department
Dal	Local food
Devi	A shrub commonly found in grounds
Dhands	Lakes / reservoir
Dhoro Puran	Dhoro means Depression & Puran is the name of place
Jhopra	A hut made of straw
Katcha	A house made up of mud and straw
Kino pani	Black water / Sewage water / Dirty water
Kharif	Summer Crop Season
Khatedars	Registered cultivators
Laar	Lower part of Sindh Province
Madressah	Religious Seminary
Masjid	Mosque
Milch	Milk Producing Animals
Moghas	Outlet
Pacca	Made of bricks
Taluka	Sub District
Rabi season	Winter crop season
Roti	Locally homemade bread
Rali	Handmade bed cover
Ramsar site	Site protected under Ramsar Convention on Wetlands
Sim nala	Drain
Siro	Upper part of Sindh province
Wah	Watercourse/canal
Wadera	Head of the village
Wattan card	Government ID card for flood victims
Warabandi	System for rotation in irrigation right
Wicholo	Central part of Sindh Province
Zamindar	Landowner

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EXECUTIVE SUMMARY

Introduction

Various drainage projects have been executed on left bank of Indus and deltaic area of Sindh during five decades to combat the adverse impacts of drainage, water disasters, and the twin problem of water logging and salinity. This has degraded the productivity of agricultural lands and resulted in environmental, social and economic problems. Construction of Left Bank Outfall Drain Stage–I (LBOD-I) was under taken in 1985. The ultimate disposal of drainage water was to the Arabian Sea through KPOD, DPOD and Tidal Link. The stakeholders at Benazirabad, Sanghar and Mirpurkhas have positive perceptions about the LBOD because their waterlogged lands have been reclaimed, more fresh water is made available from underground through scavenger wells, crop production has increased, lands have become more fertile and stormwater disposal became quick. The people of Badin and Thatta have negative perceptions on the grounds that the failure of the outfall system has brought miseries for them. Their lands have been degraded, and turned into saline; wetland ecosystem is completely damaged and degraded and livelihood opportunities have shrunk. They always remain under fear that heavy rains, storms and cyclones may hit any time. The government as usual always relies on adhoc arrangements for relief and rescue operations and the conditions may go out of control. They always feel vulnerable, because they don't see any organized plan to face such disasters. The project benefitted the areas in Benazirabad (Nawabshah), Sanghar, Mirpurkhas districts but created problems especially in the coastal area of Badin and Thatta districts.

The Louis Berger Group/Indus Associated Consultants has been assigned the preparation of a Regional Plan for the Left bank of the Indus River from Guddu Barrage to the Delta and Coastal Zone. Phase I of this four phase project is dedicated to identification of issues and problems associated with the impacts of spreading water logging and salinity; institutional breakdown for management of water delivery, drainage, floods and disasters; environmental problems and resultant spread of poverty and deteriorating livelihoods among the growing population.

Diversion of river flows and consequent exacerbation of drainage problems was introduced by improvement of inundation canals and subsequent construction of barrages at Sukkur in the 1930s, at Kotri in the 1950s and at Guddu in the 1960s. SCARP developments were planned by the Lower Indus Project (LIP) team during the 1960s and successively financed and constructed since the 1970s. The SCARP wells are a combination of those to pump freshwater directly to distributaries and minors, those that pump saline groundwater and skimming wells that pump relatively fresh water from shallow aquifers and more saline water from deeper strata to prevent up coning.

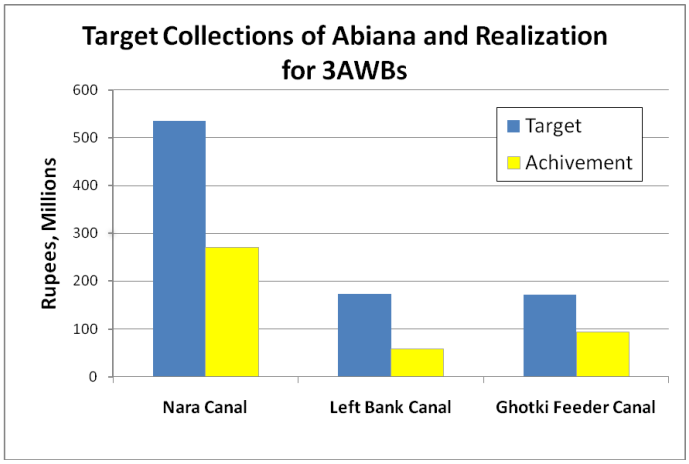
The report is structured in three parts, this executive summary, the main body of the report, and annexes and drawings. Chapters of the report summarize the Background to the Project, the Approach and Methodology followed; the Findings, Problems and Associated Issues; and eight Thematic Sections. Thematic groupings summarize detail of the work and findings that address the requirements of 34 Tasks of the contract. Annexes contain details of interviews that engaged more than 5,000 stakeholders plus a large body of secondary information.

The methodical approach, as described in Chapter 3 of this report, was followed and a considerable body of findings, problems and issues, as is presented in Chapter 2 of this report were identified.

A Plan with a Consultative Approach

Deterioration of Infrastructure and Operations

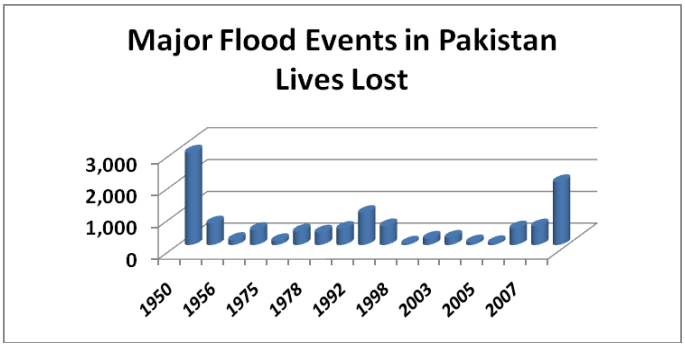
The canals, drains and river structures are deteriorating. This infrastructure deterioration is contributing to increasing severity of the disasters that accompany floods, water logging and salinity and worsened poverty and decline of livelihoods in the country side.



Thus, most of the excellent developments of the 40 year period, 1950 to 1990, have been allowed to deteriorate to the point that they now are a burden rather than an asset to national solvency. The hope of the Revised Action Program (RAP) of the 1980s and the introduction of Reform in 1995 are as yet unrealized. And now in the first decade of the new millennium reform is languishing and there is need to provide a jump start.

Deficient Collections of Water Charges

Through a combination of administrative decisions, some outside the control of IPD, water charges still are derived from Abiana based on rates that are set arbitrarily, are imperfectly collected, and in IPD administered areas are passed directly to the Department of Revenue. In those areas where Farmer's Organizations (FOs) have been established, revenue is collected by the FOs and is shared with the AWBs: total collections for AWBs are shown in the bar chat for the period 2001 to 2011.



Still, after a decade of Reform effort, Abiana collected by the FOs is inadequate to the needs for operation, maintenance and management (OM&M) of the canal systems. For both organizations, IPD and the AWBs/FOs, collections are far short of the costs of production. The budget of IPD is adopted annually from general revenue and grants and published in the Provincial Budget report.

Natural disasters, people's perceptions and WSIP

A succession of catastrophic events including the 1999 cyclone and its effects in the Coastal Zone of Badin and Thatta, rainfall floods of 2003 and 2006 in the interior of the Province, and the mega Indus River flood of 2010 that breached bunds and flooded overbank, have generated vocal reactions from the populace and in turn a strong desire on the part of government to provide solutions to redress grievances of the entire populace.

The primary engine of restarting the stalled program of reform is embodied in the WSIP, programmatically and financially. This Regional Planning Program is intended to directly address

issues that have arisen especially with respect to structural deterioration, water logging and salinity, floods, disasters, and the spread of poverty and deterioration of livelihoods.

Approach to the Study and Report Presentation

Format of the Regional Master Plan Report

The report is structured in three volumes, this executive summary, the main body of the report in volume I, annexes in volume II and the Atlas in volume III. Chapters of the report summarize the background to the Project, the approach and methodology followed; the findings, problems and associated issues; and eight Thematic Sections. Thematic groupings summarize detail of the work and findings that address the requirements of 32Tasks of the contract. Annexes contain details of interviews that engaged more than 5,000 stakeholders plus a large body of secondary information. The Atlas summarizes the work and findings of 2 Tasks.

There is value to the deliberative approach of the Sindh Government. This project is conceived in four phases with this first phase being a thorough vetting of issues and problems at all *stratas* of society.

The methodical approach, as described in Chapter-3 of this report, was followed and a considerable body of findings, problems and issues, as is presented in Chapter 2 of this report were identified.

A Participatory Approach

A central point in the preparation of the WSIP Regional Plan is preparation of the Plan in consultations with communities and other major stakeholders. One of the key '*lessons learnt*' (see PAD, WB, 2007) has been to make participatory approaches to development crucial to project design based on social considerations. Genuine participation and involvement from the community and other relevant stakeholders, thus, is viewed as essential throughout the planning and design process not only for this phase of the work but throughout all four phases.

General Approach to the Studies

To address the diverse requirements and outcomes required in the 34 tasks of Phase I of the Project, the Consultant grouped tasks under eight themes and carried out the work of each thematic area in four steps:

- Planning process
- Secondary data collection, review, critical evaluation and analyses
- Primary data collection, review and critical analyses
- Collation of findings and identification of resultant problems and issues for presentation to stakeholders.

Each sub-team planned the activities and approaches according to the particular task groups assigned. Sources of required data were identified, followed by informational meetings with concerned departments, reconnaissance surveys, and specially developed interaction with communities and other major stakeholders.

Methodology for Addressing Issues of Eight Thematic Areas

Five structural and non-structural requirements are to be addressed in the course of preparation of this four phase Regional Plan: 1) flooding along the LBOD and Indus River and intrusion of seawater in the Coastal Zone, 2) potential measures for rehabilitation of the LBOD system, Dhands

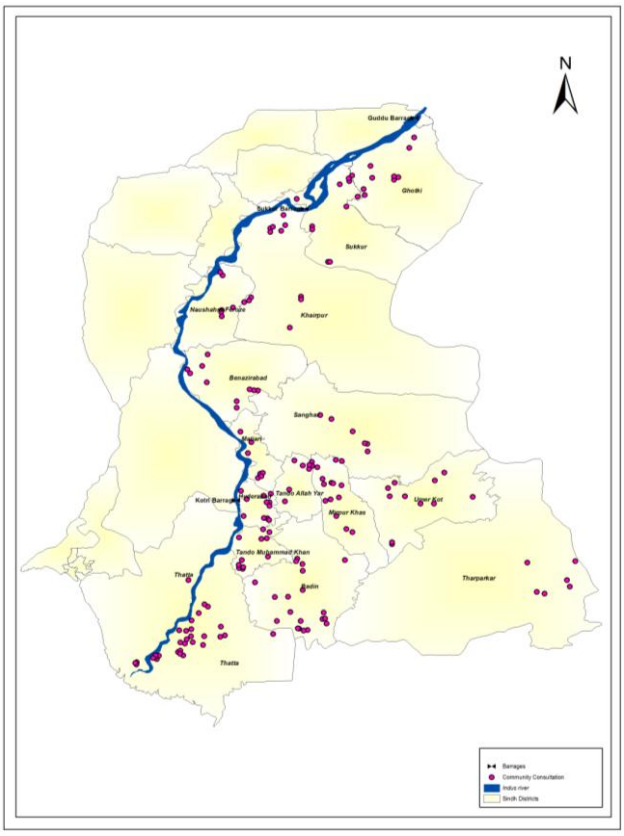
and Tidal Link, 3) ongoing structural and non-structural programs and identification of additional project needs, 4) determination of institutional arrangements for effective management of water delivery, maintenance of drainage, flood operations and disaster response, and 5) identification and systematic documentation of conditions in the countryside with respect to water delivery, water quality, agriculture, fisheries, poverty, livelihoods, health and general welfare.

Problems and Issues associated with each objective requirement were initially explored through review of secondary information of reports and available data followed by a designed primary data collection program. Collection of primary data occurred during repeated consultations with stakeholders at all levels of society through surveys, interviews, workshops, and field reconnaissance. Thus during Phase I of the project, surveys and interviews were carried out across the region after careful design and confirmation by SIDA. Additionally, field surveys were carried out for observation of conditions and for collection of basic data to provide perspective to the positions of stakeholders while recognizing that some are well informed and the opinions of others are fanciful.

Review and Use of Secondary Data

In accordance with the outlined planning criteria, the Consultant collected, reviewed and analysed extensive secondary data and reports. Publications, documents and reports consulted are listed in the bibliography. Stake holders associated with each topic were identified and consulted during the process of data collection. Stakeholders included beneficiaries, affected communities, NGOs, influential local people and staff of government line departments.

Literature review and collected data provided a firm base for an understanding of the project area, its infrastructure and prevailing social conditions. The secondary sources also were important for identification of strengths and gaps of past and ongoing projects, structural and non-structural, and for identification of the core issues. Early recognition of issues was important for setting an appropriate communication strategy and the selection of methodological tools for interaction with communities and stakeholders.



Coverage of Stakeholder Consultation

Primary Data Collection, Review and Critical Analysis

The LBG/Indus sub-teams planned and conducted approximately 200 field trips during Phase I of the Project. Primary data was collected largely with communities and other major stakeholders. To approach communities and stakeholders efficiently and to limit data collected to that required for analyses; LBG/Indus prepared a comprehensive communications strategy. The strategy is briefly outlined in the report section of Thematic Area 7.

Approach to Community Consultations

Community consultations were the venue for collection of most of the raw data and information for all themes and issues of phase I of the study. An important objective of this phase of the project was to identify, together with communities and other stakeholders, relevant issues and problems. And in accordance with this objective, data collection and analysis required a primarily qualitative approach. The large geographical area is diverse and complex with a multiplicity of issues. Thus a multi-dimensional methodological approach, that employed a variety of investigative tools, was adopted for the consultations and assessments regarding the environmental, poverty, socioeconomic and other task-related requirements.

The combination of methodological tools (triangulation) enabled reasonable insight into communities' perceptions about contemporary problems, causes of the persisting poverty and problems and community concerns and suggestions about the effects of Project related issues on their livelihoods. The discussions were attended by beneficiaries in villages served by existing drainage projects and intended beneficiaries in the villages that are expected to be served by planned projects. The discussion centered on a structured checklist, and some open ended questions to solicit their perceptions about the performance of the completed projects.

Although the overview of the Consultant's TOR directs the focus of the study be with respect to drainage and flood issues, the Consultant has included issues and problems not explicitly related to the drainage and flood as required by a number of the 34 Tasks. Further such a narrow focus could not be maintained since stakeholders lack faith that anyone considers their opinions or that their pleas and opinions will be passed to the relevant authorities. This consideration was fully confirmed in areas where some consultations with the stakeholders were conducted in the past and the stakeholders repeatedly stated that no value was given to their opinions and suggestions were not considered at all in past projects and programs.

Regional Coverage of Community Consultations

There are 3,259 villages/settlements in the Project area (UNOCHA 2010 and PCO). The Consultant accessed 148 villages, which represent around 4.5% of the sample universe. Each of the fifteen Project area districts and each of the three Area Water Boards were represented in the consultations on the Project issues and problems.

To ensure full and equal involvement of men and women of all ages, backgrounds and social status during the consultations, especially with respect to activities which directly affect individual lives and lives of their communities, a multi-dimensional approach was used for planning and conducting of consultations. The consultations were conducted at five levels:

1. Grassroots level – 148 villages
2. District level – 15 districts
3. Area Water Board level – 3 Area Water Boards
4. Regional level – Left Bank, Indus Delta and Coastal Zone of Sindh
5. National level

Community consultations were conducted for a full range of topics with an area focus depending on the dominate concern in the area. Consultations focused on LBOD/drainage issues and problems at 36 sample villages, while 40 villages in the Lower Sindh were consulted on poverty issues, 60 on economic and livelihood issues and 12 on environmental issues, Table 7.2, Main Report. Moreover, the **C**onsultant made almost 200 reconnaissance trips across the Project area. More than 300 different organizations, NGOs, CBOs and others were represented at consultations and over 5,000 stakeholders were directly consulted in the first phase of the Project. The area directly accessed during consultations represents over 300,000 residents.

"According to facts/ field conditions/ surveys conducted time to time , in almost 13 Years only two disasters have been reported on Tidal Link, First was a Cyclone on 21st May 1999, Other was in Monsoon rains 2003 overtopping of Spinal Drain near Kadhan & Tando Bago during heavy rains, First One was natural Disaster it would have created same destruction any how, Second One was mismanagement on part of Operation & Management agencies: In 2003 during Heavy Monsoon Rains Irrigation Channels like Nara Canal were not Closed from Head in time, but when conditions (Overtopping expected Breaches of Irrigation Canals) were getting out of Control that Irrigation Channels were given escape into LBOD that was already flowing at its full design discharge capacity of 4000 cusecs, that rain flood water of about 12000 to 14000 cusecs when flowed towards sea and coupled with a High Tide (High Tide Timing was ignored while opening escape) resulted in overtopping of LBOD, but after one week LBOD was the only water way that drained out overtopped flood water back into Sea. After that incident the then President of Pakistan ordered immediate action by Army Engineering Core and NDP authorities to take remedial measures, in result LBOD Spinal Drain size was increased and its embankments were covered with Stone pitching, after that till today LBOD has passed 2006 heavy Rains/ Flood effluent and 2010 Rain/ Flood effluent from Left Bank of River Indus also feeding Fresh Rain Water to Dhand Complex of Badin Area & no any incident is reported."
Mr. Noor Memon, PCMU May 2011

The consultations with stakeholders and affected communities included the following methodological tools: workshops, open community consultations, focus group discussions, key informant interviews, informal interviews, and establishment of channels for feedbacks and continuity of stakeholder involvement.

Approach to Assessment of Flooding along the LBOD and Indus River and Intrusion of Seawater in the Coastal Zone

Among important studies reviewed was the 2009 feasibility report of NESPAK, ACE and DMC which presented alternatives for rehabilitation and rationalization of flood capacities of LBOD, DPOD, KPOD, and the Tidal Link. Simultaneously each alternative presents program components for protecting large areas of the coastal area through a program for construction of bunds and structures.

"The project is a good example of non-transparent mechanism used by (International Financial Institutions) IFIs. No single piece of information was shared with communities. No public consultations were arranged. Resultantly, the project has a big technical flaws and causing serious social, livelihood and environmental problems in coastal areas of Badin. During recent rains of 2003 and overflowing of drain constructed under the LBOD led to flooding of vast area, 30 people died, thousands were dislocated, thousands acres of standing crop was damaged. We believe that if the communities had been consulted in the project planning phase and all the related information were shared with them; the damage would have been averted."
(Mustafa Talpur 2003)

This review was followed up by reconnaissance level surveys by engineers, agriculturalists, economists, environmentalists, fisheries, forestry and other specialists of the team who visited the Indus River downstream of Kotri, the Coastal Zone, the Tidal link, the Dhands and the LBOD/DPOD/KPOD channels. Separate surveys were made by engineers and GIS specialists to establish high water marks and to measure depths of inundation

of the several types of flooding including that caused by rainfall, high wind-driven tides, and breaches and over bank flooding along the Indus River and the LBOD.

Observations of these engineers and scientists were used to quantify and confirm validity of local stakeholder and community perceptions as presented during interviews, workshops and other local consultations.

Approach to Review of On-going and Indicated New Projects and Programs, Structural and Non-structural

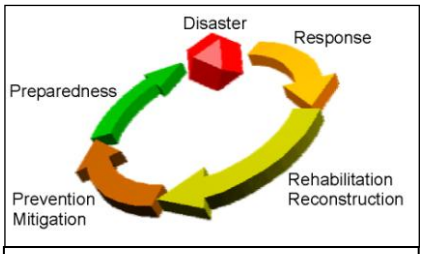
Initially reports of feasibility, design and construction of facilities were accessed through WAPDA, DGAEWM and IPD for assessing the direction of on-going construction programs and the features of completed programs and projects. Current status of facilities including structures, channels and tubewells were assessed through visits to and the securing of data from subdivisions of IPD and from SIDA. Issues, problems and deficiencies identified will guide the preparation of prefeasibility studies during phase II.

Approach to Assessment of Water Quality and Availability and Agriculture, Fisheries, Poverty, Livelihoods, Health and General Welfare

The approach and methodology to determine problems and issues associated with general welfare in the countryside through consultation is detailed at length above due to its systematic approach with scientific overtones. Details are provided in report Section 4.7 that deals with primary data collection and consultations. Additionally during the reconnaissance surveys, some water samples were collected and analyzed for discharges by industry.

Approach to the Assessment of Institutional Capacities for Effective Maintenance and Management of Water Delivery, Drainage Disposal and Flood Protection Works and Disaster Response

Initially identified were the two agencies that will: 1) determine the success or failure of the Reform Program begun in 1995 with enactment of the SIDA Act, and 2) that are involved in management, operation and maintenance of canal and drain systems and flood works in the left bank area of the Indus River. The two responsible agencies are IPD and SIDA and its two operating units, AWBs and FOs.



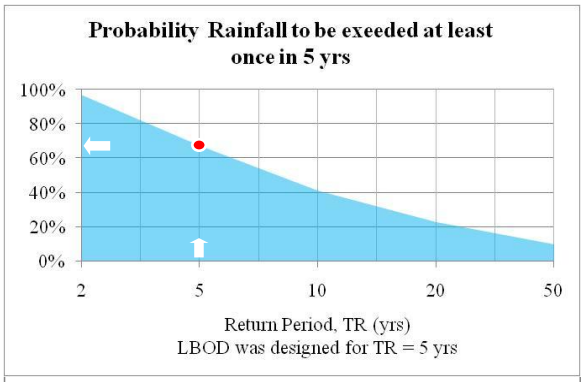
Disaster Risk Management Cycle

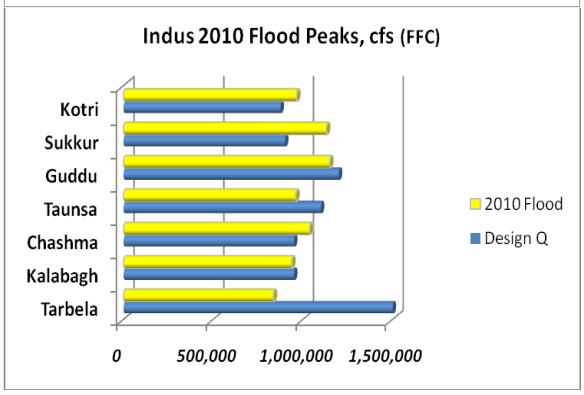
Public records including the Provincial Budgets for IPD, SIDA, and Land Reclamation, 2009-2010 and 2010-2011, were analyzed to assess personnel and mechanized capacities for maintenance, operation of canals and drains and for flood protection and remediation.

Strengths of these two organizations and their capacities to carry out routine maintenance and operation of the canal and drain systems were inferred from their tables of organization.

NGOs involved in the largely non-structural activities associated with programs that address social, economic, and cultural conditions that prevail in irrigated areas and the Delta and Coastal Zone. These entities were initially identified through registries and were assessed through the internet. Follow up was accomplished by visits, telephone and email contact. Personnel, equipment and transport capacities and legal and financial standing of NGOs were secured for short listing during implementation.

Key Findings, Issues and Problems





Issues and problems bought up by the consulted stakeholders are typologically summarized in table 3.1 of the main report. A number of the issues and problems reported therein are at times overlapping and repetitive, which is unavoidable because the causes can be diverse but converge into the same problem.

The major issues identified are summarized below:

Drainage Network and Flood Protection Infrastructure

a. The opinions of the stakeholders and communities about the LBOD were divided. Those who expressed positive opinion said that it has reduced the drain out time for flood and storm water, and has improved the productivity. Those who strongly feel that it had affected them negatively feel that it has degraded their lands, decreased farm and fish productivity, and degraded underground aquifers. The degradation is mainly due to drainage, industrial waste discharges and sea encroachment.

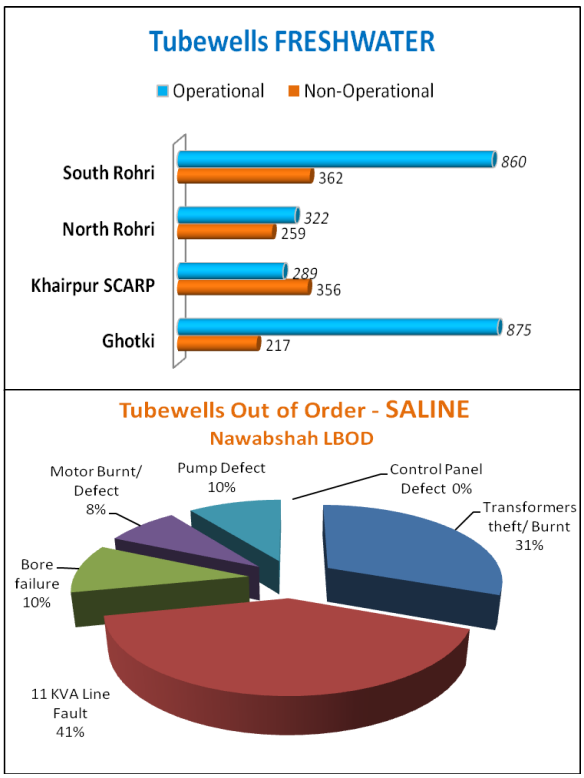
b. Communities in Badin and Thatta districts, and delta and coastal area expressed serious reservation against any future drainage projects saying that new projects will bring more devastation, including additional contaminated and poisonous urban and industrial effluent. In the absence of mitigation measures to arrest seawater intrusion through eroded tidal link and KPOD is destroying agriculture lands, salinizing aquifer and destroying the ecosystem of lakes and wetlands.

c. Stakeholders of the Ghotki district in two consultative workshops held at Ghotki and Sukkur complained of the Government of Sindh not taking any initiative in stopping the Drainage effluent of SCARP-VI mixed with industrial effluent. The effluent is disposed unattended in district Ghotki severely degrading the lands. Water logging and salinity is on the rise resulting in crop failure and depletion of the resource base with an adverse impact on livelihoods.

Disposal of Flood and Storm Water

a. Farmers feel that there is no widely known mechanism to deal with disposal of storm water and have to resort to *ad hoc* and unplanned measures thereby damaging drainage and other infrastructure. They desire development of options for safe and timely disposal of storm water

b. People complained that the government flood response was too late, particularly, rescue and relief was unplanned, and support for rehabilitation was inadequate. They were apprehensive of unexpected breaches during floods and felt concerned by the threat to the human lives, livestock, assets and livelihoods.



c. They suggested development of possible flood retardation basins, and escapes routes, etc. to protect barrages and irrigation and drainage network, physical infrastructure, vital installations, and properties. They complained of inadequate early warning mechanism or crisis management in case of super floods.

d. The perception is that national and provincial disaster management institutions are ineffective in combating flood and storm water disaster.

e. They desired development of options for safe and timely disposal of storm water. Stakeholders suggested options to harvest rainwater through conservation in the desert area for storage and recharge of the groundwater.

Operation & Maintenance of Irrigation and Drainage Infrastructure

a. The drainage network is clogged with silt and weeds. This restricts free flow of the drainage effluent and causes breaching.

b. Farmers reported that organized gangs are involved in the stealing of high tension wires, motors and pumps, electrical fittings, and in some places even the doors. Where tubewells were functioning, they were a source of power theft for non-agricultural uses. This has reduced the effectiveness of the SCARP tubewells, and reduction of water table is constrained.

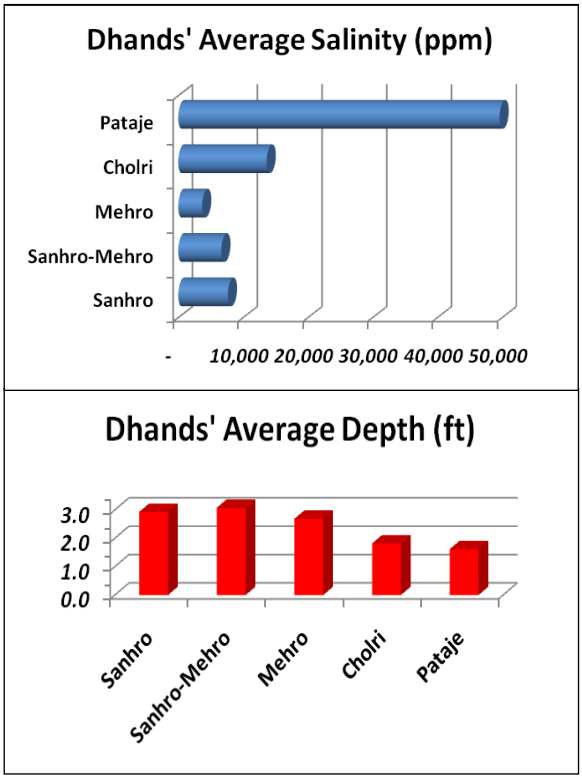
Tubewells – Tubewells are still being operated by staff of IPD even though policy is to transfer them to the private sector. Tubewells have not been maintained and 20 to 60 percent are not functioning. This situation has prevailed for decades.

The situation in three divisions of IPD that operate tubewells for drainage of saline water show similarly variable results to those depicted for fresh water tubewells.

c. Issue Related to a Program of Preventative Maintenance -- IPD is not carrying out routine maintenance and has only a limited program of reconstruction and rehabilitation that is constrained by inadequate budgetary allocations. Review of the budgets presented in the

Main Report, illustrates the severe lack of funds in the budget for other than personnel, allowances, and office expenses.

Environment and Wetlands



a. Reported negative impacts included i) deterioration in freshwater quality ii) increase in water-logging and salinity iii) shift of productive agricultural lands to un-productive wastelands v) change in agriculture farming system vi) expansion of swampy area and vii) sinking of productive mudflats in the delta. The ultimate impact of seawater intrusion was loss of biodiversity and degradation of deltaic ecosystem.

b. Forests have vital social, economic and environmental importance. Deforestation was caused due to variety of social, economic and environmental issues. The pre-dominant issues were i) Low discharges of Indus River resulting in extended droughts ii) Inadequate irrigation supplies/allocated water and actual receipt and iii) Adverse social pressures. Above factors have negatively impacted the forests and caused deforestation.

c. Issues responsible for degradation of mangroves resulting in resource base reduction are i) reduced flow of sweet water ii) reduced silt from Indus iii) inflow of pollutants from industries and intermix of industrial effluents iv) browsing by camels and grazing by livestock and v) illicit wood and fodder harvesting. This has resulted in degradation of mangrove ecosystem and loss of biodiversity and valuable habitats.

d. Pollutants entering the water sources fall in three categories viz. municipal, industrial and agricultural wastes. The main issues contaminating surface and ground waters include i) disposal of untreated industrial effluents and sewage and city garbage into canals and other fresh water bodies iii) seepage of fertilizers and pesticides from agriculture fields and soil iv) disposal of highly toxic and high BOD laden sugar mill effluents into surface drains of the main drainage system v) seawater intrusion in river carrying hyper saline water that percolates from river bed into the deep aquifers rendering the groundwater saline and unsuitable for domestic use and vi) effluents of Kotri industrial area into river and canals

e. The high pollution level of surface and groundwater led to different environmental consequences such as reduction of biodiversity, ecosystem dysfunction

eutrophication, alteration of aquatic habitats and contamination of downstream and marine ecosystems, increase in water related diseases and decrease in agricultural productivity.

f. The coastal wetlands are degraded due to seawater intrusion. The seawater has changed the wetlands ecosystem by adversely affecting the fauna, flora, wild life and biodiversity, habitats, fish and livelihood opportunities. The inland freshwater wetlands have been degraded due to reduced flows in the river and consistent drought conditions. These wetlands habitats are either dried up or turned brackish for the want of freshwater.

g. Fisheries, waterfowl and wildlife habitats have been seriously degraded and the livelihood opportunities have dwindled. There is need for a management plan for managing this valuable resource on scientific lines.

SIDA needs to be freed of restraints imposed by IPD - Serious constraints to transfer of the AWB systems to SIDA are hampering reorganization. The transformation of SIDA, AWBS and FOs into utilities began well but has been stalled due to the reluctance and active opposition to formation of utilities by IPD.

h. Over mining of underground water has led to saline water encroachment in the fresh groundwater areas. Indiscriminate conjunctive use of marginally saline underground is degrading soil quality which adversely affects productivity in the long run.

Institutional Issues

a. National and provincial disaster management institutions are ineffective in combating flood and storm water disaster and the plans to cope with likely Tsunami disaster.

b. Most farmers expressed their dissatisfaction, and expressed the need for improved monitoring and accountability.

c. It is a general impression of the consulted communities that Farmers' Organizations (FOs) are dysfunctional. Almost all the farmers are aware of the Farmer Organization (FO), but only few are aware of their mandate, responsibilities, and functions. The majority of the consulted stakeholders and communities believe that the Irrigation Department sells water to the rich and the powerful".

The IPD organization is out of date, with respect to staffing, office locations, and lack of mechanized maintenance crews. Yet IPD is the only institution that has a basic budget and potential capacity to manage, maintain and operate the systems for delivery of irrigation, industrial and M&I water; disposal of agricultural and storm water drainage; routing of water and floods at barrages and along the Indus River; and to maintain flood protection infrastructure before, during and after floods

d. FOs do not have enough power to ensure a proper share of water for their communities. Local powerful individuals and waderas control the work of the FOs to the detriment of the local people

e. The Irrigation Department does not maintain the irrigation system regularly and properly; and mismanages funds.

f. Serious constraints to transfer of the AWB systems from IPD to SIDA are hampering reorganization of SIDA. IPD, itself, needs reorganization to routinely and equitably distribute water, to manage the Indus River and main canals and to maintain flood protection infrastructure before, during and after floods. The stakeholders reported that there is widespread institutional mismanagement and mismanagement of funds for operation and maintenance

Quality of Life, Socioeconomic Wellbeing and Livelihoods

a. Safe and clean drinking water is not available particularly in the saline underground water areas and in delta and coastal area.

b. In the delta and coastal area due to the swampy conditions the incidence of various water borne and contagious diseases is quite high. Similarly un-drained and stagnant rain water in the entire left bank also serves as a breeding place for mosquitoes, flies, and other insects.

c. The access to education services is inadequate, particularly for girls. The situation is marred with absenteeism of staff, shortage of trained teachers, absenteeism of students, increasing dropout rates, etc. Similarly, health services in rural areas are inadequate, particularly for women. Absenteeism of medical and paramedical staff-medical supplies is issues. The poor health services are evident from frequent and chronic illness, malnutrition, and high infant mortality rates.

d. Due to collapse of tidal link and the associated structures, the freshwater bodies in the delta and coastal areas have turned saline. Due to saline water, fish cannot get enough food and fish reproduction is decreasing as a consequence. This has destroyed the livelihood of the fisher folks and they have lost their livelihood.

e. Due to continued encroachment of seawater, and overtopping from KPOD, the productive farmland has gone out of production, and further encroachment needs to be arrested.

f. The skill level among villagers is low and there is need for skill development programs to enable them to earn livelihoods, rather than working as low wage unskilled labour. There is lack of alternate livelihood opportunities, low level of skills, and access to finance is causing unemployment.

Gender Issues

a. General issues include lack of opportunity for women's employment, low literacy rate, too many children per family, family debts due to high dowry expenses, lack of education and other basic facilities in villages. As well there is lack of sanitation facilities for women, absence of prenatal services, and absence of any consultations with women.

Community Consultation

a. The majority of the consulted villages and stakeholders report the absence of meaningful consultations with their communities prior to visits by the Project team. There is disbelief that anyone will consult locals at all. When consulted previously, no value was given to their opinions and suggestions and they doubted if their suggestions will be considered. Women are generally ignored in the consultative process.

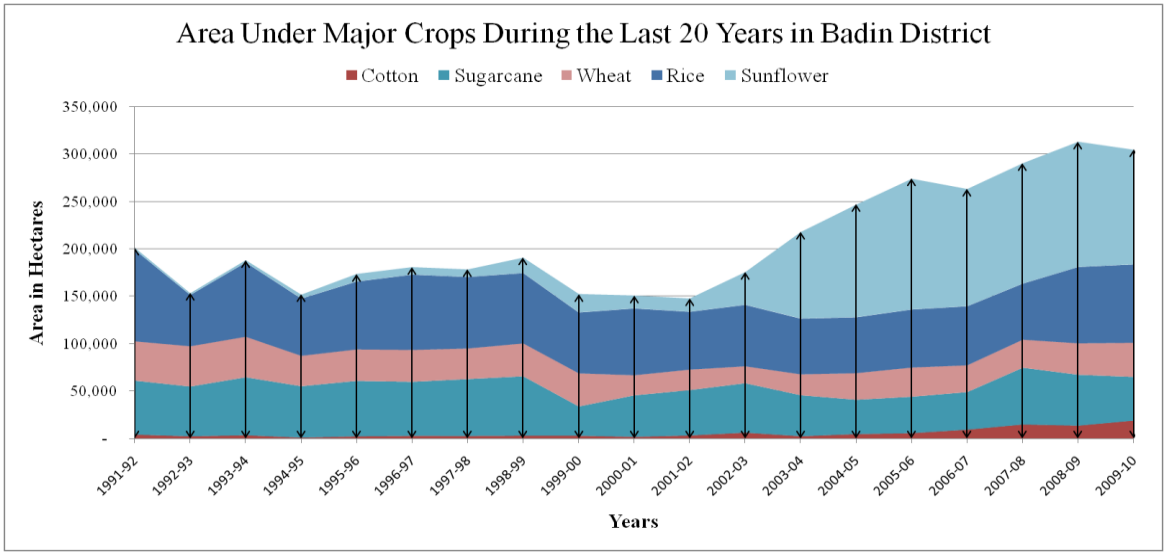
b. Road, health, sanitation and absence of basic services were generally noted in project area.

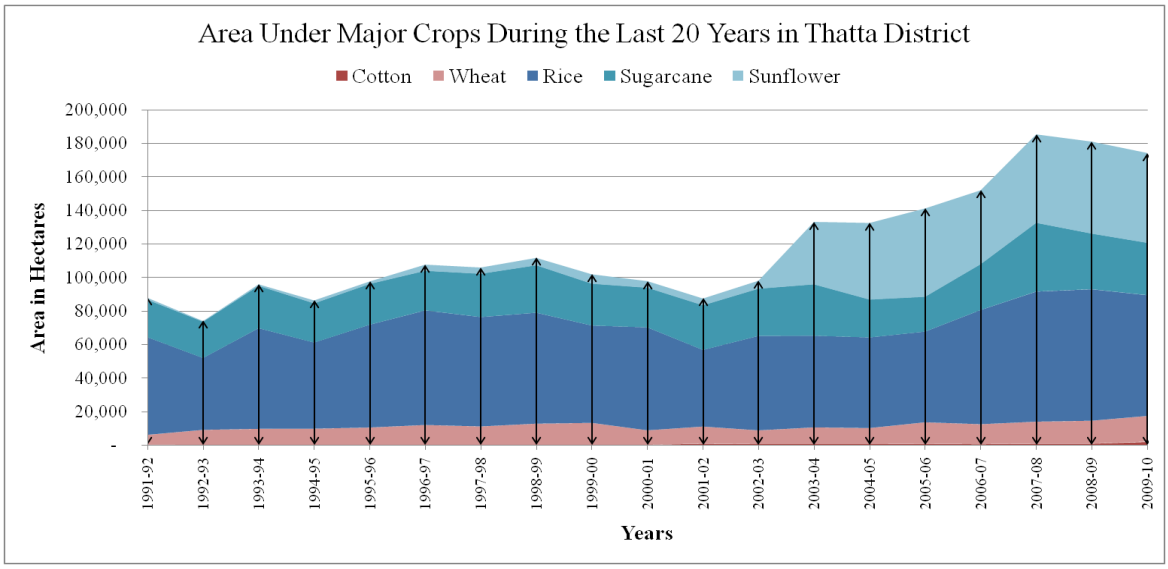
Agriculture and Irrigation Sector

a. Lack of availability and shortage of irrigation water is a serious concern expressed by most of the consulted villages, particularly for farmers located in the tail reaches of the system. Shortages and uncertainty in the irrigation supplies- and absence of equity are the main constraints in efficient utilization of water resources. However, people at upper reaches of canal commands and distry/watercourse level utilized water at full potential and their yields and production increased. This resulted in overall increase in crop production at district level, although tail enders recorded their severe resentment against this unlawful practice.

b. Availability of good quality agricultural inputs such as certified seed, fertilizers, pesticides, need to be ensured. Agriculture support services such as agricultural extension, animal husbandry and veterinary support services, soil testing, etc. are generally inaccessible.

c. In the areas affected with soil salinity farmers are dependent on low value crops and there is a need to introduce bio-saline agriculture.




Area Under Major Crops During the Last 20 Years in Thatta District
Cotton
Wheat
Rice
Sugarcane
Sunflower
Area in Hectares
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
1991-92
1992-93
1993-94
1994-95
1995-96
1996-97
1997-98
1998-99
1999-00
2000-01
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
Years

1. INTRODUCTION TO THE STUDY

1.1. Introduction to the Project and this Report

Government of Sindh started the reforms of the management of the entire irrigation system with the approval of SIDA Act 1997, shifting the responsibilities for the management of irrigation and drainage infrastructure from the governmental centralized provincial Irrigation and Power Department (IPD) to autonomous bodies: the Sindh Irrigation and Drainage Authority (SIDA), Area Water Board (AWBs) and Farmers organization (FOs). The Sindh Water Management ordinance 2002 replaced SIDA Act 1997. The immediate goal of reforms in Sindh is restore equitable and reliable water delivery to the farmers. The ultimate goal is, of course, the improvement of agricultural production. At present Sindh Irrigation and Drainage Authority (SIDA) is executing the World Bank funded Water Sector Improvement Project Phase – 1 (WSIP-I) The overarching objective of WSIP is to improve the efficiency and effectiveness of distribution of irrigation water in three Area Water Boards (Ghotki Canal AWB, NARA Canal AWB, Left Bank Canals AWB), particularly with respect to measures of reliability, equity and user satisfaction. This will be achieved by:

1. Strengthening and fast tracking the institutional reforms that are already underway in Sindh[1].
2. Improving the irrigation system in a systematic way covering key hydraulic infrastructure, main and branch canals, and distributaries and minors;
3. Enhancing long-term sustainability of the irrigation system through participatory irrigation management and developing institutions for improving operation and maintenance (O&M) of the system and cost recovery

The project also has a component[2] to support detailed studies and preparation of a Regional Plan for the area on the Left Bank of the Indus River, for rehabilitation and improvement of collection and safe disposal of drainage effluent, flood and storm water in the left bank of Indus, and rehabilitation of wetlands and the coastal zone; considering the environmental importance of the region and its economic potential drawing upon international experience. The various components of the WSIP-I project are shown in Table 1.1. A summary of the characteristics of the WSIP-1 project and its Preparation of a Regional Plan for the Left Bank of the Indus, Delta and Coastal Zone sub-project is given in Table 1.2.

Table 1.1: Components of the World Bank Funded WSIP-I Project

WSIP-I Component	Description of Component
A	Community Development and Capacity Building
B	Improvement of Irrigation and Drainage System
C	Management Plans for Major Irrigation and Drainage Infrastructure
	Preparation of Regional Plan to Deal with Floods & Drainage Issues on Left Bank of Indus River and Designing Measures for Improvement of the Indus Delta and the Coastal Zone [This Study]

1 Sindh Irrigation and Drainage Authority (SIDA) has established a total of 345 Farmer Organizations (FOs), in three Area Water Boards (AWB) - as legal entities under the Sindh Water Management Ordinance of 2002 (SWMO 2002)

2 The sub-component C-2 of SWIP-I deals with the provision of these studies

WSIP-I Component	Description of Component
D	Project Monitoring, Evaluation and Supervision of Environmental Management Plan
E	Project Coordination, Monitoring, Technical Assistance and Training

Table 1.2: Summary of Water Sector Improvement Project Phase-1 (WSIP-I) for the Lower Indus River Basin

Period	Sponsor	Project and component name	Abbreviation	Objective	Methodology
Dec 2007 – April 2013	World Bank	***Project***: Water Sector Improvement Project – Phase I[3]	**WSIP-I**	Improve the efficiency and effectiveness of distribution of irrigation water in three AWB[4]s (Ghotki, Nara and Left Bank), particularly with respect to measures of reliability, equity and user satisfaction.	(a) Deepening and broadening the institutional reforms that are already underway in Sindh; (b) Improving the irrigation system in a systematic way covering key hydraulic infrastructure, main and branch canals, and distributaries and minors; (c) Enhancing long-term sustainability of irrigation system through participatory irrigation management and developing institutions for improving operation and maintenance (O&M) of the system and cost recovery
April 2010 - April 2013		***Subproject***: Preparation of a Regional Plan for the Left Bank of the Indus, Delta and Coastal Zone	**RMP-LBG**	Prepare for the Government of Sindh (GoSindh) a regional master plan for addressing the flooding issues and providing proper drainage to the area on the left bank of the Indus River through	***Phase-I*:** Inventory and assessment of existing conditions and identification of issues and problems, preparation of a report that can form the basis of consultations with all stakeholders to reach an agreement on definition of issues and problems. ***Phase-II*:** Identification of solutions covering structural and non-structural options, and institutional and management measures and their technical environmental and social

[3] Project Implementing Agency is the Sindh Irrigation and Drainage Authority (SIDA)
[4] AWB are Area Water Boards – There are 345 Farmer's Organizations in three Area Water Boards in the Lower Indus River Basin

Period	Sponsor	Project and component name	Abbreviation	Objective	Methodology
				appropriate structural and non-structural measures, including remedial measures for any outstanding deficiencies in the Left Bank Outfall Drainage system, measures for retention and/or safe disposal of drainage, storm and flood water, improvement of wetlands in the delta area and in the coastal zone recognizing their environmental importance and considerable economic potential for the local communities.	feasibility, approximate cost, workability and ranking based on pre-feasibility level studies and analysis. ***Phase-III*:** Preparation of detailed feasibility including technical, economic, environmental and social viability and implementation/institutional arrangement for the solutions identified under Phase II as high priority. ***Phase-IV*:** Preparation of detailed designs and bidding documents for the most preferred solution for implementation according to the international standards and implementation manuals and institutional arrangements for non-structural solutions.

The regional plan is to be prepared in four study phases. The main focus of the – Phase-I, study is to prepare an inventory and assessment of existing conditions and the identification of issues and problems. This will form the basis of consultations with all stakeholders to reach an agreement on the definitions of issues and problems. This Phase-I study is also to cover issues related to the supply of water and management of drainage & waste water effluent, expected to be generated by the development of the Thar Coal mines and power complex in the future as planned by the government.

The Phase-I Report is to be finalized through extensive consultations with the population, water users and stakeholders in area on the Left Bank of the Indus River, Delta and Coastal Zones; and was to help identify and prioritize issues for which the solutions have to be developed during the following Phases of the study.

This document is the final Report for Phase-I Study and is the required first output of the project as discussed above.

1.2. Background to the Project

Sindh Province has a vast irrigation and drainage network and it is one of the primary beneficiaries of the Indus Basin Irrigation System of Pakistan (IBIS). The IBIS is considered as one of the largest contiguous irrigation systems in the world. Of the total 14 barrages of the IBIS, Sindh has three major barrages on the Indus River that divert approximately 48 million acre feet MAF (59.0 billion cubic meters- BCM) of water annually to the 14 main canal commands in Sindh Province. These canal systems have an aggregate length of 13,325 miles (21,445 Km), which serve a gross command area (GCA) of 14.391 million acres (5.8 million ha). There are also about 42,000 watercourses (tertiary channels), which have an aggregate length of about 75,000 miles (120,000 Km). The water diversion in the study area (Table 1.3) is approximately 11.6 MAF for eight canal commands.

Table 1.3: Major Barrages on the Indus River in Sind Province

Barrage Name	Nearest city	Year constructed	Diversion Quantity Left Bank (MAF)
Guddu	Ghotki	1962	3.484
Sukkur	Sukkur	1932	5.532
Kotri	Hyderabad	1955	2.577

A plan showing this extensive barrage, canal and drainage system is shown in Figure 1.1

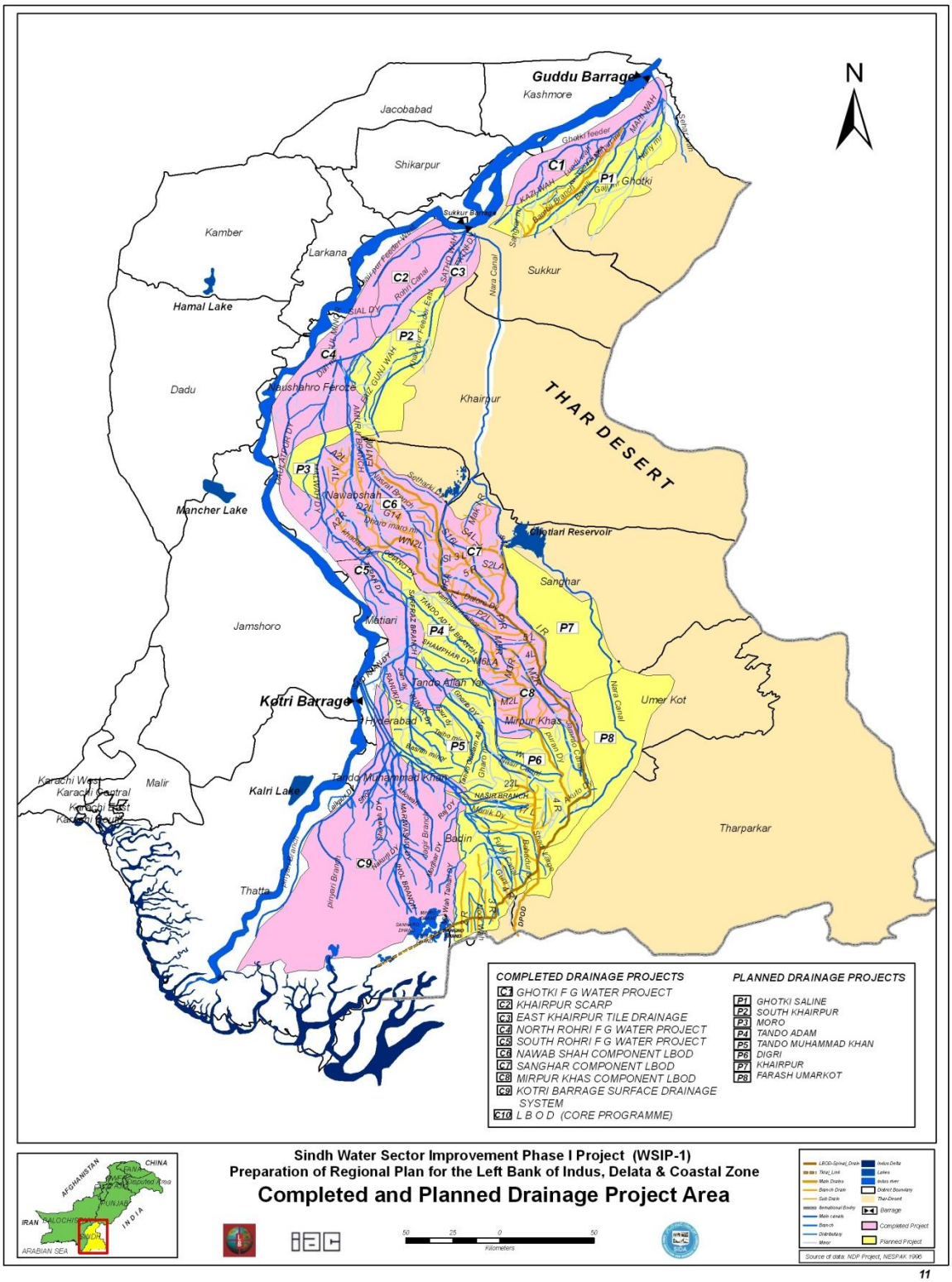


Figure 1.1: Plan of the Barrage, Canal and Drainage system of Lower Indus Region

1.2.1 Salinity and waterlogging

Around 78% of the area in Sindh Province is underlain by saline groundwater which is unsuitable for irrigation and other uses. Surface and sub-surface drainage systems are inadequate, resulting in much of the drainage effluent being either retained in the basin or disposed of into rivers, canals,

and through a drainage network. There are 13 existing surface drainage systems in Sindh, which serve a total area of over 6.2 million acres (2.5 million hectares) and have an aggregate length of about 3.8 thousand miles (about 6.1 thousand Kms). In addition, there are two sub-surface drainage systems, which serve an area of 0.10 million acres (0.04 million ha).

Due to an inadequate drainage network and the flat topography of the basin, nearly one-fifth of the canal command area is affected by water logging and salinity – widely referred to as the *twin problems* or *twin menace*. A map showing the surface areas of water logging and salinity is given in Figure 1.2.

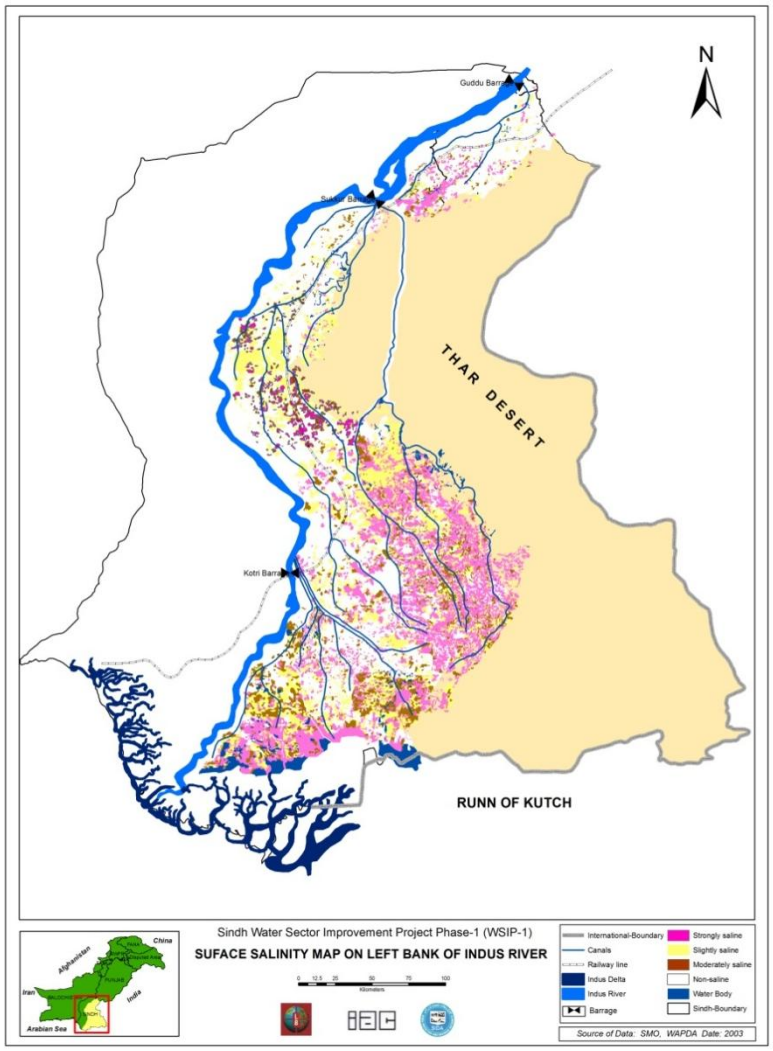


Figure 1.2: Waterlogging and Surface Salinity Status Left Bank of Lower Indus Region

To address the problems of water logging and salinity in the Left Bank of the Indus River, the Left Bank Outfall Drain (LBOD) was constructed. The LBOD collects drainage water from the three districts of Sukkur Barrage command area (Shaheed Benazirabad, Sanghar, and Mirpurkhas) and drains to the sea through a Tidal Link drain constructed as part of the LBOD project. LBOD has performed well and the upper part of the LBOD area has benefited from the drainage. However, there are several issues unresolved in the outfall area and coastal zone.

A chronological history of the development of irrigation and drainage, and a genesis of the salinity and drainage problems in the study area is given in Vol-II Thematic area 4.2, Table 4.1.2. These twin problems, combined with increased development in the region, demand the preparation of a

comprehensive Regional Plan for the handling of flood and drainage problems of the area on the left Bank of the Indus River, the River Delta and its Coastal Zone.

1.2.2 Project/Study Area

The project study area includes all areas in Sindh Province lying on the Left Bank of Indus River, including the river delta, associated wet lands, and adjacent coastal zone. In particular, it covers the irrigation areas served by the Indus River canals off-taking from the left bank of Guddu, Sukkur and Kotri barrages; the area covered by the Left Bank Outfall Drain (LBOD), and its catchment and backwash areas.

The delineation of the project areas for the study is shown in Figure 1.3.

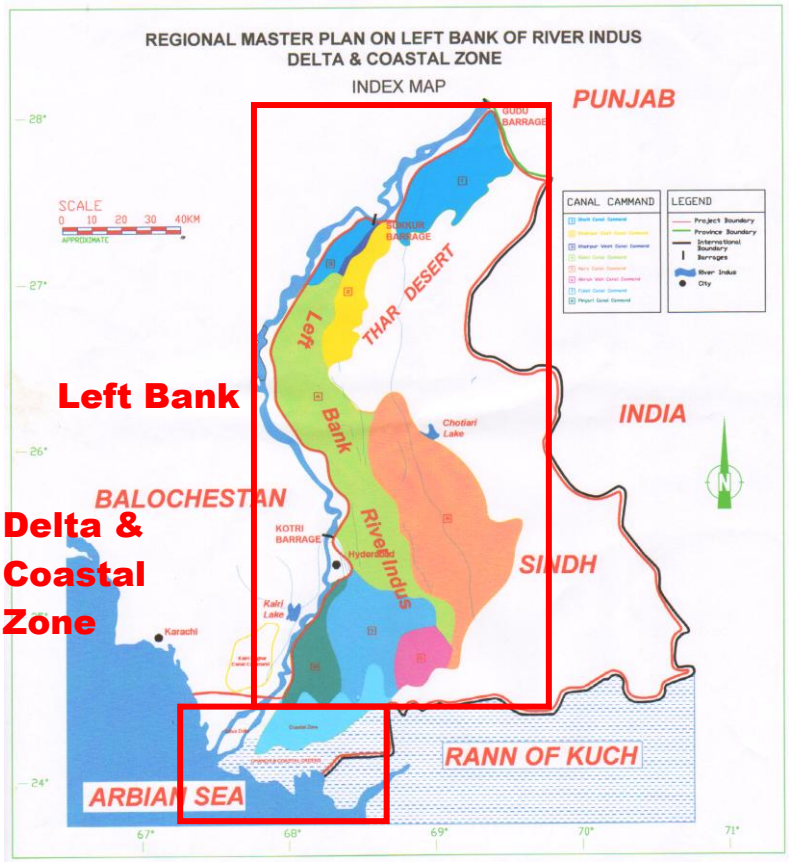


Figure 1.3: Map Showing the Study Area: Left Bank of Indus, River Delta and Coastal Zone

Originally it was expected that it would be possible to consider the Indus River Delta and Coastal Zone separately, and to develop different Phase-I issues and problems for the two areas. However the complex nature of the morphology and the interaction of tides and river morphology in the two areas shown in Figure 1.4a and 1.4b make it impossible to separate out drainage and flooding effects in the Delta and Coastal Zone. For this reason, the two areas are taken as one morphologic regime in the study.

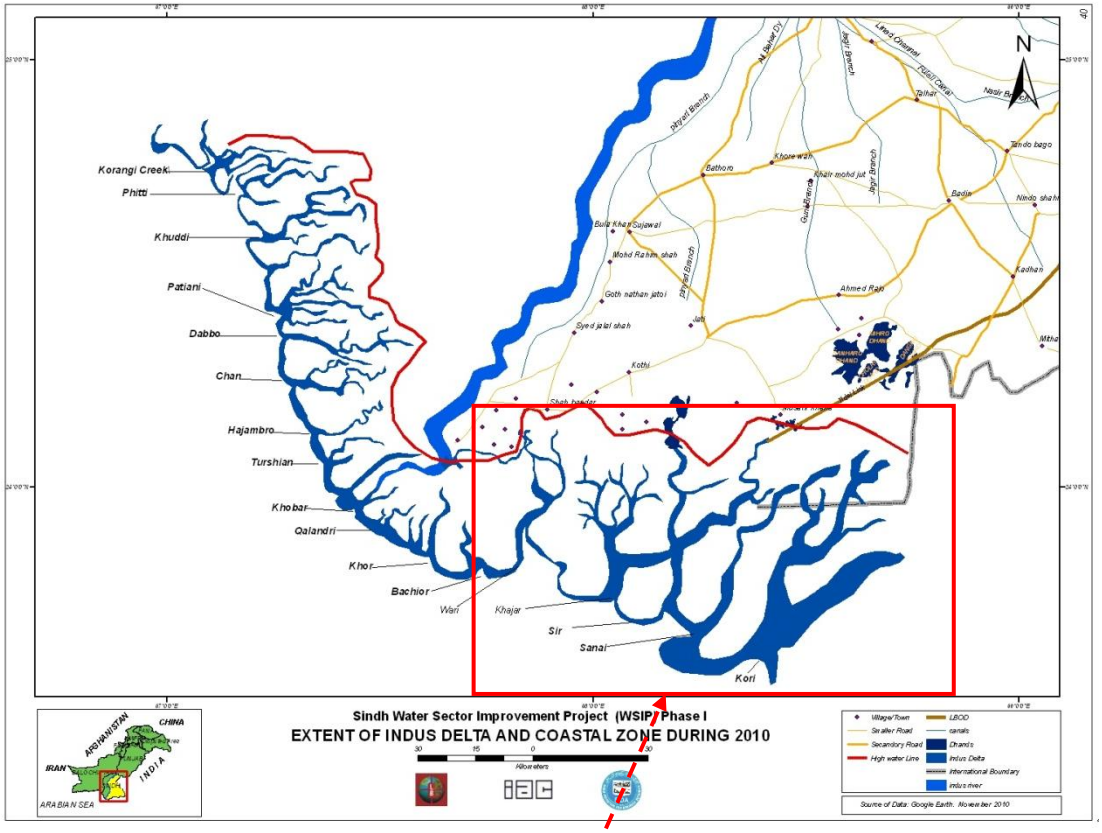


Figure 1.4a: Extent of Indus River Delta and Coastal Zone in the Study Area

Figure 1.4b: Google Earth Photo of Indus River Delta and Coastal Zone in the Badin Study Area

1.3. Objectives and Scope of Work

1.3.1 Objectives

The objective of consultancy services is to prepare for the Government of Sindh (GoSindh) a Regional Plan for addressing the flooding issues and providing proper drainage to the area on the Left Bank of the Indus River - including the River's Delta and Coastal Zone - through appropriate structural and non-structural measures, including remedial measures for any outstanding

deficiencies in the Left Bank Outfall Drainage (LBOD) system; measures for retention and/or safe disposal of drainage; storm and flood water; improvement of wetlands in the delta area and in the coastal zone; recognizing their environmental importance and considerable economic potential for local communities.

These studies have been carried out in consultation with the stakeholders starting from the beginning to the end of the process covering the identification of the issues, and an analysis and indicative design of solutions. The work has been performed in a phased manner. Each phase was conducted through consultations and shared understanding with the stakeholders leading to key decision necessary for carrying out further work under subsequent phases of the study.

1.3.2 Phased investigation

The assignment was designed to be performed in four phased studies as defined below:

***Phase-I*:** Inventory and assessment of existing conditions and identification of issues and problems, preparation of a report that will form the basis of consultations with all stakeholders to reach an agreement on definitions of issues and problems. This will also cover issues related to supply of water and management of drainage & waste water effluent expected to be generated by development of the Thar Coal mines and power complex in the future as planned by the government. The Phase-I report will be finalized through extensive consultations with the population, water users and stakeholders in area on the Left Bank of the Indus River, delta and coastal zones; and should help identify and prioritize issues for which the solutions have to be developed during the Phase-II study.

***Phase-II*:** Identification of solutions covering structural and non-structural options, and institutional and management measures and their technical, environmental and social feasibility, approximate cost, workability and ranking based on pre-feasibility level studies and analysis. Development of a comprehensive Regional Plan to address the problems of flooding and drainage composed of an optimal mix of improved structural, non-structural, institutional and management measures selected to enhance developmental objectives in the study/project area. This phase will also include consultations with stakeholders in order to identify solutions for which detailed feasibility is to be carried out under Phase-III studies.

***Phase-III*:** Preparation of detailed feasibility including technical, economic, environmental and social viability and implementation/institutional arrangements for the solutions identified under Phase II as high priority. This phase will also result in consultations based on the feasibility studies, and identification and prioritization of structural and non-structural solutions and their ranking for which detailed designs will be prepared.

***Phase-IV*:** Preparation of detailed designs and bidding documents for the most preferred solution for implementation according to international standards and implementation manuals, and institutional arrangements for non-structural solutions.

1.4. Summary of the Project

The key components of the Regional Plan Study are given in Table 1.4. In addition, the following requirements of the project Terms of Reference were followed in undertaking all aspects of the study:

1.1. The Client for the Regional Plan is the Government of Sindh, and all of its administrative components. However implementation of the Regional Plan is to be designed and to be implemented by a wide range of actors and civil society.

1.2. The beneficiaries of the Regional Plan are the populations on the Left Bank of the Indus River; and the population in the Delta and Coastal Zone. Other areas in Sindh, including the Right Bank of the Indus River, were not part of the study area.

1.3. The development sectors that the Regional Plan was to focus on are drainage and flooding only. Other development sectors such as irrigation and or social sectors are being considered in other components of the WSIP-I and are not a part of the Master Plan study.

1.4. Particular interest is to be directed to the assessment of deficiencies in the Left Bank Outfall Drain System (LBOD). This was further divided into assessment of drainage collection, drainage conveyance and drainage disposal.

1.5. The study considered combined collection, transport and disposal of both drainage water and excess flood water. This is similar to studies in urban areas where combined collection of waste water and storm water require remediation before the combined polluted water flow can be safely discharged to existing water courses.

1.6. Particular attention was directed to improvement of the wetland environment in the Indus River Delta and Coastal Zone.

1.7. Any remedial measures selected to address issues and problems were to include both structural and non-structural options

1.8. The study was based on an assessment of Issues and Problems; to be followed by proposed Options and Solutions.

1.9. All work efforts were to be based on extensive consultations with stakeholders: i) to identify issues and problems; ii) to analyse options and solutions; to design remedial measures;

Consultations and a shared understanding with stakeholders were required before work on a primary phase of the study could be completed; and the successive phase of the study could be started.

Table 1.4: Summary of Study Requirements

Study Characteristic:	Study Requirement
Client:	Government of Sindh Province
Beneficiaries:	Sindh Province: 1. Population on Left Bank of Indus River 2. Population of Delta and Coastal Zone
Sectors to be considered:	1. Drainage 2. Flooding
Executing Agency:	Planning & Development Department, Government of Sindh Province
Implementing Agency:	Sindh Irrigation and Drainage Authority
Sponsor:	The World Bank

1.5. Scope of the Phase-I Study

1.5.1 Expected Phase-I Output

As stated above, the scope of the Phase-I study was an inventory and assessment of existing conditions and the identification of issues and problems, through preparation of the Phase-I report to be finalized through extensive consultations with the population, water users and stakeholders in area on the Left Bank of the Indus River, delta and Coastal Zone; and to help identify and prioritize issues for which solutions have to be developed during the Phase-II study.

The Phase-I study was to also cover issues related to supply of water and management of drainage & waste water effluent expected to be generated by development of the Thar Coal mines and power complex in the future as planned by the government.

1.5.2 Terms of Reference for Phase-I study

The detailed Terms of Reference for work preformed for the Phase-I study are given in Table 1.5. All studies were focused on the study area of the Left Bank of the Indus, the Delta and the Coastal Zone making up a major part of the Lower Indus Basin in Sindh Province.

Table 1.5: Detailed Description of Questions Considered in Phase-I Study

Task No.	Task Description
Task I-1	Document, review and examine all available reports on comprehensive planning in the project area (Left Bank Indus, Delta and Coastal Zone)
Task I-2	Review and examine rain water harvesting and storage of storm water in Dhoras[5]
Task I-3	Document, review and analyze reports and research on seawater intrusion into surface water and ground water
Task I-4	Document, review and evaluate systems of data collection, processing and analysis for comprehensive water use planning and irrigation water deliveries, drainage, flood management and planning
Task I-5	Document and review causes of deforestation and strategies for reforestation
Task I-6	Document and review climatic conditions, major hydrological events and meteorological events that have impacted flooding and drainage
Task I-7	Document major water structures and review their role in water resources and irrigation/drainage planning and flood management
Task I-8	Describe and analyze physical resources in the study area (soils, climate, surface water, ground water, existing irrigation and drainage, land use, vegetation, biology and other)
Task I-9	Analyze the potential impacts of climate change on a flood management master plan
Task I-10	Document the location, extent and adequacy of existing infrastructure in the study area (roads, utilities, market, water diversion facilities, schools, health facilities and other
Task I-11	Study, document and analyze options for supply and disposal of water to and from the Thar Coal area
Task I-12	Determination of human resources, farm size, etc. and socio-economic surveys for the project area

[5] Old natural depression lakes

Task No.	Task Description
Task I-13	Review and analyze the performance of on-going and completed projects for incorporation into the proposed master plan
Task I-14	Review the institutional, technical and physical capacity of provincial agencies associated with irrigation and drainage [and flood management]
Task I-15	Evaluate the capacity of local institutions (NGOs) to implement components of the master plan
Task I-16	Prepare maps showing key features in the study area (water systems, road networks, drainage networks, water logging, salinity and others)
Task I-17	Map all settlements and collect key data in the coastal and delta areas
Task I-18	Document and review poverty and vulnerability assessments in lower Sindh; including coastal and delta areas
Task I-19	Evaluate and recommend methodologies for alleviating poverty and improving livelihood based on landlessness and decreasing land entitlements
Task I-20	Develop implementation arrangements and monitoring and evaluation (M&E) methods for livelihood activities in coastal and delta areas
Task I-21	Document, review and evaluate methods for flood management and O&M for the river basin
Task I-22	22: Review and evaluate current methodologies for disaster management and develop procedures for managing disasters
Task I-23	23: Document and assess socio economic goals, objectives and principals for the formulation of flood management options
Task I-24	24: Carry out an evaluation of how to manage the minimum required quantity of Indus water to pass through the Kotri Barrage
Task I-25	25: Document, review and analyze research and studies on coastal mangroves
Task I-26	26: Review research studies and plans to understand the impact of development of the ecosystem,
Task I-27	27: Review and analyze the water quality of ground and surface water on the Left Bank of the Indus
Task I-28	28: Collect and analyze data on how the population of the left bank of the Indus is influenced by industrial affluent and how water quality can be improved
Task I-29	29: Review and identify the sources of water pollution, and declining quantities and quality of surface and ground water
Task I-30	30: Study potential impacts of the fault line and earthquakes on structural and non
Task I-31	31: Develop a methodology and plans for public participation with stake holders
Task I-32	32: Design the intervention to adequately share with all key stakeholders
Task I-33	33: Report on the analysis and its identification of major and high priority issues
Task I-34	Carry out consultations, with local and provincial/national workshops, to finalize the Phase-I study report and to develop a shared understanding of issues that should be addressed in subsequent stages of the study

1.5.3 Functional Grouping of Individual Phase-I Study Tasks

The results of the work performed for Phase-I are conveniently grouped into eight thematic areas presented in chapter 4 of this summary report. Thirty two tasks were grouped into eight thematic

areas and two tasks were grouped into atlas. Each topic covers several subjects and includes several tasks as presented in Table 1.6. Each of the nine topics discusses a separate area of concern in the two target sectors of the study – drainage and flooding.

Table 1.6: Topic Outline for Summary of the Task-I Study

Topic of Concerns for Phase-I Task Studies

Subjects Covered	Phase-I Tasks Included
I – Overview and Development of Planning for Drainage and Flooding	
✓ Planning studies ✓ Background to the problems of drainage and flood management ✓ Data collection ✓ Consultations and workshops	T-1: Document and review all available reports T-4: Document and evaluate planning studies T-33: Report on identification of issues and analysis (This report)
II – Water Resources and Water Usage for Drainage and Flooding	
✓ Rain water harvesting ✓ Delta and coastal zone problems ✓ Storm water retention and reuse after flooding	T-2: Review and examine rainwater harvesting and storage of storm water usage T-11: Study and analyze options for water supply to Tar Coal Field
III – Impact of Drainage and Flood on Environment And Wetlands	
✓ Salt water intrusion ✓ Deforestation ✓ Soil, climate, surface water, and ground water resources ✓ Land use ✓ Vegetation ✓ Biological resources ✓ Water quality ✓ Mangroves ✓ Lower Indus River Basin ecosystem ✓ Down stream conditions below Kotri Barrage ✓ Ground water quality ✓ Surface water quality ✓ Industrial effluents ✓ Ground water pollution ✓ Surface water pollution	T-3: Document, review and analyze research on sea water intrusion T-5: Document and review deforestation and strategies for reforestation T-8: Description and analysis of physical resources T-9: Analyze potential impacts of climate change T-24: Evaluate quality of Indus River water T-25: Document research on mangroves T-26: Review studies and plans for development of Indus eco-system downstream of Kotri Barrage T-27: Review and analyze information on groundwater and surface water quality T-28: Evaluate how population is affected by industrial pollution T-29: Identify sources of ground water and surface water pollution
IV – Water Disaster Management and Mitigation	
✓ Disaster management ✓ Water disaster and flood management ✓ Year 2010 super-flood lessons learned ✓ Climate, hydrology and meteorology ✓ Salt water intrusion ✓ Deforestation	T-6: Document and review climatic conditions, hydrological and meteorological conditions T-21: Document, review and evaluated methods and planning for flood management T-22: Review and evaluate current methods for disaster management. T-30: Study the impact of faulting and earthquakes on the study area

Topic of Concerns for Phase-I Task Studies

Subjects Covered	Phase-I Tasks Included
✓ Earthquakes and faulting	
V – Structures for drainage and Flood Protection	
✓ Irrigation structures ✓ Drainage structures ✓ Flood protection structures ✓ Operation and maintenance (O&M)	T-7: Review water structures and drainage structures planning and management T-10: Document extent and adequacy of infrastructure T-13: Review and evaluate the performance of existing and on-going structures
VI – Overview of Current Agriculture, Livelihood, and Economic Aspect of Drainage & Floods	
✓ Overview of Agriculture Sector and description of socioeconomic conditions ✓ Framework for improvement of livelihoods and its implementation in the delta and coastal area, and ✓ Socioeconomic goals of flood management	T-12: Determination of human resources, farm size, etc. and socio-economic surveys for the project area T-19: Landless and poverty nexus and methods for improving livelihood opportunities in the delta and coastal area T-20: Implementation arrangements for improving livelihood activities in the delta and coastal areas. T-23: Socio-economic goals of flood protection
VII - Social Issues from Drainage Operation and Flooding	
✓ Stakeholder consultations ✓ Stakeholder interventions ✓ Poverty	T-18: Document and review poverty assessments in lower Sindh T-31: Develop methodology and plan for consultations with stakeholders T-32: Design interventions with key stakeholders T-34: Carry out consultations, with local and provincial/national workshops, to finalize the Phase-I study report and to develop a shared understanding of issues that should be addressed in subsequent stages of the study
VIII – Review of Capacities of Provincial Agencies Involved in Execution of The Irrigation and Drainage Project and its Management	
✓ Human resources ✓ Physical capacity	T-14: Review institutions, technical and physical capacity of provincial agencies T-15: Evaluate the capacity of local institutions to implement the Regional Master Plan
Atlas – GIS and Mapping for Drainage and Water Disasters	
✓ Physical resources ✓ Physical location ✓ Settlements	T-16: Prepare maps showing key features T-17: Map all settlements in WSIP-I project area

2. METHODOLOGY AND APPROACH TO PHASE I OF THE REGIONAL PLANNING PROGRAM

A central point in the preparation of the WSIP Regional Plan is preparation of the Plan in consultations with communities and other major stakeholders. One of the key '*lessons learnt*' (see PAD, WB, 2007) has been to make participatory approaches to development crucial to the Project design and social consideration. Participatory approach is considered fundamental to the short and long-term success of this Project. Genuine participation and involvement from the community and other relevant stakeholders is essential throughout the planning and design process.

2.1. Methodologies and Approaches Used to Address Eight Thematic Areas

Five structural and non-structural requirements are to be addressed in the course of preparation of a Regional Plan for the Left Bank of the Indus River, Coastal Zone and Delta. The Plan is to address: 1) flooding along the LBOD and Indus River and intrusion of seawater in the Coastal Zone, 2) potential measures for rehabilitation of the LBOD system, Dhands and Tidal Link, 3) ongoing structural and non-structural programs and identify additional project needs, 4) conditions, perceived and real, in the countryside with respect to government engagement in water delivery, water quality, agriculture, fisheries, poverty, livelihoods, health and general welfare, and 5) determine institutional arrangements for effective management of water delivery, maintenance of drainage, flood operations and disaster response.

Problems and Issues associated with each objective requirement were to be explored during repeated consultations with stakeholders at all levels of society through surveys, interviews, workshops, and field reconnaissance. Thus during Phase I of the project, consultation with the communities and other major stakeholders, surveys and interviews were carried out across the region after careful design and confirmation by the Client. Additionally field surveys were carried out for observation of conditions and for collection of basic data to provide perspective to the positions of stakeholders while recognizing that some are well informed and the opinions of some are fanciful.

2.2. General Approach to the Studies

To address the diverse requirements and outcomes required in the 34 tasks of Phase-I of the Project, the consultant grouped 32 tasks under eight themes and 2 tasks in atlas and carried out the work of each thematic area according to the adopted general approach and methodology as adapted to each specific theme. Application of the general approach was conducted as follows:

1. Planning process
2. Secondary data collection, revision and critical evaluation and analysis
3. Primary data collection, revision and critical analysis
4. Collation of findings and identification of resultant problems and issues for presentation to stakeholders.

Each of Consultant's specialized sub-teams planned the activities and approaches according to the particular tasks assigned to the sub-team. Sources of required data were identified, followed by informational meetings with relevant departments; reconnaissance surveys and specially developed interaction with communities and other major stakeholders. Planning was concentrated around the major objective – documentation and analysis of current conditions and identification of issues and problems related to the Project.

2.3. Methodology for Planning Studies

Each major study was planned according to the objectives of the particular study. Generally, all studies and approaches followed the main criteria outlined as follows:

a) Identifying existing legal, budgetary and other official documents

b) Identifying existing relevant studies/reports/maps

c) Identifying different parameters/indicators, ideas and applications used in the studies/reports

d) Identifying the main methods and techniques used in the analysis and design of the reports

e) Understanding and rationalizing the significance of the problems, solutions and structures

f) Synthesizing and developing our own professional judgement including through visits to and inspections of areas that have been impacted by floods, seawater intrusion, contaminated drain water and where water shortages prevail.

g) Developing appropriate approach, methodology and tools

2.3.1 Secondary Data Collection, Revision and Critical Analysis

In accordance with the outlined planning criteria, the Consultant collected, reviewed and analysed extensive secondary data, publications consulted are listed in the bibliography. Each study/task required review of selected literature, relevant reports and existing studies as well as contacts with relevant agencies and organizations involved in the specific area.

The first step was identification of stakeholders for each area of interest and introductory meetings with them during the process of data collection. These included beneficiaries, affected communities, NGOs working in respective areas, and local influential people. Government line department officers were contacted at the Meteorological Department, Forestry Department, Coastal Development Authority, Agricultural Department, Cane/Production Managers of Sugar Mills, civil society representatives, AWBs, CBOs, FOs, WUAs, Abadgar Water Board, Environmental agencies, representatives and technocrats including personnel from PCMU, SIDA, IPD, WAPDA and Water Experts, just to name a few.

Information about relevant organizations and NGOs were assessed through the local networks and the internet. Follow up for information was accomplished by visits and telephone and email contacts. Personnel, equipment and transport capacities and legal and financial standing of NGOs were secured for use during implementation to facilitate short listing. The Consultant established a database of relevant NGOs working in the Project area.

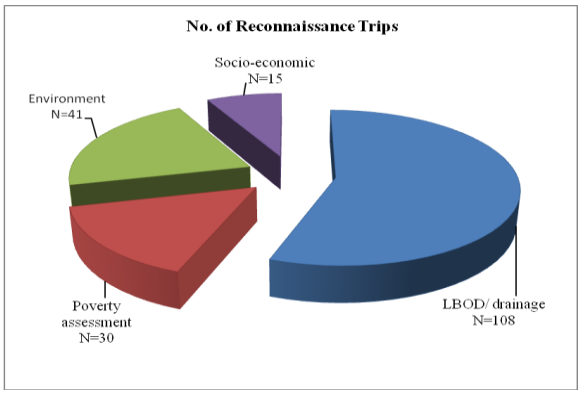
The next step was collection of data (reports, literature, maps, data on rainfall, water table depth, relevant revenue, provincial budget, Barrages, head regulators, drains, canals, irrigation, available statistics on population and economic indicators etc). Library resources of SIDA and local universities were accessed. Information gained was complemented by the Web search on various components of the set tasks such as environmental and wetland problems of the Project area, pollution of surface and underground water, socioeconomic and poverty characteristics of the Project area, flood etc. Each Consultants sub-team gained considerable information and perspective through revision of these documents and reports.

Revision of literature and other relevant data were assessed and used for further planning by each Consultant's sub-team. It formed a solid base for familiarization with and understanding of the

Project area and relevant components of the Regional Plan Phase I. In addition, it served as the base for a variety of specific assessments, critical analysis and evaluations of existing situation, identifications of strengths and gaps of relevant past and ongoing projects and other relevant structural and non-structural interventions in the Project area. Furthermore, the secondary sources were of the utmost importance for identification of the core issues as well as for setting the appropriate communication strategy and methodological tools for interaction with communities and stakeholders.

2.4. Primary Data Collection, Revision and Critical Analysis

The primary data collection encompassed a few layers of actions which are not strictly conducted in the presented order, but rather simultaneously or overlapping. Primarily, each Consultant's sub-team planned and conducted reconnaissance field trips. There were almost 200 such trips during the Phase I of the Project. Each reconnaissance trip conducted had a specific aim corresponding to the sub-team's assigned tasks.



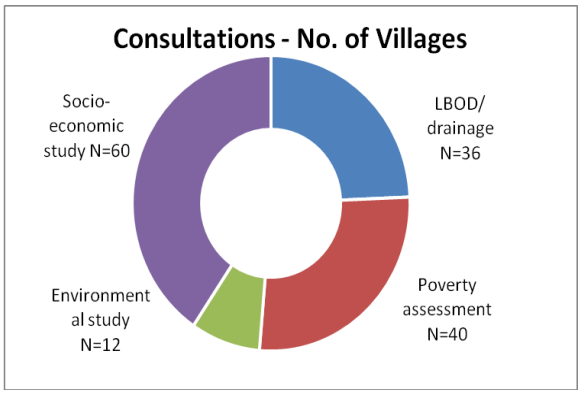
One of the major steps in collection of primary data was consultations with communities and other major stakeholders. In order to access communities and stakeholders, the Consultant prepared a communications strategy. The brief outline of the communication strategy is presented in the Thematic Area 7.

2.4.1 Community Consultations Approach

The main objective of this phase of the Project was to **identify, together with communities and relevant stakeholders, Project relevant issues/problems.** In accordance with this objective data collection and analysis required a primarily qualitative approach. In addressing the tasks and objectives stated in the Terms of Reference, the Consultant formulated a methodology that would realistically cover the issues relevant in the Project area. The large geographical area is diverse and complex with a multiplicity of issues. Thus, a multi-dimensional methodological approach, with a variety of methodological tools, was adopted for the consultations and assessments regarding the environmental, poverty, socioeconomic and other task-related requirements.

2.4.2 Sampling Design and Sample Size

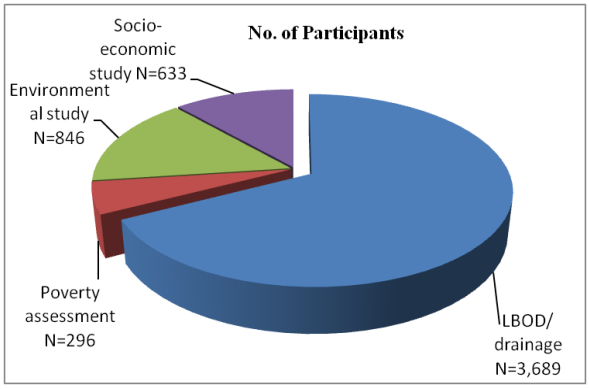
A feature of qualitative sampling is that a small number of cases are sampled. The aim is to collect data that provides in-depth view for understanding Project related issues as seen through the eyes of the affected people. The corresponding sample methodology involved non-probability sampling as it did not aim to produce a statistically representative sample or draw statistical inference. The targeted phenomenon/issue needs only to appear once in the sample.



In order to fairly cover the whole Project area, a purposive sampling within a multi-dimensional approach was considered as one of the most applicable approaches to address the aims of the defined tasks. The combination of methodological tools (triangulation) enabled reasonable insight into communities' perceptions about contemporary problems, causes of the persisting poverty and problems and community concerns and suggestions about the effects of Project related issues on their livelihoods. In total, 36 out of 61 identified villages were chosen to comprise the sample for the LBOD/Drainage issues/problems study. The selection of a sample village within identified villages was determined according to issues prevailing in each area.

All eight districts in the Lower Sindh are included in the consultations on poverty. Based on adopted criteria rural Union Councils in each district were identified with the help of stakeholders, UC offices and local NGOs. One Union Council in each district and one Deh in the Union Council were selected randomly to comprise sample. Representatives from each village in a sampled Deh participated at consultations. Overall for assessment poverty, 40 villages from the area were consulted.

The approach and methodology adopted for the socioeconomic study included: review of past and ongoing project documents and studies, compilation and analysis of secondary data, and findings from the focus group discussions in the randomly selected communities of the Study area, both, where drainage works are in place and where they need to be extended. Relevant published data was collected, collated and analyzed.



The field survey has been conducted to map out the prevailing socioeconomic conditions in the command area of the left bank of Indus River. Two areas were delineated, namely, 1) area served by completed drainage projects implemented under various programs, such as SCARPs, LBOD Stage-I, and NDP, referred in this report as Zone A; and 2) areas that are planned and or being considered for extension in the future, referred hereafter as Zone B.

Distributaries or minor canals were randomly selected in each of the sub regions. Three watercourses, one each in the three reaches, head, middle, and tail, also were randomly selected. In addition, three villages were randomly selected in the delta/coastal zone. Out of the 60 selected villages, 36 are in Zone A, while 24 are in Zone B, including three villages in the coastal zone.

Village profiles were prepared for each of the selected settlements based on focus group discussions held at each village. The discussions were attended by beneficiaries in villages served by existing drainage projects and intended beneficiaries in the villages that are expected to be served by planned projects. The discussion centered on a structured checklist, and some open ended questions to solicit their perceptions about the performance of the completed projects.

2.4.3 Stakeholder Consultations

There are 3,259 villages/settlements in the Project area (UNOCHA 2010 and PCO). The Consultant accessed 148 villages, which represent around 4.5% of the sample universe. Each of the fifteen Project area districts and each of the three Area Water Boards were represented in the consultations on the Project issues and problems.

To ensure full and equal involvement of men and women of all ages, backgrounds and social status during the consultations, especially with respect to activities which directly affect individual lives and lives of their communities, multi-dimensional approaches were used for planning and conduct of consultations. The consultations were conducted at five levels:

1. Grassroots level – 148 villages
2. District level – 15 districts
3. Area Water Board level – 3 Area Water Boards
4. Regional level – Left Bank, Indus Delta and Coastal Zone of Sindh
5. National level

Overall, the Consultant conducted community consultations on LBOD/drainage issues and problems in 36 sample villages, 40 villages in the Lower Sindh were consulted on poverty issues, 60 on economic and livelihood issues and 12 on environmental issues. (Table 4.7.2) Moreover, the Consultant made almost 200 reconnaissance trips across the Project area. More than 300 different organizations, NGOs, CBOs and others, were represented at consultations and over 5,000 stakeholders were directly consulted in the first phase of the Project. The area directly accessed by consultations represents over 300,000 inhabitants.

The consultations with stakeholders and affected communities included the following methodological tools: workshops with stakeholders, open community consultations with sample village population, focus group discussions, key informant interviews, informal interviews, observation and established system for feedbacks and continuity of the stakeholders' involvement.

2.5. Flooding along the LBOD and Indus River and Intrusion of Seawater in the Coastal Zone

Among important studies reviewed was the 2009 feasibility report of NESPAK, ACE and DMC which presented alternatives for rehabilitation and rationalization of flood capacities of LBOD components for protecting large areas of the coastal area through a program for construction of bunds and structures.

This review was followed up by visits of engineers and agriculturalists, economists, environmentalists, and fisheries, forestry and other specialists of the team who visited the Indus River downstream of Kotri, Coastal Zone, the Tidal link, the Dhands and the LBOD/DPOD/KPOD channels. Separate visits and surveys were made by engineers and GIS specialists to establish high water marks and to measure depths of inundation of the several types of flooding including that caused by rainfall, high wind-driven tides, and breaches and over bank flooding along the Indus River and the LBOD. Observations of these engineers and scientists will be used to quantify and confirm validity of local stakeholder and community perceptions as presented during visits, interviews, workshops and other local consultations.

2.5.1 Review of On-going and Indicated New Projects and Programs, Structural and Non-structural

Initially reports of feasibility, design and construction of facilities were accessed through WAPDA and IPD for assessing the direction of on-going construction programs and the features of completed programs and projects. Current status of facilities including structures, channels and tubewells were assessed through visits to and the securing of data from subdivisions of IPD and from SIDA. Issues, problems and deficiencies identified will guide the preparation of prefeasibility studies during phase II.

2.5.2 Water Quality and Availability and Agriculture, Fisheries, Poverty, Livelihoods, Health and General Welfare

The approach and methodology to determine problems and issues associated with general welfare in the countryside is detailed at length due to its systematic approach with scientific overtones. Details are provided in the report sections above under the headings, "primary data collection" and "consultations".

2.5.3 Institutional Arrangements for Effective Maintenance and Management of Water Delivery, Drainage, and Flood Protection Works and Disaster Response

Initially identified were the two agencies that: 1) will determine the success or failure of the Reform Program begun in 1995 with enactment of the SIDA Act and 2) are involved in operation, maintenance, and management (OM&M) of canal and drain systems and management of flood works and floods affecting the left bank area of the Indus River. The two responsible agencies are IPD and SIDA and its two operating units, AWBs and FOs.

Public records including the Provincial Budgets for IPD, SIDA, and Land Reclamation, 2009-2010 and 2010-2011, were analyzed to assess personnel and mechanized capacities for maintenance, operation of canals and drains and for flood protection and remediation.

RSPs and NGOs are involved in the largely non-structural activities associated with programs that address social, economic, and cultural conditions that prevail in irrigated areas and the Delta and Coastal Zone. These entities were initially identified through registries and were assessed through the internet. Follow up was accomplished by visits, telephone and email contact. Personnel, equipment and transport capacities and legal and financial standing of NGOs were secured for use during implementation to facilitate short listing.

3. CONSOLIDATED DRAINAGE AND FLOOD SUBSECTOR ISSUES AND PROBLEMS: VOICES OF THE STAKEHOLDERS

3.1 Introduction

This chapter presents a summary of major issues and problems related to the collection, disposal and management of drainage effluent, flood and storm water, its impact on the quality of life of communities, their livelihood, environment, and need for preventive, mitigation, and corrective measures to be considered in the future planning of structural and nonstructural interventions and investment (including execution and implementation of any rehabilitation, extension, construction, and management). Based on the ToR for the Study in hand, one of the main outputs of the Phase I of the Study is the documentation of perceived issues and problems related to the subsector and documented in various earlier studies, and most importantly, as perceived by the stakeholders at large, representing their apprehensions, threats, and aspirations.

3.2 General Approach

To accomplish this, the Consultants made an extensive review of various documents and reports, and conducted a series of extensive stakeholder consultations through interviews with knowledgeable people, interacting with rural populace during field visits, conducting discussions with focus groups, male and female, in the villages, undertaking case studies, and district and subregional level workshops. The consultation covered about 148 villages and was attended by more than five thousand participants. The location of these villages is depicted in the attached map 3.1.

Although the Consultant's ToR focus exclusively on drainage and flood issues, the Consultant have included issues and problems not explicitly related to drainage and flooding. The consideration is based on the stakeholder's disbelief that anyone would consider their opinions at all and their pleas to pass their opinions to the relevant authorities. In areas where some consultations with stakeholders were conducted in the past, the stakeholders stated that no value was given to their opinions and suggestions. People do not believe that any of their suggestions will be considered at all.

> '*There has never been any program of consultation like this before because you came for the first time in our village. If some officers come, they meet only a big person of the village and go back. They never consulted us on such important issues' (Sahib Khan Lund village, Ghotki)*
> *'We don't have big hopes that you will solve our problems but we are happy that at least someone came to us for consultation on important issues related to our lives'. (Tig village, Ghotki*)
> *(Unedited in their own words)*

Considering that this document is to be shared by all the stakeholders, particularly rural communities, it is felt that it has to respect the participating stakeholders desire, therefore the consultants have also included stakeholder's concerns related to overall agriculture, water management, and socioeconomic issues and problems.

The documented voices of the stakeholders, particularly marginalized stakeholders, are an important feedback that needs to be considered in the planning cycle. Continued stakeholder participation would dispel any misconception, ward off any negative misperceptions, create confidence between target communities and planners, executing, implementing, and managing institutions, and most importantly will create a sense of ownership. The target beneficiaries should not be seen as passive beneficiaries, but as partners in the development process.

3.3 Summary Findings

Issues and problems brought up by the consulted stakeholders are typologically summarized in the following table 3.1. The main issues include those related to: i) collection and disposal of drainage effluent; ii) disposal of flood and storm water; iii) operation and management of the irrigation and drainage infrastructure; iv) environment; vi) institutional performance; vii) socioeconomic wellbeing and livelihoods, particularly in the lower delta, coastal zone, and the lower reaches of the drainage system; viii) agriculture support services; and ix) access to social and physical infrastructure. Many of the issues and problems reported are at times overlapping and repetitive, hence unavoidable.

Table 3.1: Summary of Issues and Problems

N°	MAIN ISSUE	DESCRIPTION
A.	**Drainage Network Related**	
	The LBOD/KPOD outfall infrastructure was not designed properly and has caused miseries to the communities in lower reaches	• The opinion of the stakeholders and communities about the LBOD is divided. Those who expressed a positive opinion stated that it has reduced the drain out time for stagnant flood and storm water, and has improved the productivity. • Those who strongly feel that it has affected them negatively feel that it has degraded their lands, decreased farm and fish productivity, and degraded underground aquifer. The degradation is mainly due to overtopping of drainage effluent, transportation of industrial waste, sea encroachment, etc. The damaged tidal link has widened considerably and turned into a creek.
	Stakeholder's are apprehensive of any reconstruction or extension of LBOD and/or KPOD	• Communities in Badin and Thatta districts, and in the delta and coastal areas, expressed serious reservations against any future drainage projects. • Total rejection stems from bad experience of villages along the LBOD/KPOD. People suspect that new projects will bring more devastation, including additional contaminated and poisonous urban and industrial effluents. • The absence of mitigation measures to arrest seawater intrusion through the collapsed tidal link and KPOD is destroying agriculture lands, and bringing about salinization of aquifers in the respective corridors as well as salinization of lakes and wetlands.
	A need is felt to extend the drainage network in the upper and middle parts of the left bank	• Farmers in areas without any drainage infrastructure/network desire that drainage projects are constructed in their respective areas to control water logging and salinity menace, to reclaim culturable waste and to increase their farm productivity.
	Drainage effluent intrusion from Southern Punjab in Ghotki Area	• In the Sukkur region stakeholder workshop, participants expressed their serious concern on drainage effluent intrusion from Southern Punjab which is fast degrading productive land

N°	MAIN ISSUE	DESCRIPTION
		into marsh, forcing farmers to migrate and thereby lose their livelihood.
B.	**Disposal of Flood and Storm Water Related**	
	Communities along the flood protection feel vulnerable to flood havoc	• People complain that the government flood response is always too little and too late, particularly rescue and relief is unplanned and support for rehabilitation is inadequate. • Communities, particularly along the flood protection works and beyond, are apprehensive of unexpected breaches during floods. They feel vulnerable and fear threats to the human lives, livestock, access to social services, movable and immovable assets, food security and livelihoods. • They suggest the development of possible flood retardation basins, escapes routes etc. that would protect barrages and irrigation and drainage networks, physical infrastructure, vital installations, and other private and public properties. • They also feel an absence of any standard operating procedures or protocols to trigger timely flood protection and preparedness measures in consultation with vulnerable communities. • Also there is no early warning mechanism or crisis management in case of super floods.
	There is inadequate infrastructure to safely dispose off and conserve storm water in case of high rainfall	• Farmers feel that there is no widely known mechanism to deal with disposal of storm water and so have to resort to ad hoc and unplanned measure thereby damaging the drainage and other infrastructure. They desire that various options for safe and timely disposal of storm water be planned. • Stakeholders suggest that IPD/SIDA should explore various options to harvest rainwater in the desert area for storage and recharge of groundwater, and in lakes/dhands to revitalize fishing potential
C.	**Operation & Maintenance of Irrigation, Drainage, and Flood Protection Infrastructure Related**	
	Inadequate and poor O&M of the drainage system, including subdrains and on-farm drains	• The drainage network, particularly main and secondary drains are in dilapidated condition and clogged with silt and weeds. This restricts free flow of the drainage effluent leading to occasional breaching.
	A significant proportion of SCARP tubewells are non operational	• Farmers report that a significant proportion of drainage wells are not operating due to want of major repairs and replacement. It was observed during the field visits that most

N°	MAIN ISSUE	DESCRIPTION
		of the tubewells have been vandalized. It was reported that organized gangs are involved in the stealing of high tension wires, hook up connections, motors and pumps, electrical fittings, and in some places even doors. Where these tubewell are functioning, they are sources of power theft for non-agricultural uses. As these are not functional, farmers have abandoned the connecting farm ditches and in some cases the subdrains. This has reduced the effectiveness of the SCARP tubewells, and lowering of the water table is constrained.
D.	**Environment Related**	
	The continued and unabated environmental degradation due to seawater intrusion	• For the last ten years downstream Kotri flows has been less than allocated in the 1991 accord, hence adverse effects on the ecology, biodiversity, habitat for birds, sediment deposit, area under mangroves and riverine forest, growth of fish resources, livelihoods etc. and all these need to be addressed. • Absence of a plan to check seawater intrusion reaching up to about 150 km in the river, destroying the ecology and causing land degradation. • Adverse impacts of seawater intrusion include degrading of canal water quality for domestic use in the areas close to the coast, increasing of arable land salinization rendering it unproductive, and dwindling of fish catch due to increasing salinity levels in the lakes/dhands. • Both structural and non structural options need to be explored to find a sustainable solution to the problem of sea water intrusion and ecosystem instability. • Seawater intrusion has destroyed the ecosystem of the coastal area wetlands thereby affecting fisheries, wildlife, waterfowl and livelihood in general. Mitigation of such damage would require structural and non structural interventions.
	The pollution level in the river, irrigation canals, and drains is increasing significantly	• Drinking water sources, both surface water and groundwater, are increasingly polluted due to unchecked disposal of untreated pollutants emanating from the increasing disposal of urban sewerage and solid waste, leaching of agrochemicals, untreated hazardous industrial waste, particularly from sugar mills. This pollution is destroying aquatic life in the water bodies and livelihood of the communities. • Despite cost effective available techniques, there is a lack of compliance and ineffectiveness of EPA to control pollution and contamination of water ways and of the drainage system.
	Deforestation of riverine	• Deforestation of riverine forests is inducing over spilling of

N°	MAIN ISSUE	DESCRIPTION
	forest	flood waters. • The authorised and unauthorised clearing of riverine forests is destroying river and delta ecology and morphology. • The general law and order situation in the riverine belt is encouraging indiscriminate denudation of mangroves and riverine forests. • The speed of afforesting and replanting in riverine area is slower than its decline.
	Deforestation of mangroves	• As a coping strategy the inhabitants started denuding the mangroves not only to meet their fuel wood requirement, but also to fetch money. Hence the need to introduce social forestry programs is felt. • Ineffective control for checking denuding of mangroves and riverine forest for fuel and its sale, animal feed, and charcoal making is further accentuating the loss of vegetation. • The speed of expansion and regeneration of mangroves is slower than its decline.
	Over mining of underground water	• Over mining of underground water is leading to saline water encroachment in the fresh groundwater areas. • Indiscriminate conjunctive use of marginally saline ground water is degrading soil quality which will adversely affect productivity in the long run.
	Degradation of Wetlands	• The coastal wetlands are degraded due to seawater intrusion. The seawater has changed the wetlands ecosystem by adversely affecting the fauna, flora, wild life and biodiversity, habitats, fish and livelihood opportunities. • The inland freshwater wetlands have been degraded due to reduced flows in the river and consistent drought conditions. These wetlands havitats either dried up or turned brackish for the want of freshwater. • Fisheries, waterfowl and habitats have been seriously degraded and the livelihood opportunities have dwindled. There is need for a management plan for managing this valuable resource on scientific lines at par with the developed nations.
E.	**Institutional Related**	
	Disaster Management and Preparedness	• National and provincial disaster management institutions are ineffective in combating flood and storm water disasters. • Absence of plans to cope with likely Tsunami or any seismic disaster.

N°	MAIN ISSUE	DESCRIPTION
	Dissatisfaction with the overall performance of the drainage project staff	• Most farmers expressed their dissatisfaction and the need for improved monitoring and accountability.
	Poor awareness of SIDA, AWBs, and FOs mandates.	• Most respondents (except for a few), are not aware of the Sindh Irrigation and Drainage Authority (SIDA), and there is a need to propagate the relationship between SIDA and AWBs. • Most participants are generally aware of the Area Water Boards (AWB) and its role and responsibilities, however there is a felt need to further disseminate their responsibilities. • It is a general impression of the consulted communities that Farmers' Organizations (FOs) are dysfunctional. Almost all the farmers are aware of the Farmer Organization (FO), but only few are aware of their mandate, responsibilities, and functions.
	Other Institutional Issues	• The majority of the consulted stakeholders and communities believe that most of the staff of the Irrigation Department are not fair in maintaining equity in water distribution. • Abiana (collected by the FOs) is not adequate to operate and maintain distributaries and minors, and funds are mismanaged. • IPD and SIDA and associated AWBs and FOs are not well organized, located, staffed and equipped (mechanized) to carry out even routine operations and maintenance functions. • There are just a few specifically allocated reserves for coping with floods and other disasters. • There is no identified budget and adequate organizational capacity for O&M of the Tidal Link and LBOD. • FOs do not have enough power to ensure a proper share of water for their communities. • Local powerful individuals and waderas control the work of the FOs to the detriment of the local people. • FOs' chairmen are selected rather than elected. • The Irrigation Department does not maintain the irrigation system regularly and properly; and mismanages funds. • The capacity to collect irrigation statistics in terms of staffing, funding, adequate software and hardware, and training is limited • Consulted stakeholders form Badin and Thatta think that the World Bank should compensate the population for lost lives,

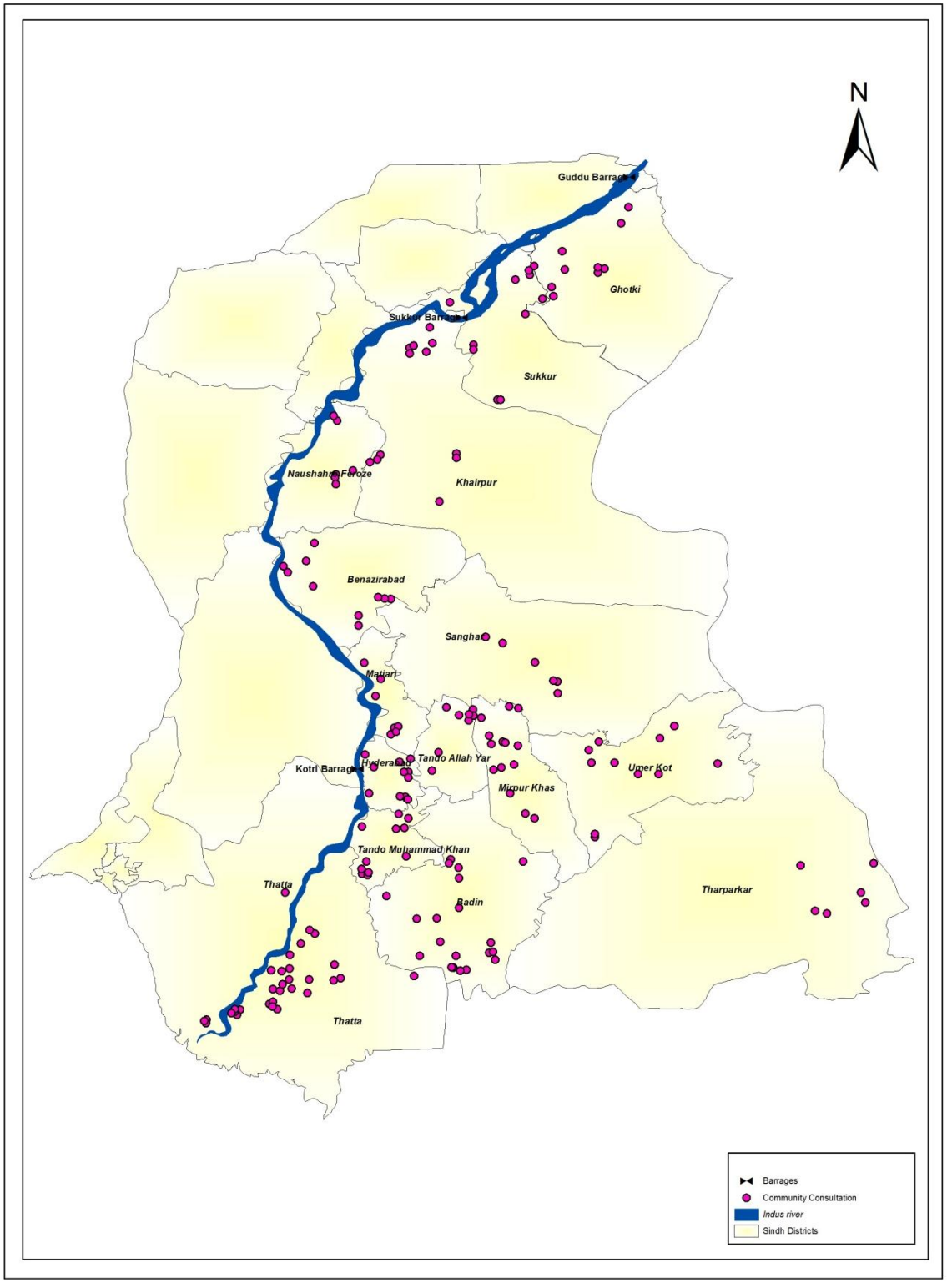
N°	MAIN ISSUE	DESCRIPTION
		livelihoods and degraded environment caused by the LBOD. • Every change in the government brings to a closure started development schemes; so many projects have never been finished.
F	**Quality of Life, Socioeconomic Wellbeing and Livelihoods Related**	
	Availability of safe fresh drinking water	• Safe and clean drinking water is not available particularly in the saline underground water areas and in the delta and coastal areas. • Seawater intrusion in the delta and coastal areas has salinized underground water, restricting the availability of fresh groundwater for domestic use • Untreated municipal sewage disposed off into freshwater bodies is used for domestic purposes by thousands of people living in areas with brackish underground water. Less than 8% of total wastewater released daily is, only partially, treated before it is released into the surface water bodies.
	Breeding ground for diseases	• In the delta and coastal areas, due to the swampy conditions, the incidence of various water borne and contagious diseases is quite high. • Similarly un-drained and stagnant rain water in the entire left bank also serves breeding places for mosquitoes, flies, and other insects.
	Access to education and health services	• The access to education services is inadequate, particularly for girls. The situation is marred with absenteeism of staff, shortage of trained teachers, absenteeism of students, increasing dropout rates, etc • Similarly, health services in rural areas are inadequate, particularly for women. Absenteeism of medical and paramedical staff and shortage of medical supplies are the main issues. The poor state of health services is evidenced by frequent and chronic illnesses, malnutrition, and high infant mortality rates.
	Adverse impact on livelihood	• The encroachment of seawater into the grazing lands in the delta and coastal areas has reduced the carrying capacity of such areas. The situation is further exacerbated by indiscriminate grazing of the limited available resources. This has also significantly reduced the income of households who depended solely on livestock income. There is a need to designate areas where camel grazing is managed through

N°	MAIN ISSUE	DESCRIPTION
		controlled grazing and rotation. • Due to the collapse of the tidal link and associated structures, the freshwater bodies in the delta and coastal areas have turned saline. Due to saline water, fish cannot get enough food and fish reproduction is decreasing as a consequence. This has destroyed the livelihood of the fisher folks. • Due to continued sea encroachment, productive farmland has gone out of production. Further encroachment needs to be arrested. • The delta and coastal areas has been a back quarters in the economic growth and lag behind in livelihood opportunities. The skills level is low and needs skills development programs to enable them to earn a living, rather than working as low wage unskilled labour. • Lack of alternate livelihood opportunities, low level of skills, and access to finance, is causing unemployment.
	Increasing poverty in the delta and coastal zones	• Because of landlessness and lack of alternate livelihood opportunities, poverty and food insecurity is increasing, particularly in the delta and coastal areas.
	Lack of enabling factors for introduction of ecotourism	• The poor physical infrastructure has inhibited ecotourism which could be a source of livelihood for delta and coastal area communities.
G.	**Agriculture and Irrigation Sector Related**	
	Irrigation shortage is causing low productivity	• Lack of availability and shortage of irrigation water are serious concerns expressed by most of the consulted villages, particularly for farmers located in the tail reaches of the system. Shortages and uncertainty in the irrigation supplies, and absence of equity are the main constraints in efficient utilization of water resources. • Sukkur and Ghotki stakeholders stated that the drainage water of SCARP-IV together with the effluents from industries is diverted unattended to the Ghotki district. The toxic drainage effluent enters the Bagoo Wah and spreads in the fertile and productive lands damaging the crops and degrading their lands. They demanded the government of Sindh for immediate stoppage of the drainage effluent from Punjab that has degraded their valued land resources.
	Low agricultural productivity due to various constraints	• Farmers felt that the improvement in irrigation management and drainage system alone is not enough for improving productivity and livelihood. They felt that timely availability of good quality inputs, such as certified seed, fertilizers,

N°	MAIN ISSUE	DESCRIPTION
		pesticides and herbicides, need to be ensured. • Similarly, getting fair prices for output is an issue and the marketing system needs improvement, as arhtis are not fair in their dealings. • Agriculture support services, such as agricultural extension, animal husbandry and veterinary support services, soil testing, etc. are generally inaccessible.
	Lack of research and extension support for adopting biosaline agriculture	• In the areas affected with soil salinity, farmers are dependent on low value crops and there is a need to introduce salt tolerant food and cash crops, and appropriate fodder crops, to sustain the animal population.
H	**Gender Related**	
	Major issues	• Lack of opportunity for women employment • Low literacy rate • Too many children per family • Family debts due to high dowry expenses • Lack of education and other basic facilities in villages • Lack of sanitation facilities for women • Absence of prenatal services • Absence of any consultations with women
J	**Community Consultation Related**	
	General issues	• The majority of the consulted villages and stakeholders report the absence of meaningful consultations with their communities. There is disbelief that anyone will consult locals at all. • In areas where some consultations with stakeholders were conducted in the past, the stakeholders stated that no value was given to their opinions and suggestions. • People are apprehensive about their suggestions being considered and taken note of. • Women are generally ignored in the consultative process. An absence of social inclusion of women in voicing their opinions and participating in the decision making process in public spheres of their lives is persistent.
L	**Other Related Issues**	
	General issues concerned with	• Farm to market roads network and spur roads are in

N°	MAIN ISSUE	DESCRIPTION
	development	dilapidated condition, and constraints access to basic services. • There is a lack of proper sanitation which breeds disease and causes poor health.

Map 3.1: Coverage of Stakeholder Consultation Villages



4. THEMATIC AREA STUDIES

4.0 Background to the Thematic Task Studies

As discussed above, all of the 34 study tasks specified for Phase-I of the Regional Plan Study were aggregated into the eight thematic task areas identified in Table 4.0.

Table 4.0: Thematic areas Identified and Studied in Phase-I of the Regional Plan Preparation

No.	Thematic Area
1	Overview and Development of Planning for Drainage and Flooding
2	Water Resources and Water Usage for Drainage and Flooding
3	Impacts of drainage and Flood on Environment and Wetlands
4	Flooding, Disaster Management and Mitigation
5	Structures for Irrigation Drainage and Flood Protection
6	Overview of Current Agriculture, Livelihood, and Economic Aspect of Drainage & Floods
7	Social Issues of Drainage Operation and Flooding
8	Review of Capacities Of Provincial Agencies Involved in Execution of the Irrigation and Drainage Projects and its Management

Each thematic summary of the task studies was prepared to give a broad overview of the methodology used for collection of the required information, the assessment of the information, and a statement of the issues and problems identified for the thematic area. Topics covered for each theme, based on the terms of reference of the Regional Plan study include:

1. Background to the thematic area study
2. Methodology used to address the thematic area
3. Selection of data sources and references for the thematic area study – primary and secondary sources
4. Key findings of the thematic assessment
5. Consultation methods used and stakeholder inputs to the thematic assessment
6. Issues and problems identified for the thematic area
7. Important references and data resources for the thematic area

The methodology and issues and problems have been summarized in separate chapters to avoid repetition. The objective of this summary report is a document that presents a shared understanding of issues and problems of drainage and flooding for identification of options and solutions to serve as an agreed stakeholder basis upon to build the Regional Plan for the Left Bank Indus, Delta and Coastal Zone to mitigate impacts of drainage and flooding for all classes of stakeholders.

4.1 OVERVIEW AND DEVELOPMENT OF PLANNING FOR DRAINAGE AND FLOODING

4.1.1 Background to the planning thematic area study

In order to meet the scope of the Phase-I study, being mainly an inventory and assessment of existing conditions and the identification of issues and problems related to drainage and flooding, the topics related to the planning for drainage and flooding in the area on intervention were studied using the tasks listed in Table 4.1.1.

Table 4.1.1: Topic Outline for Summary of the Thematic Area 1 Study

Topic of Concerns for Phase-I Task Studies	
Subjects Covered	**Phase-I Tasks Included**
I – Overview and Development of Planning for Drainage and Flooding	
✓ Planning studies ✓ Background to the problems of drainage and flood management ✓ Data collection	T-1: Document and review all available reports T-4: Document and evaluate planning studies T-33: Report on identification of issues and analysis (This report)

Irrigation schemes –and their direct link to drainage- have often failed in the past because they have focussed mainly on the engineering, production and productivity and economic concepts of the scheme, failing to recognize the social and environmental aspects of the scheme; and Sindh is not an exception. Large schemes have – until a couple of decades ago- been considered the most effective means to enhance agricultural productivity and as is reported in the literature, major donors have focussed their fight against poverty investing generous financial support in such projects, where the major concern focused on technological aspects ignoring the socio-economic, institutional/ administrative and socio-political aspects.

There was little concern about the fact that large irrigation systems require the establishment of effective, efficient and dependable administrative institutions to properly manage the systems by implementing actions that guarantee proper maintenance of the infrastructure and appropriate operation of the system to ensure fair water distribution among the water users. At present a chronic problem observed is that the tail enders- at the end of the irrigation scheme do not get enough water. Lack of maintenance and improper operation of irrigation canals and drainage systems are in large, responsible for waterlogging and salinization of the agricultural lands. Poor irrigation practices at on-farm level also contribute to waterlogging and salinity of the lands.

Irrigation system beneficiaries seem to believe that since the construction of irrigation and drainage infrastructure is conducted by the Government, their operation and maintenance also rests with Government agencies. After the failure of a number of schemes in the past, international donors insist on beneficiaries' involvement in the conceptualization, construction, operation and maintenance of irrigation and drainage projects.

Pakistan's Indus River Basin Irrigation System is the world's largest and probably more complicated integrated irrigation system, and highly complex drainage system. The need to protect crops from unpredictable rainfall variations and to provide with irrigation water during the dry season promoted the construction of infrastructure to control the water flow in the rivers. The need to communicate and transport from both sides of rivers encouraged the construction of bridges to cross them. Even though considerable progress in river management has been achieved during the last century, our human knowledge of river behaviour is still highly empirical. There are vast areas of river behaviour and its interactions through human intervention in the form of dams, barrages, bridges, and other structures are still not properly understood.

In the specific case of the Indus River in Sindh, the barrages stop the sediment flow, significantly affecting the ecology of the downstream Indus River Delta area. Bridges constrain water flow,

raising water levels and encouraging silt deposition upstream and increasing water velocity downstream of them. During the 2010 floods, the predictions about water velocities and time lags were inaccurate because the effects of human intervention affect the river behaviour. People's encroachment into riverside areas reduced the cross section forcing the river to overflow embankments with the devastating effect on people life's, belongings and infrastructure.

4.1.1.1 Chronology of irrigation and drainage development in Sindh

The following is a brief chronological history of the development of irrigation and drainage in Sindh. Included is a chronological history of the implementation of major irrigation projects; a history of drainage problems; planning and development of the Left Bank Outfall Drain (LBOD) system; a summary of the implementation of the Tidal Link and the Cholri Weir; and a summary of how Sindh Province irrigation and drainage reached its current condition and state.

A chronological history of the implementation of the major irrigation and drainage infrastructure in the Lower Indus Basin in Sindh Province is given in the tables below:

Table 4.1.2: Chronology of Major Irrigation Infrastructure in Sindh

Year or period	Activity	Discussion
Several thousand years	Development of irrigation in the Indus River Basin in what is now the Sindh Province of Pakistan	The Indus River Basin is one of the oldest irrigated river basins in the world
Mid 1800's	Irrigation canal systems were extended and improved during the time of British rule	Water resource planning and comprehensive irrigation was developed at the Roorkee hydraulic research station
Late 1800's	A major program for improvement and construction of new inundation canals was undertaken	
1924	The construction of barrages was started	
1932	Barrage commanded irrigation was introduced with the construction of Sukkur Barrage system	Barrage commands a gross area of some eight million acres on the left bank of the Indus River
1955	Kotri Barrage completed	
1962	Guddu Barrage completed	
1985-1997	Under LBOD Stage-1 Project remodelling of Nara Canal and Chotiari Resorvior were undertaken.	
1998-2004	Under NDP balance works of LBOD Stage-1 were undertaken.	

Table 4.1.3: Chronology of Drainage Problems in Sindh

Year or period	Activity	Discussion
1932	The need of drainage was realized but water table at that time was so deep that it	

Year or period	Activity	Discussion
	was not considered an urgent priority to provide drainage	
1930 – 1950	Development of large scale agriculture coupled with primitive irrigation practices resulting in over irrigation through unlined canals constrained by topographical relief of the natural drainage caused the water table to rise	
1950's	High water table brought the twin problem of water logging and salinity, destroying vast tracts of fertile lands	
1950's	Cyclic monsoon storms flooded large areas and brought the water able at the surface in areas where it was already high	
1959	Studies were initiated initially in the Khairpur area and later in the entire Sindh under Lower Indus Project (LIP)	Water logging and salinity problem became aggravated
1966	Log-term development plan for the areas irrigated by the Guddu, Sukkur and Kotri barrages was prepared under LIP Report. In May 1961 WAPDA published a report entitled "Programme for water logging and salinity control in irrigated areas of West Pakistan" comprising of 10 year Programme for water logging and salinity control measures through development of groundwater resources. 16 salinity control and Reclamation projects (SCARPs) were identified for Lower Indus Region. SCARP Projects completed on Left Bank of River Indus in study area were. ➢ Ghotki (Fresh Ground water) completed during 1976-90 ➢ SCARP Khairpur completed in 1963-70 ➢ SCARP North Rohri (Fresh ground water) completed in 1969-1979 ➢ East Khairpur Tile drainage Project completed in 1985 ➢ SCARP south Rohri (Fresh ground water) completed in 1976-1090 ➢ Left Bank outfall drain stage-1 Project started in 1985 and completed in 2003	

Year or period	Activity	Discussion
	Seven main surface drainage systems in Left Bank Kotri Barrage command have been rehabilitated under National Drainage Program.	
1970 - 1980	The waterlogged area reached its maximum extent (up to 20 to 30 percent of the irrigated lands in the Indus Basin) causing serious threat Water logging and Salinity.	
Present	In Sindh Province, 54% of the land area is affected by salinity and 24 percent of land is severely waterlogged.	

Table 4.1.4: Chronology of the LBOD in Sindh

Year or Period	Activity	Discussion
1959	One of the major projects proposed under LIP was the construction of the Left Bank Outfall Drain (LBOD) and its component projects	Left Bank Outfall Drain (LBOD) Project relates to the Sukkur Left Bank Command area All of this command area is supplied with perennial irrigation, supporting the extensive and intensive cultivation activities in developed in the province
1966 & 1969	Speedy construction of LBOD was recommended in the LIP proposal and in LBOD Planning Reports produced by WAPDA	In the first phase the main storm drain was to be built for an estimated effluent of drainage from some six million acres of land from the outlet into the sea to the junction with the South Rohri Main Drain This programme was based on the condition that development of individual projects in the catchment was to take place independently Due to financial constraints and in absence of internal drainage, the construction of the proposed main and out fall drain did not take place
1972	A revised plan for a Phase-I was prepared by WAPDA Project	In the catchments chosen for first phase of LBOD a part of only

Year or Period	Activity	Discussion
	Planning Directorate with catchments areas covering a vast area between Jamrao and Mithrao canal with provision of storm drainage of five day duration and of five year return period i.e. 8" inches of rain, and its construction in various phases	one main drain East Nara Main Drain with its junction with the outfall drain was proposed
1974	The construction of LBOD Phase-I was initiated comprising the LBOD Spinal Drain from RD 159 to 450, the Dhoro Link from RD 0 to 17, the Dhoro Puran Outfall Drain from RD 0 to 110, LBOD Branch Drain from RD 0 to 132 and its internal drainage system, covering an area of 0.226 million acres	
Beginning 1979	The completed works begun in 1974 proved very beneficial during heavy rain storms by saving standing crops, livestock and Infrastructure which could have been otherwise damaged by flooding	
1980	The mandate and nature of LBOD Project was revised by UK based Overseas Development Association (ODA) Consultants, proposing the construction of a Spinal Drain of about 285 miles in length and 10 component drainage projects to provide storm and sub-surface drainage for a gross area of 4.9 million acres	The revised LBDO had an estimated cost of Rs 26.00 billion excluding price escalation and interest during construction Due to financial constraints, a bankable LBOD Project was prepared and offered to the World Bank and other agencies for appraisal and financing. However the revised proposal did not meet the standards for financing by external agencies
1982	World Bank financed studies to review and update the LBOD Project undertaken by M/S M. MacDonald under UNDP financing	The revised project was much smaller in scope with only a few priority projects
April 1983	Based on World Bank Studies and GoP's financial constraints, CDWP proposed WAPDA to prepare a core programme for the completion of LBOD Spinal Drain.	This core programme was approved by the ECNEC at a total cost of Rs. 1196.849 million

Year or Period	Activity	Discussion
November 1983	Consultants Sir M. MacDonald Ltd reviewed the project in light of the World Bank advice and a reduced and less expensive project known as LBOD Stage-1 was prepared	This plan was jointly reviewed and appraised by the Bank and co-financiers including ADB, the Saudi Fund for Development (SFD), British Overseas Development Association (ODA), Islamic Dev. Bank (IDA), Swiss Fund, Canadian Development Association and Government of Pakistan (who later approved the revised plan)
1983 - 1985	The work for construction of LBOD Spinal Drain from RD 450 to RD 816 under a Core Programme was started in 1983 and completed in 1985	Construction included the spinal drain, three main drains and three component projects covering above 1.3 million acres. The outfall capacity of the Spinal Drain was 4600 cusecs, discharging partly through the Dhoro Puran Drain (DPOD) into Shakoor Dhand and partly through the Kadhan Pateji Outfall Drain (KPOD) and a Tidal Link into the sea through Shah Samando Creek
February to August 1984	PC-I for LBOD Stage I project was submitted to Government of Pakistan and was approved by ECNEC	
1985 -1986	Construction work on the project started	

Table 4.1.5: Chronology of the Tidal Link and Cholri Weir

Year or Period	Activity	Discussion
1980s	The Tidal Link Was recognized as needed to dispose of the saline effluent in a manner that it does not damage other agricultural areas or bodies of fresh water in the lower basin	
1980s	Pre-design studies for Tidal Link were carried out to demonstrate that drainage of low laying agricultural areas connected to the LBOD System will not be adversely	

Year or Period	Activity	Discussion
	affected by high spring tides and on-shore winds, particularly in monsoon season	
September 1987	Sir M. MacDonald & Partners Principal Consultants of LBOD Stage-I project commissioned Delft Hydraulics to perform a pre-design study for the alignment of the tidal link and outfall	The Link, 26 mile long, had a constant bed width of 92 feet and side slope of 1 in 3. The bed slope was 1 in 14,000 that resulted in a bed level of-17 ft. at outfall in Shah Samando Creek
October 1989	The construction of the Tidal Link and outfall was scheduled to begin	Financed with assistance from the Saudi Fund
September 1991	The construction contract for the Tidal Link was awarded to China Harbor Engineering Company	The construction cost was RS. 787million and the contract period was 41.5 months
Late 1994	Construction of the Tidal Link was completed on schedule	
1995	In the first year of operation, the Tidal Link had disposed of an estimated 30 billion cft of water containing 3 million tons of salt from the irrigated area of lower Sindh	This volume of water corresponds to an average of 7 inches depth of water over the entire 1.27 million acres of the project area
1990s	Cholri Weir was constructed to preserve the environment and prevent outflows from the Dhands; but to permit some inflow at high tide and attenuation of peak water level. For this purpose an overflow weir was provided in the Tidal Link northern embankment at Cholri Dhand	Dhands are natural lakes existing in the tidal range of the delta The level of this weir was chosen to limit water levels to their seasonal maximum in the Dhands. The weir was designed for flow in either direction according to the tidal cycle with the crest level of 4.5 ft and a length of 1800 ft with 94 bays. Under the worst storm flow / tidal conditions, the water level in the Dhands was not to exceed 6 feet

4.1.2 Key Findings of the Thematic Assessment

4.1.2.1 Current state and circumstances of drainage in Sindh

A summary of how Sindh Province irrigation and drainage reached its current condition and state is given in Table 4.1.6.

Table 4.1.6: Current State and Circumstances of Drainage in Sindh Province

Year or Period	Activity	Discussion
June, 24 1998	Due to various technical reasons, the Tidal Link was damaged and the Cholri Weir structure collapsed	WAPDA named consultants responsible for the faulty design of Cholri Weir
May 21 1999	In disastrous tropical cyclone-2A hit tidal areas of Thatta and Badin Districts. As a result, sea water over-ran Tidal Link and destroyed its structures	A total of 54 breaches occurred at different locations along Link. Both the embankments were caved-in. The channel is, however, operational functioning as a natural water way and effluent of all the three components Nawabshah, Sanghar and Mirpurkhas of LBOD including Spinal Drain is being delivered through the channel into the sea
March, 2000	World Bank fielded a Fact Finding Mission to understand the technical details and process of the failure and the damage to the Tidal Link, the environmental and social consequences, and to suggest to the Government of Sindh further steps to be taken	
July 2003	There were heavy rains, sea storm and flooding in Badin District, Sindh Pakistan	Water also entered to the area by the canals in the left bank below Kotri
2004-05	Emergency works were executed in order to restore functioning of the outfall drains (KPOD and DPOD)	Work was performed in association with V Corps Engineers of the Pakistan Army
September 10, 2004	Communities belonging to Badin District, Sindh submitted a *Request for Inspection* to the World Bank's Inspection Panel, in which issues related to the LBOD Stage 1 Project were raised.	
April 2006	There was another flood event in the LBOD project area in due to intensive rains in the Lower Sindh	No water reached to the area by the canals in the left bank below Kotri during the 2006 Event After this flood event the banks of MMD were repaired and strengthened both by Nara Canal AWB and Left Bank Canals AWB in the reaches located in

Year or Period	Activity	Discussion
		their respective jurisdictions
July 2006	The Panel issued its report outlining the findings of the investigation	
July 2006	The World Bank Management issued its Response	In the light of Panel's recommendations the Board of Executive Directors of the Bank approved a Short Term Action Plan
2005 - 2007	Left Bank Canals AWB prepared 18 Nos. PSDP schemes for execution during the period 2005-07 in order to strengthen both banks of LBOD from RD 204 to RD 159, and KPOD in various reaches	The work is still on-going and incomplete
Prior to year 2007 monsoon season	IPD undertook repair works of LBOD system	

4.1.2.2 Inventory of Available Reports

The latest and more important study for WSIP-I Component C Regional Plan is the Feasibility Report; Re design of LBOD Stage-1 Badin Area Drainage System conducted by NESPAK for WAPDA from 2007 to 2010. The summary of the key components is presented in below. The review of the available reports identified by the WSIP-I Component C consultants is presented in Vol-II Thematic Area 4.1.

Summary of Project: Re design of LBOD Stage-I Badin Area Drainage System

The feasibility Study for Re-design of LBOD Stage-I Badin Area Drainage System was conducted by WAPDA through consultants M/S NESPAK-ACE-DMC (JV) under the directive of the President of Pakistan: "*WAPDA in consultation with Government of Sindh should carryout feasibility Studies for re-designing of the system for the benefit of people of Badin district and adjacent low lying area, which were badly affected during unexpected extraordinary rainfall in 1994 and 2003 monsoon with intensity between 200 mm to 304 mm*"

The reports submitted by the Consultants, NESPAK were reviewed by the SIDA and the Stakeholders and extensive interaction was maintained among the WAPDA, SIDA, Stakeholders, and NGOs. A committee comprising representatives of Irrigation Power Department, WAPDA, NGOs, and Stakeholders was constituted with the Managing Director SIDA as Chairman.

WAPDA/NESPAK analyzed two alternatives and three options for the second alternative. The particulars of each alternative and the options along with the stakeholders' alternative are summarized in Table 4.1.7 below.

Table 4.1.7: Feasibility Report for Redesign of LBOD Stage-I - Badin Area Drainage System - June 2009[6]

Component of Alternative	Alternative-1	Alternative-2A *(Recommended by NESPAK-ACE-DMC Design JV)*	Alternative-2B	Alternative-2C	Alternative-3 *(Recommended by Stakeholders)*
Improvement of drainage system	Rehabilitation/remodelling of Spinal Drain (SD) to carry 7,300 cusec Rehabilitation of Dhoro Puran Outfall Drain (DPOD) to carry 2,200 cusec Remodelling of Kadhan Pateji Outfall Drain (KPOD) to flow 5,100 cusec at RD 159; and to discharge 7,200 cusec at outfall point in Tidal Link Maximum storm water flow in project = 9,400 cusec	Remodelling of Spinal Drain to carry 7,300 cusec Minor remodelling of DPOD to discharge 3,000 cusec Remodelling of KPOD to flow 4,300 cusec at RD 159; and to discharge 6,400 cusec at outfall point in Tidal Link Maximum storm water flow in project = 9,400 cusec	Remodelling of Spinal Drain to carry 7,300 cusec Minor remodelling of DPOD to discharge 3,000 cusec Remodelling of KPOD to flow 4,300 cusec at RD 159; and to discharge 6,400 cusec at outfall point in Tidal Link Maximum storm water flow in project = 9,400 cusec	Remodelling of Spinal Drain to carry 7,300 cusec Minor remodelling of DPOD to discharge 3,000 cusec Remodelling of KPOD to flow 4,300 cusec at RD 159; and to discharge 6,400 cusec at outfall point in Tidal Link Maximum storm water flow in project = 9,400 cusec	Rehabilitation of the Spiral Drain; no remodelling Remodelling of the DPOD to carry 4,000 cusec Increasing capacity of DPOD weir located at RD 126 to convey 4,000 cusec Rehabilitation of the KPOD; no remodelling Construction of a new drainage disposal outlet for the KPOD at RD 52
	Water level of SD and KPOD equal to the last design water level Increase flow capacity in SD & KPOD achieved by widening the drains	Widening the cross-section; and raising the surface water level of the remodelled SD, DPOD and KPOD by 2 feet above the last design water level	Widening the cross-section; and raising the surface water level of the remodelled SD, DPOD and KPOD by 2 feet above the last design water level	Widening the cross-section; and raising the surface water level of the remodelled SD, DPOD and KPOD by 2 feet above the last design water level	Strengthening and stone pitching of selected reaches of Spiral Drains and outfall drains Rehabilitation of surface drains in Badin, Mirpurkhas, Sanghar and Nawabshah
Control of tidal effect and sea water intrusion	Plugging of creeks and reconstruction of embankment along the southern side (Indian	Plugging of creeks and reconstruction of embankment along the **southern side** (Indian	Plugging of creeks and reconstruction of embankment along the **northern side** of Tidal	Plugging of creeks and reconstruction of embankment along the **southern side** (Indian	Plugging of creeks and reconstruction of embankment along the **southern side** (Indian border

[6] WAPDA (2009), *Feasibility Report for Redesign of LBOD Stage-I, Badin Area Drainage System*, Volume 1, Main Report and Appendices, NESPAK-ACE-DMC Joint Venture, Pakistan Water and Power Development Authority (WAPDA), Hyderabad, Pakistan, June 2009

Component of Alternative	Alternative-1	**Alternative-2A** *(Recommended by NESPAK-ACE-DMC Design JV)*	Alternative-2B	Alternative-2C	**Alternative-3** *(Recommended by Stakeholders)*
in dhands & drainage system	border side) of Tidal Link	border side) of Tidal Link	Link	border side) of Tidal Link	side) of Tidal Link from RD -80 to -155
	Plugging of Tidal Link near RD -145 Top plug top elevation = 0.0 feet amsl	Plugging of Tidal Link near RD -145 Plugging of Tidal Link at -110 as a back up to plug at RD -145 Plug top elevation = 0.0 ft amsl	Plugging of Tidal Link near RD -110; two plugs 1000 ft apart for safety reasons Plug top elevation = 0.0 ft amsl	Plugging of Tidal link near RD -110 and RD -145 Plug top elevation = 3.5 ft amsl	Plugging of Tidal Link near RD -145 to check sea water intrusion
	Provision of a structure with flap gates near RD -13 of KPOD	Provision of a structure with flap gates near RD -13 of KPOD	Provision of a structure with flap gates near RD -13 of KPOD	No structure on KPOD near RD -13	Provision of a structure with flap gates near RD -5 of KPOD to check sea water intrusion
Protection of cropped area and villages	Flood protection bund for villages and cropped areas in the north of Achh, Sainhri and Addah dhands	Flood protection bund for villages and cropped areas in the north of Achh, Sainhri & Addah dhands	Flood protection bund for villages and cropped areas in the north of Achh, Sainhri & Addah dhands	Flood protection bund for villages and cropped areas in the north of Achh, Sainhri & Addah dhands	Flood protection bund for villages and cropped areas in the north of Achh, Sainhri & Addah dhands
	Flood protection bund for village Khan Bahadur Lund located near RD 28 of KPOD	Flood protection bund for village Khan Bahadur Lund located near RD 28 of KPOD	Flood protection bund for village Khan Bahadur Lund located near RD 28 of KPOD	Flood protection bund for village Khan Bahadur Lund located near RD 28 of KPOD	Flood protection bund for village Khan Bahadur Lund located near RD 28 of KPOD
	Flood protection bund between RD -15 of KPOD and the tail of Mirwah Minor	Flood protection bund between RD -15 of KPOD and the tail of Mirwah Minor	Flood protection bund between RD -15 of KPOD and the tail of Mirwah Minor	Flood protection bund between RD -15 of KPOD and the tail of Mirwah Minor	Flood protection bund between RD -15 of KPOD and the tail of Mirwah Minor
	Flood protection bund between the tail of Mirwah Minor and the outfall of Fuleli Guni drain	Flood protection bund between the tail of Mirwah Minor and the outfall of Fuleli Guni drain	Flood protection bund between the tail of Mirwah Minor and the outfall of Fuleli Guni drain	Flood protection bund between the tail of Mirwah Minor and the outfall of Fuleli Guni drain	Flood protection bund between the tail of Mirwah Minor and the outfall of Fuleli Guni drain

Component of Alternative	Alternative-1	Alternative-2A *(Recommended by NESPAK-ACE-DMC Design JV)*	Alternative-2B	Alternative-2C	Alternative-3 *(Recommended by Stakeholders)*
Other works	Access road cum bund in between dhand system and the sea	Access road cum bund in between dhand system and the sea	Access road cum bund in between dhand system and the sea	Access road cum bund in between dhand system and sea	Access road up to RD -145 of Tidal Link
	No new drain	No new drain	Construction of new drain parallel to KPOD to recharge Pateji Dhand with storm water	No new drain	
	No new weir	No new weir	Construction of a new structure in place of Cholri weir but at a different location	No new weir	
					Provision of 2 new community centres, facilities for fishing boats, and mobile pump

WSIP-I Component C Regional Plan Consultants Critical Assessment

The report compiles general data about LBOD Badin area and provides useful information for the Regional Planning Consultants Phases II & III.

Among the more important contributions are the consultation and stakeholders' workshops reports. The document proposes increasing the design flowrate from 5 years return period to 10 years. It analyzes two alternatives; the first one widening the canal bed and raising the embankments but keeping the same water level inside LBOD and the second, one raising the embankments and raising the water level inside the drain.

The first option was discarded due to the high remodeling cost. The second option was further divided into three options. There seems to be a contradiction among the options, because options 2A and 2C recommend a bund on the Southern side (Indian border) to protect the Tidal Link and nothing on the Northern side, which means that there is no need of protection on the Northern side. Option 2B recommends a bund on the Northern side and nothing on the Southern side, which implies that there is no need of protection on the Southern side.

The Tidal link L-section was observed by the NIO under the WAPDA/NESPAK study and is presented among the results. The maximum scouring reported is about 60 to 70 feet.

Despite this important data, no other geotechnical investigation was found (it is unknown if there were any subsurface explorations or not).

WAPDA recommends a plug at RD (-) 145 of Tidal Link which in view of the scouring reported (60 to 70 feet deep) is highly questionable without detail geotechnical investigations. Any structural solution to Tidal Link must be supported by soil mechanics explorations at least 100 feet below.

The recommendation of including a flap gate Structure near RD (-) 5 of KPOD needs to be supported by proper geotechnical investigation.

The original LBOD design was for 5 years return period flow, which implies a probability of 50% of having at least one similar or greater storm to occur in a period of 3 years. The chances that the maximum capacity will be reached or exceeded every three years are the same as tossing a coin into the air every three years and hoping for it to fall head up.

The 2003 storm experienced has a return period of 6.6 years. This implies a probability of 56% of having at least one similar or greater storm to occur in a period of 5 years. The flowrate proposed by WAPDA/NESPAK corresponding to 10 years return period implies a probability of 52% of having at least one similar or greater storm to occur in a period of 7 years and 80% in a period of 15 years. Increasing the capacity of LBOD has significant implications and is rigorously opposed by some of the stakeholders. If this is the case, some measures will be needed for the people to be prepared to react during flood events, because flooding will be part of their lives.

Data Collection and Preliminary Analysis

The data collection related to drainage and flooding is done by various Government organizations. The data collection responsibility of some Ministries, Agencies and Departments with potential direct involvement with WSIP-I and a summary of the findings regarding the data collection,

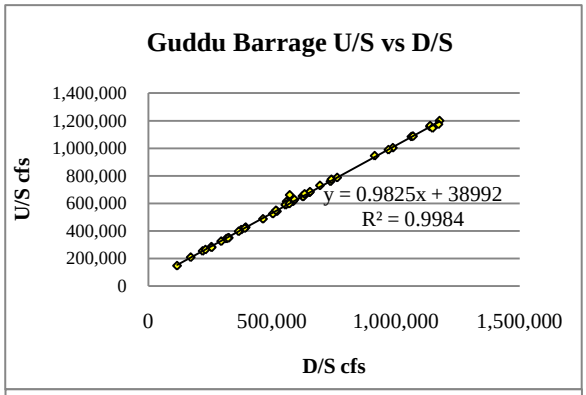
detailing the agency in charge, the systems of data collected and its suitability for planning and decision making is given in Table 4.1.8. Due to insufficient budget, equipment, trained man power and data processing facilities concerned departments need improvements to enhance their capabilities.

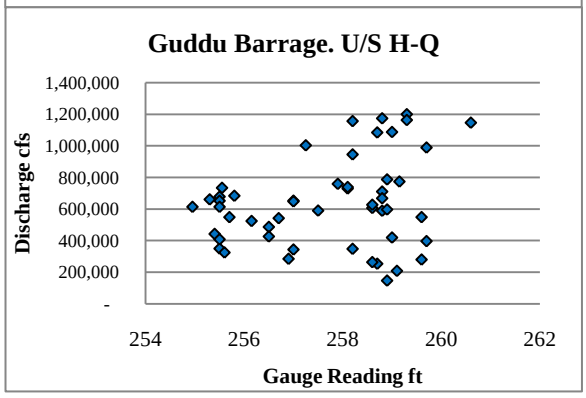
In water resources projects the data collection is vital for the proper administration of the systems, where MEASUREMENT is synonym of MANAGEMENT. If you can measure it, then you can manage it. In general terms it can be stated that the data collected by some Government agencies is insufficient, not easily available, unsystematic and inaccurate for proper decision making.

In 2005, FAO conducted a rapid appraisal survey of Ghotki, Nara and Left Bank Canal AWB, where they concluded that the cross regulators and head gate structures of the Nara Canal System are not used as control structures. Instead, the canals are operated using staff gauges downstream of the cross regulators as an alternative for flow rate control, thus the data collected and/or the decisions made/reported using these readings are highly inaccurate. FAO concluded that local staff does not have either the technical training or the equipment needed to properly calibrate rated control sections.FAO further highlighted that more emphasis should be placed during the modernization planning and training on proven flow measurement devices and technologies.

Barrages Data and Analysis

Guddu Barrage



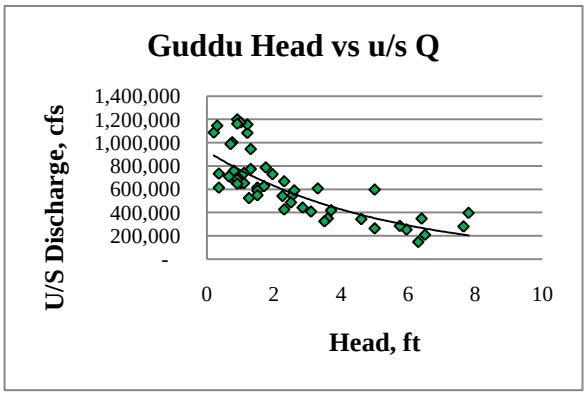


Data for the upstream and downstream peak discharges at Guddu Barrage from 1963 to 2010 were made available to the Consultants. The plot of discharges upstream versus downstream of Guddu Barrage show a perfect linear correlation, as can be seen in the figure. Despite the sediment deposition/scouring, wear and tear of the gates and other parameters that might be affecting the flowrate, this correlation remains the same and leads us to believe that the stage discharge relationship upstream and downstream might have not been updated most likely since 1963. The flowrate through the barrage gates under normal conditions behave as non modular flow and non modular flows are highly susceptible to any variations on the physical conditions of the control points. This somehow implies that the reported discharges are approximate. How approximate? This data needs further investigation before any conclusion can be adopted. The data is presented in Vol-II Thematic Area 4.1.

Data for Head-Discharge Relationship at Guddu Barrage

As per the request of the panel of experts the head-discharge relationship of Guddu Barrage was analysed. The discharges upstream of the Barrage were ploted against the corresponding upstream gauge readings. No correlation was found. The same exercise was conducted for the downstream head discharge relationship. In this case the trend is clear, however the coefficient of correlation is in the lower range.

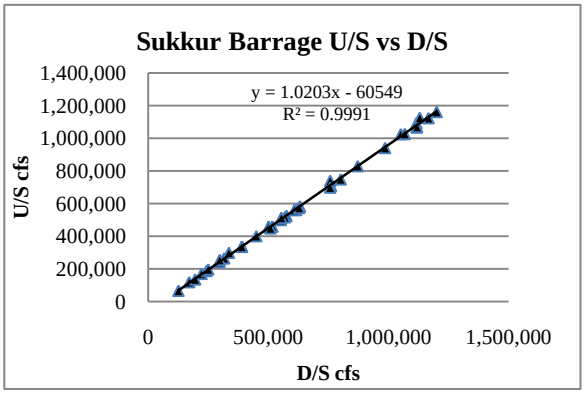
The available head (upstream gauge readings minus the downstream gauges readings) were plotted against the discharges reported upstream and also downstream. A general trend in both cases is observed, however, the correlation is low. From the chart it can be observed that as the available head increases, the discharge decreases, which mean that few gates are open, letting smaller discharges pass and storing water in the lake formed by the Barrage.



Sukkur Barrage Data

Withdrawals Capacities as per Design and Presently Sanctioned Data

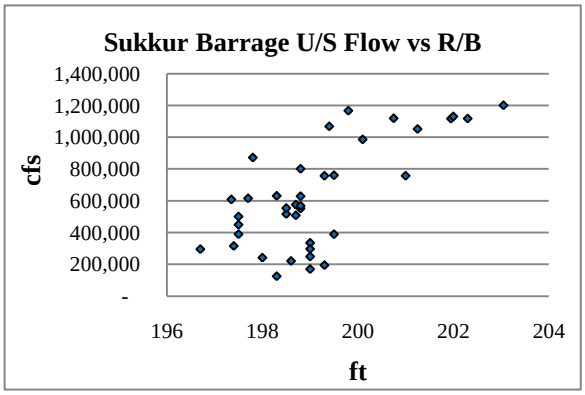
According to the Sindh Irrigation and Power Department, Sukkur Barrage feeds three canals on the right bank: (i) Dadu, (ii) Rice and, (iii) North Western and four on the left bank: (i) Khaipur West, (ii) Rohri, (iii) Nara and, (iv) Khaipur East. The total withdrawals capacities during the design phase from the right bank were 18,960 against 29,315 cusecs sanctioned at present. The withdrawals capacities from the left bank were 28,570 and 35,413 cusecs as per design and presently sanctioned and the combined withdrawals from right and left during design and present are 47,530 and 64,728 respectively.



The plot of discharges upstream versus downstream of Sukkur Barrage as per the data published by the IPD from 1973 to 2010 (presented in Vol-II Thematic Area 4.1) show a perfect linear correlation as can be seen in the figure below. This correlation indicates that the withdrawals from right and left have not been altered since 1973, which somehow contradicts the statement about the original and presently sanctioned withdrawals. This data needs further investigation before any conclusion can be adopted.

Data for Head-Discharge Relationship at Sukkur Barrage

Being aware that the discharges through the gates of Sukkur Barrage hydraulically behave as submerged orifices, and therefore for proper analysis the available head is required, in an attempt to find the head-discharge relationship of Sukkur Barrage, the discharges upstream of the Barrage were plotted against the gauge readings on the right bank abutment. No correlation was found.



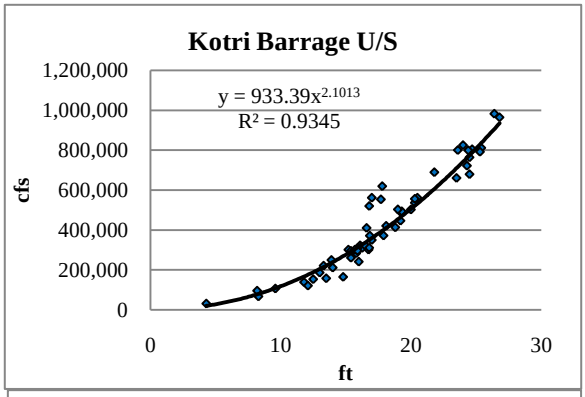
Since the data does not indicate the number of

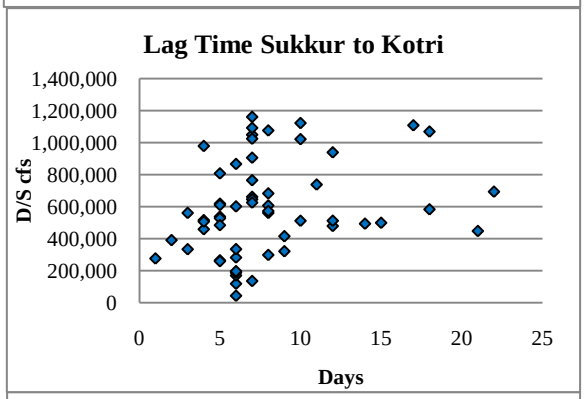
gates open, neither the openings of each of them during the time the readings were recorded, no conclusions can be withdrawn at this stage, but a word of caution regarding these data is suggested, as well as further investigation.

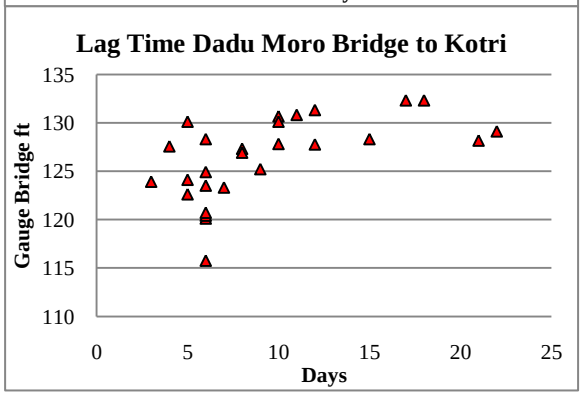
The data provided by the IPD provides upstream and downstream gauge readings at Pier 23, which allows us to estimate the available head for submerged flow. The discharges upstream of the Barrage were plotted against the head at Pier 23 and once again no correlation was found. Since there is a linear relationship between upstream and downstream discharges, it is concluded that a plot of downstream flowrates and the available head at Pier 23 will present no correlation either. Once again, since the data does not indicate the number of gates open, neither the openings of each of them during the time the readings were recorded, no conclusions can be drawn at this stage, but a word of caution regarding these data is suggested, as well as further investigation.

Kotri Barrage Data

The plot of discharges upstream versus downstream of Kotri Barrage as per the data made available by the IPD from 1955 to 2010 (presented in Vol-II Thematic Area 4.1) show a perfect linear correlation. This correlation, as the correlation of the other two barrages, indicates that the withdrawals from right and left have not been altered since 1955, despite the silt deposition/scouring and normal wear and tear of the gates. Moreover, such a perfect fit leads to believe that the relationship is linked more to an analytical study rather than a field discharge calibration of gates. These data needs further investigation before any conclusions can be adopted.







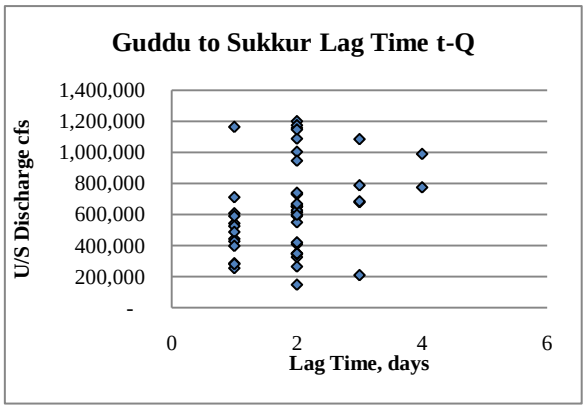
Data for Head-Discharge Relationship at Kotri Barrage

As in the case of Sukkur Barrage, the discharges through the gates of Kotri Barrage hydraulically behave as submerged orifices, and therefore for proper analysis the available head is required. However, in an attempt to find the head-discharge relationship of Kotri Barrage, the discharges upstream of the Barrage were plotted against the gauge readings on Kotri Gauge. The correlation found is encouraging. The correlation shows a power function type of relationship between the upstream discharges and the gauge readings. The exponent of the equation calculated is the slope of a log-log plot of the same parameters.

Since the data does not indicate the number of gates open, neither the openings of each of them during the time the readings were recorded, no conclusions can be drawn at this stage.

Lag Time

The lag-time reported for the time the water took to travel from Sukkur Barrage to Kotri Barrage was plotted against the discharge reported downstream of Sukkur. No relationship was found. It may be observed that the discharge received at Kotri, differs from the discharge released from Sukkur. Sometimes it increases and some others it diminishes, which may explain the reasons the two sets of data do not correlate with each other.



Dadu Moro Bridge

The data provided by the IPD includes gauge readings at Dadu Moro Bridge. This data was plotted against the lag-time reported for the time the water took to travel from Sukkur Barrage to Kotri Barrage. No relationship was found. Once again it may be observed that the discharge received at Kotri, differs from the discharge released from Sukkur. Sometimes it increases and some others it diminishes, which may explain the reasons why the two sets of data do not correlate with each other. Perhaps there is no relation between the time it takes for the water to travel and the gauge readings at Dadu More Bridge and other parameters might have to be identified to be able to predict the water travel time.

Lag time Guddu to Sukkur

The lag time reported for the water to travel from Guddu to Sukkur Barrage was ploted against the discharge of Guddu Barrage and also in a separate chart against the discharge of Sukkur Barrage. The lag time varies from one to four days. Within this very short range the data does not provide a good correlation. Perhaps the lag time should be measured in hours rather than in days.

4.1.3 Issues and Problems Identified for the Thematic Area

A number of studies related to agriculture, irrigation, drainage, flooding, poverty and development have been conducted in Sindh. On one hand some of the studies and reports are obsolete and need to be updated because the cropping patterns change, the demand changes (population doubles every 25 to 30 years) and the price/cost changes. On the other hand, the stakeholders complain that the feasibility studies have already been conducted and question the investment in studies that have already been conducted before.

Specific comments about the issues and problems regarding data collection by different agencies are presented in Table 4.1.8. In general terms, the following can be said in relation to the adequacy and timing in systematic/ systemic manner for use/ decision making:

- Insufficient budget for data collection
- Insufficient equipment for data collection
- Insufficient trained personnel for data collection
- Insufficient will for data collection

Table 4.1.8: Data collection related to drainage and flooding is done by various Government organizations

No.	Agency	Systems of data collection	Comments on data collection
1	**WAPDA**	1. Monitor and manage the dams and reservoirs for irrigation releases from the point of view of specific hazard peculiar to that area; 2. Provide telemetric data from rain gauge stations and flood data from Indus River Basin to the Flood Forecasting Division of the Pakistan Meteorological Department;	**Water & Power Development Authority (WAPDA)** **Background** Water and Power Development Authority (WAPDA) was created by Govt: of Pakistan in 1958 and it was divided into two major divisions namely Water & Power. Water Sector (WAPDA) was held responsible for: - Planning evaluation and preparation of feasibility reports of mega and small projects like Dams. Reservoirs, Flood Management and SCARP (Tubewell) Projects. - For all above projects WAPDA was and is responsible for: • Clear Statement of objectives • Collection of required data and its analysis. • Project investigations. • Preparation of preliminary design and cost estimate. • Analysis of Plans for economic viability • Selection of most attractive sometimes called the definite plan. • Preparation of monitoring plan with a view to receive feedback for the planning of future projects. **Functions** Responsible for Monitoring and O&M of projects working under WAPDA, like Dams, Reservoirs, Drainage & Irrigation Projects, Discharges at Rim stations of all rivers, Snow melting discharges at Barrages, upper & Lower Indus Basins of Country. **Over View/Comments** WAPDA is one the main Organization of the country which has played major and positive role in Agriculture as well as in Power sectors. It has the credibility to construct mega projects like, Dams, Reservoirs and also provided the network of Drainage & Irrigation System within the country. These projects are running well, however there are some handicaps in running the projects due to the following factors. Major Dam sites are filled before time, especially in Kharif Season, when there is high demand for supplying the irrigation water at Lower Indus Barrages for cultivation of cash crops like cotton and Rice. - Rim Stations are not properly monitored. Major issues regarding LBOD due to failure of Tidal system has created panic in Badin area.

Table 4.1.8: Data collection related to drainage and flooding is done by various Government organizations

No.	Agency	Systems of data collection	Comments on data collection
2	**Provincial Irrigation Department IPD**	1. Along with WAPDA, monitor and manage the dams and reservoirs for irrigation releases from the point of view of specific hazard peculiar to Sindh; 2. Data regarding repairs of flood protection works in the pre-flood season; 3. Inspect breaching of sections and carry out repair and improvement works of flood protection embankments.	**Irrigation and Power Department (IPD)** **Background** The Irrigation System of Country is the largest integrated irrigation network in world, serving 34.5 million acres of contiguous Cultivated Land. The System is fed by the waters of Indus and its tributaries. The salient features of the system are three major storage reservoirs, namely, Tarbela and Chashma on River Indus and Mangla on River Jehlum, 19 barrages: 12 inter-river Link canal and 43 independent irrigation canal commands. - **Diversion of river Water** Diversion of river Water into canal is made through Barrages which are gated diversion weirs. The main Canals in turn deliver water to branch canals, distributaries and minors. The Diversion in Lower Indus region is regulated through three Barrages i-e Guddu, Sukkur and Kotri Barrages. The Barrage and Canal System of the region is under control of Sindh Irrigation Department (IPD). - **Role and Adequacy of Sindh Irrigation and Power Department:** Overall work of irrigation system of province is controlled through IPD Govt: of Sindh. This department was established since British regime, the first Sukkur Barrage was commissioned during 1932, second Kotri Barrages in 1954 and last one Guddu in 1962. The Whole system is under the major supervision of Irrigation Department. In addition to that IPD (GoS) is responsible to look into day to day requirements of discharges being supplied through IRSA. Also its main responsibility is to monitor the telemetry system, weather the flow through this system is perfect or something is made wrong to supply less amount of water to the lower Indus region. Not only this, but its responsibility is to get due share of water during the sowing period of Kharif and Rabi season. **Overview/ Comments** In recent past this department in local terms of people was called as a “Royal” department from the points of view of good governance point of view, best subordination, good performance, better O&M, water equity distribution, this was the best institution Technical hands, good administration and good coordination with stake holders and other allied departments. Now, under present conditions, when it has been divided into two sectors i-e SIDA (a sister organization) created during 1997 for taking over the canal system in three area water Boards its

Table 4.1.8: Data collection related to drainage and flooding is done by various Government organizations

No.	Agency	Systems of data collection	Comments on data collection
			performance in different sections has been affected, like proper maintenance of three Barrages, seasonal O&M of Canals (during closure) for desilting and maintenance of IP and NIP, control on cutting of trees on canal paths. Negligible co-ordination between sisters (SIDA) department. Poor performance for distribution of Irrigation under political pressure had damaged the image of department which was one of the leading and prominent institutions of province. Further, the management or authorities of this department have not been able to get their due share of water according to the water treaty, and even are not able to get the due share for lower Indus region during the sowing period of Kharif and Rabi crops. Also during last year flood (2010), they were not fully able to manage for passing the flood water through their systems and all previous records were broken by two main breaches at "Thori" and MS Bund, which have not only dislocated the people, but created panic on left and right bank of Indus. In perspective of above facts, it is important to re-strengthen and revive of a good intuition, which has been spoiled due to some non acceptable policies made by the Technocrats and Policy makers by the concerned authorities.
3	**Sindh Irrigation and Drainage Authority**		**Sindh Irrigation and Drainage Authority** **Background** Sindh Irrigation Drainage Authority is an autonomous organization established in 1997 main task of SIDA are: • Supply Water from Barrages to Canals. These canals will be operated by three water Boards. • Receive water charges from the Area Water Boards and from other water users. • Construct, operate and maintain Irrigation, drainage and flood protection infrastructures. • Help in formations of farmers organizations (FOs) within the three area Water Boards. • Monitoring the water equity distribution among the water users. • Responsible to share the problems with stakeholders. • Create the awareness among the communities of the area Water Boards for achieving their basic rights. • To create best co-ordination among allied departments like IPD (GoS) and WAPDA

Table 4.1.8: Data collection related to drainage and flooding is done by various Government organizations

No.	Agency	Systems of data collection	Comments on data collection
			Water Wing **Overview/ Comments** Although SIDA was created during National Drainage Program in 1997, but still it is not fully established, because of lacking good governance, poor performance of farmers organizations (FOs) and their non co-operation with the SIDA management. Poor performance of Revenue collection by the FOs and its remittance to the concerned authority. - Poor O&M of the irrigation system for example there is no proper maintenance of canal paths of both sides, nominal repair of infra structures under their jurisdiction. - Lack of co-ordination between allied departments. - Insufficient staff to handle the technical matters. - Budget provision is not up to mark for repair and rehabilitation work of system.
4	**Space and Upper Atmosphere Research Commission (SUPARCO)**	1. Provide services in disaster forecasting, monitoring and damage assessment using satellite and remote sensing technologies for floods, cyclones, oil spills, dust storms, droughts, earthquakes, tsunami and glacier depletion; 2. Establish appropriate facilities to acquire and process satellite data for study of storms, monsoons, cloud movements, dust storms, cloud top, land and sea surface temperatures, and other meteorological atmospheric processes;	**SUPARCO** **Background** In 1961, on the advice of Professor Abdus Salam the then scientific Advisor to the President of Pakistan, it was decided to setup a committee dealing with space sciences. Consequently, space sciences Research wing of the Pakistan Atomic Energy commission (PAEC) was established through an Executive order of Pakistan dated 16th September 1961. Later on, Karachi become headquarters where as other offices were opened at Lahore, Islamabad, Multan and Peshawar covering different functions of SUPARCO. **Functions** • Undertake research and conduct pilot studies based on the applications of Satellite Remote Sensing (SRS) data and Geographic Information System (GIS) technology to natural resources surveying, mapping and environmental monitoring • Undertake research studies in space and atmospheric sciences including satellite meteorology, satellite radiance, troposphere/stratosphere studies, atmospheric pollution, satellite geodesy and astronomy • Undertake research studies relating to the ionosphere and associated radio wave propagation and geomagnetism • Development, design, fabrication, assembly, and launching of: - Acquisition of SRS data for earth resources surveying, mapping and environmental

Table 4.1.8: Data collection related to drainage and flooding is done by various Government organizations

No.	Agency	Systems of data collection	Comments on data collection
		3. Provide remote sensing and satellite maps after disasters in order to show their impact;	monitoring studies - Acquisition of data for atmospheric/meteorological studies - Transmitting and receiving signals from communication satellites - Reception of signals from ships, boats and vehicles in distress under the satellite-aided search and rescue COSPAS-SARSAT programme • Establishment and operation of facilities for tracking satellites/rockets to determine their orbital parameters, trajectories, etc • Development of instrumentation for various scientific and technological experiments • Development of software for different functions
5	**Pakistan Meteorological Department**	1. A network of observing stations to generate meteorological, geophysical and phonological data. 2. A telecommunication system for speedy dissemination of data 3. Meteorological offices to analyze data for issuing forecasts and warnings for aviation, agriculture, shipping, sports, irrigation etc. 4. Climatologically and data processing units for scrutinizing, comparing and publishing data for appraisal of long term weather trends and earthquakes.	**Pakistan Metrological Department** **Background** The Climatological Data Processing Centre (CDPC) based on personal computers (PCs) was established, within Pakistan Meteorological Department in September, 1988. CDPC is located at Meteorological Complex, Karachi. This center has been established for storage, processing, retrieval printing and supply of climatological & meteorological data to end users. Two Computerized Data Processing Centers, known as Regional Data Processing Centers have been established at Karachi and Lahore. Both these Regional Computer Centers and main center have been equipped with IBM Compatible PCs, which are being operated and utilized by trained meteorological personnel to meet the need of local & foreign end users **Functions** 1. Supply of meteorological data stored on computer media to end users according to their individual requirements. 2. To make efforts for establishment of computerized meteorological database in the country in accordance with WMO requirements. 3. Issuance of a monthly climate surface/ & TEMP message of 25 & 6 stations of Pakistan respectively through GTS to WMO designated regional hub for onward transmission on regular basis. 4. Scrutiny and quality control of all meteorological data available in the data bank. 5. Training and keeping adequate staff capable of both the computer operation and the processing of meteorological / climate data. 6. Development of various Meteorological, astronomical, statistical and climatological products, in the

Table 4.1.8: Data collection related to drainage and flooding is done by various Government organizations

No.	Agency	Systems of data collection	Comments on data collection
			form of tables, maps, graphs, wind roses etc... 7. Deals with sunrise/sunset, moonrise/moonset, coordinates of new moon on 29th of each lunar month for new moon lighting, solar and lunar eclipses, seasonal forecasts for summer and winter rains. **Overview/Comments** Up till now it is not fully able to provide meteorological expertise and professional services in support of national economic development, and for the safety and benefit of the community; to provide information on meteorological and geophysical matters with the objective of traffic safety in air , on land and sea , mitigation of disasters due to weather and geophysical phenomena, agriculture development based on climatic potential of the country, prediction and modification of weather forecast in timely manner In parallel to the national interest and consistent with its assigned role from World Meteorological Organization (WMO), Pakistan Meteorological Service is supposed to aim to deliver quality forecast, warning and advisory services to the communities of coastal zone area and fisherman fishing in the territories of Arabian sea falling within the boundary limits of the country

4.2 WATER RESOURCES AND WATER USAGE FOR DRAINAGE AND FLOODING

4.2.1 Background

Water resources in the study area comprise of three components surface water, ground water and storm water. Surface water is supplied through Guddu Sukkur and Kotri barrages. Groundwater comprising of fresh ground water strip on left bank adjacent to River Indus and some pockets scattered in other areas. The remaining area is underlain by saline ground water of marginal and brackish quality. Storm water is generated from rainfall which can be harvested and collected in the existing naturally occurring depressions or artificial ponds.

In order to meet the scope of the Phase-I study, being mainly an inventory and assessment of existing conditions and the identification of issues and problems related to drainage and flooding, the topics related to rain harvesting and options for Thar Coal were studied using the tasks listed in Table 4.2.1.

Table 4.2.1: Topic Outline for Summary of the Thematic Area 2 Study

Topic of Concerns for Phase-I Task Studies	
Subjects Covered	**Phase-I Tasks Included**
II – Water Resources And Water Usage for Drainage and Flooding	
✓ Rain water harvesting ✓ Storm water retention and reuse after flooding	T-2: Review and examine rainwater harvesting and storage of storm water usage T-11: Study and analyze options for water supply to Tar Coal Field

4.2.1.1 Surface Water Resources

The main source of the surface water is River Indus. Irrigation water in the study area is diverted from Indus River through eight main canals. Ghotki Feeder Canal takes off from Guddu Barrage. Khairpur East Canal; Khairpur West Canal; Rohri Canal and; Nara Canal off take from Sukkur Barrage. Akram Wah; Fuleli Canal and; Pinyari Canal off take from Kotri Barrage. Salient features of the irrigation network which supply water in study area is presented in Table 4.2.2. Annual entitlements and withdrawals of eight canals are presented in Table 4.2.3.

Annual Water entitlement of Ghotki Feeder Canal is 3.484 MAF (Million acre feet) Khairpur West is 1.148 MAF, Khairpur East 1.319 MAF, Nara Canal 7.803 MAF, Rohri Canal 8.297MAF, Fuleli Canal 3.280 MAF, Pinyari Canal 2.593 MAF and Akram Wah 1.786 MAF with total annual entitlement of all 8 Canals is 29.562 MAF. Annual withdrawals of 8 Canals for years 2004-05, 2005-06, 2006-07, 2007-08, 2008-09 and 2009-10 were 26.7, 29.0, 24.8, 25.199, 22.02 and 23.696 MAF.

Table 4.2.2: Barrages & Main Canals in the Study Area

Barrage	Canal	Canal Classification	Water Allowance (DES) Per 1000 acres (Cusecs)	Maximum Authorized Discharge (Cusecs)	GCA (Million Acres)	CCA (Million Acres)
Guddu	Ghotki Feeder	Non-Perennial	6.0	11670	1.017	0.855
Sukkur	Khairpur East	Perennial	3.2	2550	0.570	0.369
	Khairpur West	Perennial	3.2	2150	0.424	0.322
	Rohri	Perennial	2.7	16936	2.667	2.601
	Nara	Perennial	2.8	13861	2.502	2.240
Kotri	Akram Wah(Lined Channel)	Perennial	6.1	3770	0.518	0.487
	Fuleli	Non- Perennial	14.0	14330	1.111	0.929
	Pinyari	Non- Perennial	4.44	10490	0.948	0.786

Source: History and Irrigation Practices IPD April 1993

Table 4.2.3: Entitlement and Canal Withdrawals in Guddu, Sukkur, and Kotri Barrage Sub-Regions in Study Area

Sub-Regions/Canal	GCA (MA)	CCA (MA)	Entitlement (MAF)	2004/05 (MAF)	2005/06 (MAF)	2006/07 (MAF)	2007/08 (MAF)	2008/09 (MAF)	2009/10 (MAF)
Ghotki Canal	1.017	0.855	3.484	2.6	3.1	3.3	3.32	2.92	2.68
Guddu Sub-Region	**1.017**	**0.855**	**3.484**	**2.6**	**3.1**	**3.3**	**3.32**	**2.92**	**2.68**
Khairpur Feeder (West)	0.424	0.322	1.148	0.9	0.8	0.8	0.832	0.844	0.856
Khairpur Feeder (East)	0.570	0.369	1.319	1.0	1.1	1.1	1.18	1.21	1.24
Nara Canal	2.502	2.240	7.803	7.0	8.0	7.2	7.25	8.58	7.43
Rohri Canal	2.667	2.601	8.297	6.1	7.2	5.9	6.5	6.26	6.39
Sukkur Sub-Region	**6.163**	**5.532**	**17.419**	**15.0**	**17.1**	**15.0**	**15.762**	**16.849**	**15.916**
Fuleli Canal	1.111	0.929	3.280	4.7	4.6	3.3	3.08	3.67	3.43
Pinyari Canal	0.948	0.786	2.593	3.3	2.7	2.2	2.06	2.3	1.87
Akram Wah	0.518	0.487	1.786	1.1	1.5	1.0	0.977	1.29	1.04
Kotri Sub-Region	**2.577**	**2.202**	**7.659**	**9.1**	**8.8**	**6.5**	**6.117**	**7.26**	**6.34**
Total Left Bank	9.757	8.589	28.562	26.7	29.0	24.8	25.199	27.074	24.936

Source: Development Statistics of Sindh 2008 for years (2004-05, 2005-06, 2006-07)
IPD for years (2007-08, 2008-09, 2009-10)

4.2.1.2 Groundwater Resources

Estimated ground water resources for the Sindh province varies between 13 to 16.2 MAF with an estimated safe yield between 4.4 to 8.1 MAF. More than 78% of the irrigated land in Sindh is underlain with saline or brackish water, which is unfit for agriculture. The shortage of irrigation water coupled with drought conditions in Sindh and the unreliability of canal water, have increased the importance of exploitation of groundwater wherever fresh water or even saline water of marginal quality is available. Fresh groundwater is found mostly in a strip parallel to the left bank of Indus River and some pockets in other areas. Reliable data on extent of groundwater use in the Province is not available. There are about 53,862 tubewells in Sindh. Of these 12,038 are public tubewells and 41,824 are in the private sector, though other unofficial estimates put the number of private tubewells much higher. The present number of tubewells is likely to be more than 70,000. Considering an operation factor of 8-10%, the groundwater pumping is estimated to be about 4.9 MAF on annual basis.

4.2.1.3 Rainfall

Annual maximum 24 hour rainfall as recorded for the period 1968 to 2008 in the study area at Badin, Chhor, Karachi (airport), Hyderabad, Nawabshah, Padidan and Rohri is presented in Table 4.2.4.

Frequency analysis of the rainfall data collected at recording stations indicate that the predicted maximum rainfall occurrence in 24 hours is in the range of 68 to 113 mm from Rohri to Badin with 5 year return period, however the expected rainfall for return periods 10, 25, 50, 100 and 200 years is quite high as presented in the Table 4.2.5.

4.2.1.4 Rainwater Harvesting

Rainwater harvesting is process of accumulating and storing of rainwater for reuses before it reaches the aquifer. Water collected from the areas which are specially prepared for this purpose is called storm water harvesting.

The quantum of storm water in the study area generated from rainfall is 6.73 MAF as presented in Table 4.2.6. Out of which 5.46MA is generated in the eight canal command areas and 1.27 MAF in Thar area which is outside canal command area. Storm water is presently disposed of through drainage systems and accumulates in the depressions or create ponding situation in the fields.

Depressions (Dhoras) in left Bank study area

Lower Indus Valley has remained the play ground for mighty Indus River and has often shifted its course from East to West touching the Khirthar ranges and again West to East hitting and dissecting the Thar Desert. In this way it has shifted its course for many times and now has been confined by weir control.

During its shifting (meandering) period, the River has left its prominent features like depressions (Dhoras) on the surface of soil in the shape of oxbows, scars and channel remnants. These prominent features are still intact and are quite visible on ground.

Table 4.2.4: Annual Maxim (24-hour duration) Rainfall Record (mm) at Various Meteorological Stations of Project Area

Year	Badin	Chhor	Karachi (airport)	Hyderabad	Nawabshah	Padidan	Rohri
1968	4.6	17.5	7.6	7.4	3.6	13	0.5
1969	0	4.1	29.2	3	13.2	19.6	1
1970	117.6	61	97	67.6	59.7	36.8	0.5
1971	42.2	51.3	23.1	18	8.6	50.3	0.9
1972	29.7	21.8	20.8	12.7	256.5	9.1	0.5
1973	35.6	32.8	104.6	21.8	17.3	27.4	0.3
1974	13.6	5	5.6	12.7	0.5	1.8	43.2
1975	61	40	31.6	29.1	52	54.9	64.6
1976	64.7	58.4	122.4	57.6	32.8	43.9	44.4
1977	60.8	88.6	207	47.4	22	32.5	24.6
1978	41.5	87.2	133.6	106.6	73	45.2	184.5
1979	241	29	166	41.6	64	16.2	35.6
1980	27	11	43.8	41	40.9	26.5	15.2
1981	138	42.2	47.6	17.7	51.2	32.9	28
1982	75.6	35.3	74	26.3	42.6	23.6	25
1983	67.4	119.9	38.9	101.7	48.2	43	46
1984	111.1	83.6	113.7	110.3	48	16	14
1985	55.7	97.6	37	30.7	35.9	48.6	23.1
1986	61.1	48.3	25.4	69.9	99	10	71
1987	0	23.7	0	14.2	0	20	18
1988	124.7	88.6	5.1	60.4	13.3	28.4	98.8
1989	95.4	86.6	58.8	79.2	27.5	20.3	63
1990	159.3	214.6	57.2	58	87.5	57.4	25.1
1991	36	20	19.5	6.5	26	42.8	5.8
1992	80	117	91.7	104.3	97	143	173.7
1993	119	123.4	9.8	27	29.2	70	49.5
1994	176.5	81.3	46.5	76.7	143	126	111.2
1995	88	60	81.3	31.2	72.2	95.5	64.2
1996	12	69.5	33.2	6.3	1.2	26.8	5.5
1997	31	36.3	24	12	30	20.5	40
1998	45.2	52.3		19.4	22		
1999	113.5	107.2		38.1	8		
2000	48.8	32.9		25.8	22		
2001	26.1	70.4		40.5	16		
2002	26	2.3		4	2		
2003	150	137.2		71	61		
2004	73	57.8		85.6	11.8		
2005	23	32.1		15.4	26.3		
2006	80	141.2		48	39.3		
2007	57.6	37.2	124.2	55	67.2	34.8	30
2008	48.4	34	54	81.4	37	32	30.9
2009	74	62.6	142	85.5	29	7	31.2
Average	**69.9**	**62.45**	**62.92**	**44.49**	**43.75**	**38.66**	**41.51**

(Source: Metrological Department)

Table 4.2.5: 24 Hour Maximum Rainfall

Return Period (Years)	Range of 24 hour Maximum Rainfall (mm)
2	27-61
3	45-56
5	68-113
10	90-147
25	118-190
50	133-221
100	157-253
200	176-284

Table 4.2.6: Annual Rainfall Potential and Available Water for Storage

District	Area in (thousand acres)	Annual Average Rainfall (m)	Annual Average Runoff Potential (mm)	Available Water for Storage in Million Acre feet (MAF)
Ghotki	1,554	35.3	16.6	.085
Khairpur	3,889	35.3	16.7	0.213
Sukkur	1,186	91	43.0	0.167
Naushero Feroze	746	91	43.0	0.105
Nawabshah	1,107	124	58.5	0.212
Chhor	1,554	268	126.5	0.645
Sanghar	2,651	268	126.5	1.100
Mirpurkhas	1,977	268	126.5	0.820
Hyderabad	1,364	183	86.4	0.387
Thatta	4,287	192	90.6	1.274
Badin	1,661	174	82.1	0.447
Sub Total	**21,977**			**5.45**
Tharparkar	4,984	165	77.9	1.274
Total				**6.724**

Past and Present Physical Status of Depressions (Dhoras)

During Lower Indus Project (LIP) studies (1964), the aerial mosaics of 1954 at the scale of 1:40,000 were used to map the different physical features of the ground among others. These photographs were used to map the exact locations of different physical features of the terrain, where it was observed that during the period of investigations most of the depression areas were under cultivation, having no problem of salinity and waterlogging.

With the passage of time, overall cropping intensities increased within the left Bank Canal commands of three Barrages. Later on this situation was changed by cultivating high delta crops, mismanagement of irrigation system and seepage losses from the network of canals, branches, distributaries and minors. Such conditions in the study area created waterlogging problem. This menace was confirmed during the soil salinity and waterlogging survey conducted in 1976-79 for irrigated areas of Indus basin by survey and Research organization Planning Division Lahore and report published in 1981. From the result it was obvious that major parts of the existing depressions (Dhoras) areas were waterlogged and mapped under the category of "Water Bodies".

In converting the depressions areas into water bodies, two major factors played the main role;

1- Increase in ground water table depth in adjacent cultivated Lands;

When the water table rises above the surface level of depressions, the horizontal underground flow from cultivated fields started flowing towards the depressions (Dhoras) areas and these served as natural drainage to the nearest cropped lands. The seepage from all around the agriculture lands, slowly nearly filled up the depressions (Dhoras) with water

2- Irrigation and Storm water.

The next factor is the irrigation and storm runoff. These have played a main role in inundating the depressions areas. The waste water of irrigation system when it is not required by crops is allowed to go into the nearest depressions. During monsoon season the storm water standing in the agriculture lands is also being drained out into these Dhoras. However, some of the wise land owners have converted them into fish ponds and are making sustainable profit.

In recent past (2000-2005), the irrigated areas of Indus basin were resurveyed under S&R, project by SCARP Monitoring organization WAPDA, using the SPOT Satellite imagery for mapping the Physical features of the ground. It was observed that condition of depressions (Dhoras) was more or less the same as compared to the previous survey conducted by WAPDA during 1981. There was little difference due to drought conditions prevailed during the survey period of (2000-2005). Overall water table was lowered down that also resulted in lowering the levels of standing water into depressions. Again during the last year's (2010) due to heavy rain fall, the water levels have been raised in depression areas. The names of main depressions (Dhoras) located at various locations of study area are mentioned in Table 4.2.7 Satellite imagery of these depressions are presented in Volume –II Thematic Area 4.2.

Table 4.2.7: Location of Naturally Occurring Dhoras and Dhands

Guddu and Sukkur Commands in Study Area

Figure	Location of Dhoras	Latitude	Longitude	Area in acres
1.	Reti	N 28°05'39	E 69°48'18"	1210
2.	Ghotki area	N 27°57'54"	E 69°21'54"	717
3.	Ghambat, Jiskani, Talpur Vada	N 27°18'36"	E 68°37'	1798
4.	Behlani	N 27°06'54"	E 68°20'42"	582
5.	Phul Town Area	N 26°42'36"	E 68°10'12"	2176
6.	Bandhi Area	N 26°37'48"	E 68°18'	1664
7.	Dour area	N 26°29'24"	E 68°16'12"	3162
8.	Bucheri area	N 26°21'	E 68°16'12"	2362
9.	Bachal Raho and Din Muhammad Zardari	N 26°15'	E 68°15'18"	1856
10.	Sakrand	N 26°10'30"	E 68°18'18"	608
11.	Tando Adam Shahdadpur, and Mansoora	N 25°51'	E 68°43'	1754
12.	Dhoro Naro			
13.	Dhoro Puran			

Depth & Quality of Water in Depressions (Dhoras):

It has been observed during the different surveys conducted mostly by Water Wing WAPDA that an average depth of water in depressions (Dhoras) ranges in between 3' - 6' ft. In those used as fish ponds, the average depth ranges from 4-7 ft.

As per the quality of water is concerned, mostly are classified as marginal water (EC ranges in between 2500 – 3000μS/cm). During shortages of irrigation water in the canal system, some of this water is pumped out for irrigating the adjacent cropped area. However, the water quality of Dhoras trapped in between highly saline lands, are considered hazardous, with EC readings of more than 3000 μS/cm, which are harmful for all types of water use.

A feasibility study is required to quantify the extent and storage capacity of each depression and availability of runoff water for storage. It is essential to conduct surveys of all potential sites. A list of natural Dhoras/depressions is presented in table 4.2.7 and Dhands in Badin area in table 4.2.8.

Table 4.2.8: List of Dhands in Badin Area

Sr. No	Dhand	Average Depth	Average water Level	Average Bed level (AMSL)	Average Salinity (PPM)
1.	Sanhro	2.93	2.02	-0.90	7654
2.	Sanhro-Mehro	3.08	1.79	-1.29	6638
3.	Mehro	2.69	1.93	-0.76	3681
4.	Cholri	1.82	3.20	1.38	13640
5.	Pataje	1.62	3.08	1.46	49,610

4.2.1.5 Thar Coal, Water Supply and Disposal

Thar coal field is spread over an area of 9100 sq.kms in a strip of 140 km (N-S) and 65 km (E-W) in Mithi, Islamkot, Nangarparkar, and Chachro Tehsils of District Tharparkar. Coal deposits have been estimated to the tune of 175 billion tons of lignite coal with an average heating value of 5774 BTU/lb. The coal power plants require pure water supply for their operations. A discharge of at least 280 cusecs are required for generation of 4000 MW electricity. The effluent being highly saline needs to be disposed off at safe places without causing any environment problems. In the key findings of this Thematic Area, options of water supply route and disposal of wastewater are discussed, analyzed and critically evaluated.

4.2.2 Key Findings

4.2.2.1 Rainwater Harvesting

The quantum of storm water in the study area generated from rainfall is 6.73 MAF, out of which 5.46MA is generated in the eight canal command areas and 1.27 MAF in Thar area which is outside canal command area. Storm water is presently disposed off through drainage systems in the area where drainage networks have been implemented and, accumulates in the depressions or create ponding situation in the fields where there are no surface drains.

There are 13 prominent depressions (Dhoras) existing in the different parts of Left Bank area. Out of these, few are being used and converted into fish ponds by the Land owners. Many others are under water having no significant use except to serve as drainage ponds for collecting the seepage from the adjacent Lands. Few depressions (Dhoras) are deep and large enough in length and could be used for rain harvesting. For this, detailed investigations are required to determine depth, length and width, so that quantum of water could be determined for storm water harvesting purpose.

Feasibility is required to quantify the extent and storage capacity of each depression keeping in view the need for storm water harvesting and availability of runoff water for storage. It is essential to conduct survey of all potential sites. Very high evaporation rates present a problem for water storage.

4.2.2.2 Water Supply to Thar Coal

As mentioned before, coal power plants require pure water supply for their operations. A yardstick for the discharge demand is 70 cusecs to generate 1,000 MW. The effluent being highly saline needs to be disposed off safely, without causing environment problems. In this part of the thematic area, options of water supply route and disposal of wastewater are discussed, analyzed and critically evaluated.

i. LBOD drainage effluent
ii. Groundwater
iii. Mined water generated from coal power plants
iv. Canal water

LBOD Drainage Effluent

Left Bank outfall Drain provides evacuation of storm water during rainfall and the ground water drainage effluent generated from the three project components Nawabshah, Sanghar and Mirpurkhas in non rainy periods. The underground brackish water pumped through Drainage Tubewells is around 1,640 cusecs. The difference of levels between LBOD RD (203) and Islamkot is 226 ft therefore water can only be supplied to Islamkot through pumping. Furthermore, due to very high salt content in the water combined with the pumping cost, makes this option not feasible.

Ground Water

Ground water investigations in Thar Coal area were carried out in 1992 by BGR (consulting firm) and WAPDA. The study concluded that in an area of about 600 sq km fresh ground water down to 40 m depth is found in Tharparkar area. The aquifer layers below 40m to 200m from ground surface comprise of deeper sedimentary laminations with resistivity up to 60 ohm-m and it contains highly saline water. For utilizing ground water for power plants, further detailed investigations may be conducted to assess the present situation.

Water Generated From Mining

Sufficient quantity of water will be generated during mining process. The quality of water will be saline as per initial investigations conducted by BGR. Further Investigations are needed for assessing the present situation of quantity and quality of mining water for use in the power plant.

Surface Water

Indus Water for Thar Coal can be considered from Guddu or Sukkur Barrages. Rainee Canal is under construction and takes-off from the left bank side upstream of Guddu Barrage. Nara Canal off-take is situated on the left bank of Sukkur Barrage. Rainee Canal will be a flood (non-perennial) canal without assured supply throughout the year. However Nara Canal is a perennial Canal with assured supply throughout the whole year. The options of Water Supply from Rainee Canal and Lower Nara Canal systems are discussed in the following paragraphs.

Rainee Canal is located on upstream of Guddu Barrage with design discharge of 5,155 cusecs. The Canal will provide water during flood period (August - Sept) for irrigation purposes to an area 0.412 MA. Water from the tail of Rainee canal RL 218.5 ft can be supplied to Islamkot RL 236 through a water carrier running along the Eastern boundary of Lower Nara Canal. The length of the lift cum gravity canal will be around 370 km. The Canal will pass through Thar Desert comprising of windblown sand dunes running from Southwest to North East. The dunes have height-up to 370 ft which would require huge excavations for construction of water carrier. Construction will not be possible due to the instability of slopes and drifting of sand that will result in the choking of the water carrier. This option will be very expensive in addition to heavy capital investment on construction of the water carrier; in addition assured water supply will not be available throughout year as Rainee Canal is a non-perennial as mentioned above.

Chotiari Reservoir.

Chotiari Reservoir is an off stream storage reservoir constructed under LBOD Stage - 1 project. Chotiari Reservoir is filled through Ranto escape off taking from Nara Canal. The design Capacity of the Ranto Canal is 6,500 cusecs. The water management plan of Chotiari Reservoir is based on the assumption that Nara Canal will be remodeled/ improved by construction of five fall Structures and re-sectioning of the canal to accommodate discharge to the order of 20,000 cusecs. This quantum of water will be available during the flooding period. Chotiari reservoir has been designed to accommodate 0.71 MAF at full supply level RL 87.5 ft. The live storage capacity of Chotiari reservoir is 0.67 MAF. The dead storage level is 64.75ft below which water will not be drawn from the reservoir. The carrying capacity of Ranto Canal has been reduced to 1,500 cusecs due to silting and also Nara Canal's carrying capacity has not been enhanced as the per-requisite works have not been completed.

There are two options available for supplying water from Nara canal system, either from Chotiari reservoir or from Farash weir situated at the tail of Lower Nara canal (Makhi-Farash Link). Nara canal off-takes on Left Bank of Sukkur Barrage with design discharge of 13,650 cusecs. The Nara

Canal System comprises sub systems of Jamrao, Mithrao, Khipro and Lower Nara Canal (Makhi Farash Link). Farash weir is at the tail end of the Lower Nara Canal.

Water supply from Chotiari reservoir is not feasible due to construction costs. However water supply from Farash regulator to Islamkot is feasible.

4.2.2.3 Disposal of Wastewater from Thar Coal

There are several sources of waste water generation within the coal power plant systems. The wastewater generated from these sources is of different quantities and qualities. The sources are: -

1. Effluents generated during regeneration of ion exchangers.
2. Alkalies effluent are generated during rinsing of anion exchangers and mixed bed exchangers.
3. Blow down from plant consists of cooling water blow down and boiler blow down.
4. Domestic waste water.

In order to establish a general layout of the proposed drain to carry out effluent from Block-2 to various saline water containing depressions (Dhands) scattered to several miles along border in the South and East-West direction, a perusal of surface spot elevations given on the toposheet is considered necessary. For this, top sheet no. NG42-15 of the area was used. This topo sheet was last modified in 1955. The spot elevations (ft) given in the toposheet were read out and based on these data, 20 feet interval contours were drawn on the map.

Examinations of the contour map of surface elevations reveal that there are two options for alignment of the drain. These options have been emerged out in consideration of general slope of land and flow direction through various valleys and natural drains within the sand dunes.

Option 1: In this option, the drain can be laid out from Block 2 to Sorungwari Dhand towards the South from the source site. This drain can later be connected with block 8 to cater for the needs of waste water disposal.

Option 2: In this option the drain can be laid out from Block 2 running South West between Block 1 and Block 4 up to Libo village from where the drain could be laid out towards the South, right up to Phatar Dhand. With this option, the disposal of effluent from Blocks 1 and 4 also become possible. The layout plan for the proposed drain under these two options is shown in Vol-II Thematic Area 4.2.

This report has been based on Google Earth information of topographic elevations. In the actual situation, field conditions could be quite different. Therefore to arrive at a final decision, detailed topographic survey of the area should be carried out for delineation of layout of the drain pipe line.

The surface elevation contour maps show that the elevation contours run almost parallel in East –West direction in the southern area. The slope is well below the minimum requirement (for drains) for attaining a minimum velocity of 3 feet/sec. Below this minimum velocity, heavily loaded suspended ash particles will be settled and accumulated inside the pipe. No self clean arrangements can be designed other than velocity.

For the above reason, the plan for layout of drain to dispose of effluent into the LBOD seems to be not feasible. Furthermore, detailed chemical and physical analysis is required to check for the pollution.

The length of the drain along the layout plan Option 1 is much shorter than the length of drain under Option 2. Furthermore, the slope of the drain meets the requirement of maintaining a minimum velocity of 3 feet per second. As such, the proposed layout under Option 1 is recommended.

The field was visited by experts who had detailed interview with the local residents and stakeholders. There is no other objection except regarding some seasonal shallow lakes which dry up during the summer season, leaving behind the salt on the surface. These salts are mostly used by the inhabitants of the area for domestic as well as for commercial purpose. These lakes need to be excluded from the inflow of the drainage effluent from the coal fields.

The Thar Coal Field and location of its block(s) to be developed initially are presented in figure 4.2.1.

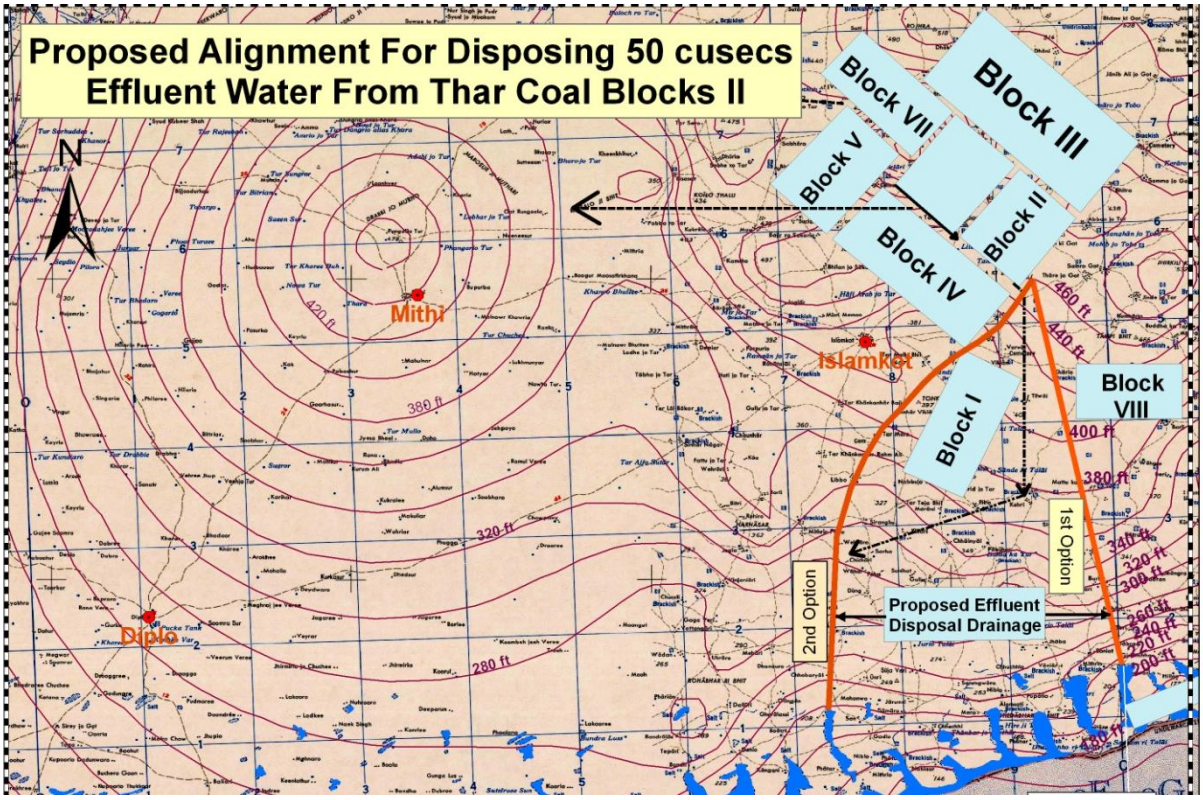
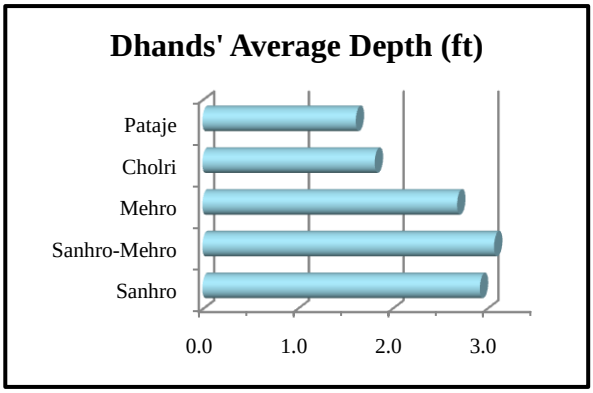


Figure 4.2.1. Layout Plan for proposed Wastewater Drain under Options 1 and 2

4.2.3 Issues and Problems



Rainwater Harvesting

Very high water evaporation rates are observed in the area, which substantially limits the use of the small dhands as the water evaporates within few months. Few depressions (Dhoras) are deep and large enough in length and could be used for rain harvesting. For this detailed investigations are required to determine depth, length and width, so that quantum of water could be determined for storm water harvesting purpose.

Supply water to Thar Coal

Each option for assured water supply to the Thar coal field, require lifting of water from low level to high level will cause considerable difficulties in the operation and maintenance of pumps.

Selection of suitable route for water supply is based on Google Earth information. Sometimes there is a lot of discrepancy between the observed and picked up ground levels from Google Earth. As such, actual topographic survey is required to delineate the true layout of the pipeline.

Disposal of Waste Water from Thar Coal

As proposed, the effluent of Thar Coal Blocks-II will be disposed off into a series of Dhands about 36.5 km from the site (option-1). The estimated quantity of the effluent water is about 36500 acre feet per annum. One lake (Dhand) as originally planned by SIDA is insufficient to store this amount of water. However, if, all the lakes (Dhands) are interconnected, (except those used by local communities for salt harvesting, see section 4.2.2.3) then the drainage effluent can be easily be disposed of without causing any flooding of the nearby villages and land.

Total surface area of all these lakes (Dhands) has been found to be 23722 acres. Taking a conservative side, if annual net evaporation (evaporation-rainfall) is assumed to be 3ft (36 inches), then annual evaporation from these ponds will be equal to 70000 acre feet that is far above the inflow of drainage water. As such there are no chances of over spillage and there would be no adverse impact on the communities living in the vicinity of the disposal site.

4.3 IMPACT OF DRAINAGE AND FLOOD ON ENVIRONMENT AND WETLANDS

4.3.1 Background of Thematic Area

The titles covered in this thematic area include: Seawater intrusion, Riverine and Inland forests located in the left bank of Indus and deltaic area Deforestation, Physical resources, Surface and Groundwater quality, Flow downstream Kotri and impact on Ecosystem, Mangroves in the coastal area, Sources of Water pollution and Pollution through Industrial effluents.

Table 4.3.1: Topic Outline for Summary of the Thematic Area 3 Study

Topic of Concerns for Phase-I Task Studies	
Subjects Covered	**Phase-I Tasks Included**
III –Impacts of Drainage and Flood on Environment and Wetlands	
✓ Salt water intrusion ✓ Deforestation ✓ Soil, climate, surface water, and ground water resources ✓ Land use ✓ Vegetation ✓ Biological resources ✓ Water quality ✓ Mangroves ✓ Lower Indus River Basin ecosystem ✓ Down stream conditions below Kotri Barrage ✓ Ground water quality ✓ Surface water quality ✓ Industrial effluents ✓ Ground water pollution ✓ Surface water pollution	T-3: Document, review and analyze research on sea water intrusion T-5: Document and review deforestation and strategies for reforestation T-9: Analyze potential impacts of climate change T-24: Evaluate quality of Indus River water T-25: Document research on mangroves T-26: Review studies and plans for development of Indus eco-system downstream of Kotri Barrage T-27: Review and analyze information on groundwater and surface water quality T-28: Evaluate how population is affected by industrial pollution T-29: Identify sources of ground water and surface water pollution

4.3.2 Methodology adopted to address the thematic areas

Information collection through Web search, primary and secondary sources

Web search was conducted on environmental and biodiversity problems of the project area with special reference to pollution of surface and underground waters. Literature on Water disasters and measures taken to mitigate the effects of flood and drainage challenges was reviewed. The consultants reviewed reports of the national and international renowned organizations working on the issues of the communities locally and globally. Copies were collected of up-dated progress reports, completed and on-going development projects, issues and problems to manage them, lessons learnt, activities undertaken to develop and monitor the resources.

i. Introductory meetings

Conducted introductory meetings with stakeholders, visited various sites especially those with high risk and vulnerability. Meetings were also arranged with the related NGOs and CEOs of

government related organizations responsible for the relief and rehabilitation tasks. Also meetings were arranged with the Irrigation Department, Environmental Protection Authority, Cane Commissioner's office and responsible officers at various barrages.

ii. Identification of stakeholders

Stakeholders for each area of interest were identified and contacted during the process of data collection. These included beneficiaries, affectees, NGOs working in respective areas, Local influential people, government line department's officers, civil society representatives, CBOs, FOs, WUAs, Abadgar Water Board representatives and Technocrats including personnel from PCMU, SIDA and Water Experts.

iii. Embark on Participatory approach

Steps were taken to listen to the stakeholders and incorporated all stakeholder views in the report. Following activities were undertaken to complete the assignment through the participatory approach:

- Arranged fact-finding and consultative meetings at local and regional levels
- Prepared draft report incorporating feedback/views arrived at meetings and literature review
- Deliberated for seeking their feedback
- Incorporated inputs of stakeholders

iv. Stakeholders Consultative Workshops

A number of consultative workshops were held at different locations of the project area. The aim of holding such workshops was to share their expertise and experiences in identifying their problems and seeking their suggestions on workable and viable solutions. These workshops provided us the information that would help in formulating the feasibility studies for various interventions.

v. Detailed field visits

The consultants visited in person most of the areas that are reported being seriously affected through floods and drainage outfall issues. The damages to the lands, properties, ecosystem, wetlands, and infrastructure were observed on site through local visits and personal interviews with groups of affectees and sometimes through village headman. All such contacts were made as per the communication strategy developed by the Social team of the project.

4.3.3 Key Findings

Seawater Intrusion

In Sindh, the sea water intrusion is mainly caused by tidal effects in Indus River, tidal link and coastal creeks. History depicts that land of Indus Delta was quite fertile as the agriculture fields existed quite close to the sea (about 5 to 7 km) mainly depended upon surface freshwater. The good quality groundwater was also available in the deltaic region just 4 to 5 km from the open sea. The freshwater based riverine forests existed along the Indus river course. The entire deltaic area was rich in biological resources.

Seawater intrusion is mainly taking place due to continuous decrease in the freshwater flows in Indus delta as a result of the development of the upcountry irrigation system and decrease in silt load. This has multi-dimensional negative impacts in the coastal area such as i) depletion of freshwater (ground and surface) in the deltaic region; ii) deterioration in freshwater quality; iii) increase in salinity; iv) degradation of productive agricultural lands into wastelands and swamps; v) Shift in cropping pattern to low value crops vi) and sinking of productive mudflats in the delta. The ultimate impact of seawater intrusion is loss of biodiversity and degradation of deltaic ecosystem.

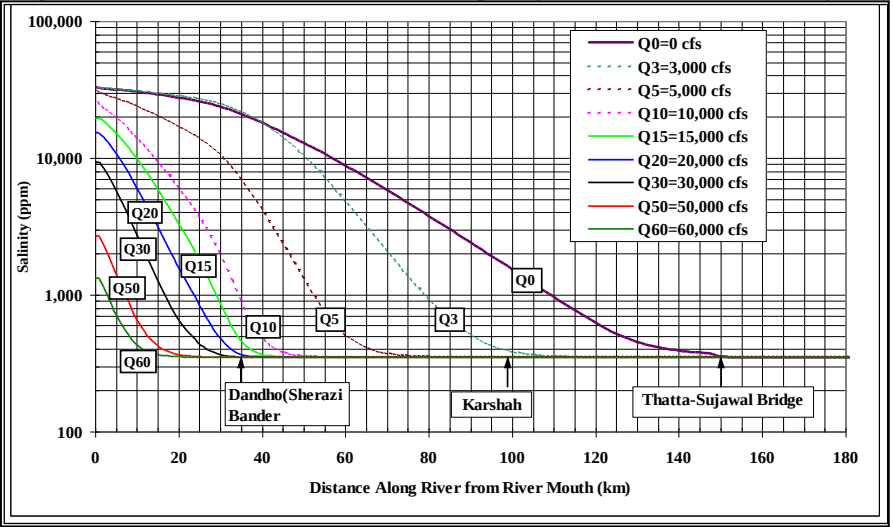


Figure 4.3.1 Shows salinity profile and seawater intrusion (source: FFCP 2005)

Seawater intrusion in the River Indus

Seawater intrusion in the river is variable and depends upon quantum of outflow in the river. MHW, ACE(Pvt.) Ltd, NESPAK jointly carried out a model study to see likely extent of seawater intrusion in the Indus River under various outflow conditions as shown in the (Figure 4.3.1). According to this study, in case of no flow in the river seawater intrusion may be experienced in the river up to about 160 km from the river mouth. With the improvement in river outflow the seawater intrusion retreats. An outflow at the rate of 30,000 cusecs limits the seawater at just 10 km away from Sherazi Bandar. It is estimated that the sea has moved inland degrading more than 485 thousand ha (1.2 million acres) of land in the districts of Thatta and Badin (World Bank 2005).

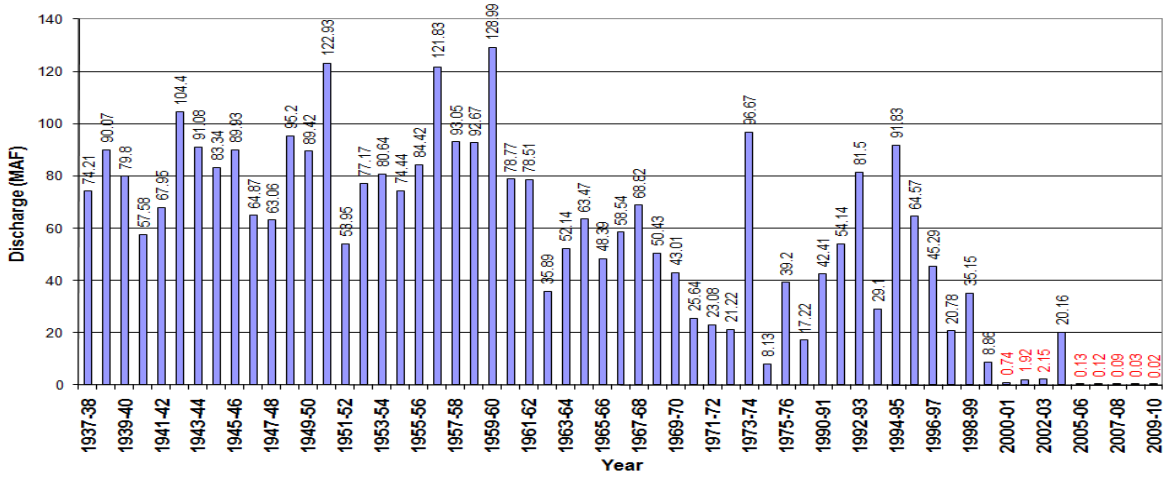


Figure 4.3.2 Discharge Volume Downstream Kotri (1937-2010 on Annual basis
(Source: IPD Sindh)

The recently built drainage system became sources of seawater intrusion for inland particularly after the collapse of the Tidal Link. It has detrimental effects on the environment and has badly disrupted the ecosystem of the area. It has also badly damaged the agriculture due to backflow of hyper saline water in the drains and in the adjoining agriculture land.

Causes of Seawater Intrusion

a) Low and variable input of freshwater and sediments
b) Rising sea level globally due to climate change

Historic record shows that during the pre Kotri Barrage era the downstream flow at Kotri used to be round the year. After the construction of Kotri Barrage, Guddu Barrage and Tarbela Dam, the downstream flow at Kotri Barrage is observed only in the flood season spread over one to two months (Figure-4.3.2 and Vol-II Thematic Area 4.3 Table -4.3.2).

Recommendations of the IPOE

The International Panel of Experts (IPOE November 2005) in their report recommended a minimum outflow of 5,000 cusecs at downstream of Kotri should be maintained, and a total volume of 25 MAF in any 5 years period (an annual equivalent amount of 5 MAF) be released downstream Kotri. During last five years the downstream Kotri flows remained significantly lower than 5 MAF as recommended by the IPOE. An another study by Joint venture of LIG (Germany), IAC (Lahore), and BCE (Peshawar), recommend that at least 4.7 MAF water needs to be released annually downstream of Kotri, only to preserve the mangrove ecosystem.

Now with the rising sea level due to global warming and the decreasing input of freshwater and sediments from the Indus River, the Indus Delta faces serious threats in the following areas:

- Ecosystem and stability of the delta
- Loss of prime agriculture land
- Seawater intrusion, rise in salinity of neighboring lands and aquifers
- Loss of mangrove forest, flora and fauna
- Loss of livelihoods of the coastal population

The viable options to significantly check the seawater intrusion and mitigate its impacts are i) to attempt to grow mangroves in all potential mud flats all along the coastal belt ii) Allow 21 MAF flow of fresh water downstream Kotri every year, all the year round to deposit silt along the coast to create new mud flats and push the seawater back to the sea. These options will increase the area of mud flats; provide nourishment for mangroves and other natural resources especially fisheries.

Sea Water Intrusion in KPOD and Tidal Link

As soon as the the tidal link began operating in 1995, it experienced erosion and scouring problems. This resulted in collapse of 250 ft section of weir in June 1998. The catastrophic cyclone 2A of 21st May 1999 have caused complete collapse of the Cholri weir and some 56 breaches occurred in tidal link on both sides..Contrary to the design, the tidal effect reached far ahead in the tidal link and KPOD. This caused the seawater to travel to dhands under the tidal influence and backwashing/receding when the tide is low. This to and fro movement of seawater in dhand complex

has changed the water quality in dhands from brackish to highly saline. Consequently, freshwater fish and reed grass have disappeared, water fowl population has decreased, and salinity of the adjoining agricultural areas has increased, thereby degrading the fertile lands. In order to revive the ecosystem, the stakeholders proposed to block out the dhands from seawater inflows by constructing bund between the KPOD/Tidal link and the dhands along the right bank of KPOD/ Tidal link. The storm water which is of good quality could be diverted to dhand complex to replenish the dhands, and to reduce the salinity level of dhand water.

4.3.4 Riverine and Irrigated Forests- Causes of Deforestation and Proposed Strategy for Reforestation

After agriculture, forestry is the second largest land use in Sindh. Forests are a natural endowment and valuable resource for the province with a distinctive feature of being renewable. Sindh is blessed with variety of forest types such as riverine forests located along both sides of Indus, irrigated plantations located in the command area of irrigation systems of Sukkur, Guddu and Kotri barrages and Coastal forests located in deltaic region of Indus. Forests have vital social, economic and environmental importance for the economy of Sindh province. They provide productive and protective functions and diversified types of services such as maintenance of environment, absorption of solar energy and sequestration of Carbon dioxide, protection of the river banks from erosion, conservation of biodiversity and wildlife, and prevention of desertification.

Area

Out of Sindh's total land area of 14.1 million ha, an area of about 1.13 million ha (8%) is under the management of Sindh Forest Department (SFD) but only an area of 2.3% is covered by productive forests, namely 241 thousand ha of riverine forest and about 82 thousand ha under irrigated plantation.

Riverine forests located in left bank of Indus river covers 157 thousand ha of which about 43.2 thousand ha is in the Sukkur district, followed by 34.5 thousand ha in Hyderabad district, about 23 thousand each in Shaheed Benazirabad and Thatta districts, about 15 thousand ha is in Naushero Feroze district, about 12 thousand in Khairpur district, and about the 6.2 thousand ha in Ghotki district. . The area under irrigated plantation is about 82 thousand ha, out of which about 35 thousand ha is in the Sukkur barrage command, followed by 29 thousand in the Kotri barrage command, and about 18 thousand ha in the Guddu barrage command. Of the total area under irrigated forest about 65 thousand is in the left bank of Indus, while about 17 thousand is in the right bank (Sindh Forest Management Plans, 2001).

Forest Management Objectives

The main objectives include: i) to increase the vegetative cover over forest lands through conversation and improvement in the existing forests for maximizing sustained production and preservation of ecosystem; ii) to meet the fuel wood and timber requirements on sustained basis; iii) to promote the environmental stability and to preserve bio-diversity and natural heritage; and iv) to intensify management and adopt post care and arrest deforestation so as to achieve the forest productivity potential.

Issues and problems causing deforestation and degradation of forests

Deforestation in the forests of Sindh is caused mainly due to social, economic and environmental reasons. Riverine Forests are complex ecosystem, ecologically suited to their natural environment and rely on annual or periodic river flooding for their survival. The predominant factors include: i) low

inundation flows in the Indus resulting in extended droughts; ii) lower than allocated irrigation supplies (Annexure 4.3.1) iii) deteriorating law and order situation in the riverine areas; iv) conversion of forest lands to agriculture use; and v) poor governance by the FD. The abovementioned factors has taken its toll on the forest cover, and resulted in deforestation in the province.

Furthermore, the Forest Management Plans which are the guiding documents for development and management of forests have either expired their duration or are incompatible with the ground realities.

Proposed Strategies/methods for reforestation of the Riverine Forests and Irrigated Plantations

i. **Artificial regeneration of riverine forests:** Regeneration shall be carried out in three stages-pre-abkalani sowings, mid-abkalani sowings, and post-abkalani. During pre-abkalani the soil is compacted, and seeds are planted, while in the mid- abkalani season seeds of Babul and Kandi in 3:1 ratio is broadcasted. In the post abkalani xerophytic species is planted in case of poor germination.

ii. **Afforestation program in the riverine forests through development schemes**: With the initiation of drought periods especially from 1997 onwards the SFD initiated development schemes in the riverine forests funded out of Annual Development Programme (ADP) through lift water irrigation, either directly from the river or installation of tube wells. This system still followed at modest and small scale, which needs to be accelerated. The approach adopted so far by the department has been without a participatory approach involving local communities/stakeholders in the planning, execution and management processes. It is proposed that strategy of "participatory forestry" be adopted for sustainability in the development of forestry.

iii. **Afforestation through agroforestry leases in the riverine and inland forests**: Sindh Forest Department prepared policy in 2005 to develop forests (riverine and inland) through leasing of forest lands to private entrepreneurs for growing agricultural crops in 75% and 25% tree woodlots in the leased area. The lease was for an initial period of five years extendable up to ten years on the basis of performance and adherence to the terms and conditions of the lease. This program needs to be continued, with necessary amendments to ensure sustainability.

4.3.5 Physical Resources of the Left Bank and Coastal Zone

The importance of natural resources in sustaining productivity and environmental protection is at present more realized than in the past. Its linkage to poverty alleviation by making the farmers partners in the development process with empowerment is relatively a new concept. Natural resources like land, water and rangelands are important for both crop and livestock farming which now has become a limiting factor.

Soils and Land Use

The soils of the Left Bank area are mainly formed by alluvial sediments deposited by Indus River. The dominant textures within the study area include medium textured soils (37.0% Buchiana Series), moderately fine textured soils (32.0% chuarkana), where as minor part of area is comprised of moderately coarse textured soils (18% Farida), and coarse textured soils (5.0% Jhang). The land use classification is given as under:

Perennial Canal Irrigated……. 34%
Non Perinnial Canal Irrigated……. 16.4%

Canal + Tube well Irrigated…… 19.3%
Area under Forest Cover…….. 0.42%
Sand Desert, Waterlogged and Saline…… 22.88%
Urban Areas, Grave Yards, Roads, Canals etc...7.00% (Annexures-4.3.3, 4.3.4, 4.3.5)

Climate and Rainfall

Sindh province is part of the subtropical region; hot in the summers and cold in the winters. Temperatures frequently rise above 46 °C (115 °F) during May and August, and the minimum average temperature of 2 °C (36 °F) occurs during December and January. The average rainfall in Sindh is only 15 to 18 cm per year. There is significant difference in various parameters of climate between the upper Sindh and the lower Sindh, and coastal areas. Temperature is higher in the upper Sindh, while humidity is relatively higher in the lower parts of Sindh. Rainfall is relatively higher in the lower Sindh compared to the upper Sindh. The wind velocity is higher in lower Sindh when compared with upper Sindh. This phenomenon explains the diversity of climate in the upper and lower Sindh.

Sindh Water Resources

Indus River is the main source of water for the province, with limited available fresh groundwater, the yearly average availability of water in the province, computed from the data from year 1970 to 1997, is 45 MAF. According to the Water Accord of 1991 Sindh is awarded 48.76 MAF for both *Kharif* and *Rabi* seasons. The worst ever drought conditions in Sindh, experienced from 1998 to 2002, showed that the province received much less water than allocated in the Water Accord.

Table 4.3.2: Water Distribution as per Water Apportionment Accord 1991

Province	Kharif (MAF)	Rabi(MAF)	Total(MAF)	Balance Flood Supplies %
Punjab	37.07	18.87	55.94	37
Sindh	33.94	14.82	48.76	37
Khyber Pukhtoonkhwah	3.48	2.30	5.78	14
Balochistan	1.80	1.20	3.00	12
Civil Canals	2.85	1.02	3.87	-
Total	79.14	38.21	117.35	

Source: Government of Pakistan

Groundwater Resources:

Estimated ground water resources for the Sindh province vary between 13 to 16.2 MAF with an estimated safe yield between 4.4 to 8.1 MAF. More than 78% of the irrigated land in Sindh is underlain with saline or brackish water, which is unfit for agriculture. There are about 13241 tubewells in Sindh. Of these about 12.859 thousand are private tubewells and about 382 are in the public sector, though other unofficial estimates put the number of private tubewells much higher. The present number of tube wells is likely to be more than 70 thousand, considering an operation factor of 8-10%, the groundwater pumping is estimated to be about 4.9 MAF on an annual basis (Azad 2003).

Groundwater Potential in Sindh:

Useable groundwater in the Province is mainly found in the Indus Plain, which is recharged from the meandering river and from the irrigation network that has been developed in the area. The other source of recharge is rainfall which is quite scanty and its contribution to the resource is limited. Rainfall recharge was 1.96 MAF (2% of 265 mm per year) as worked out by ACE and Halcrow

(2001). The recharge from return flows (22.5% of 38.2 MAF), irrigation returns (22.5% of 3.5 MAF) was assessed 8.58 MAF and 0.79 MAF respectively. In the Sindh, canal water losses have been taken as 15 % of the total average canal supply of 45 MAF for the period 1988-2000. The recharges from these canals was estimated 6.76 MAF. The recharge from the river was assessed 0.3 MAF. The total available resource of the Sindh Province was assessed to be 18 MAF. (**Muhammad Amin**).

In Sindh about 28% of the area has fresh ground water suitable for irrigation. Close to the edges for irrigated lands fresh ground water can be found at 20-25 m depth. Large areas in the province are underlain with non potable highly brackish water including Thar, Nara and Kohistan. In Tharparkar including Umerkot, the situation is further complicated by the occurrence of high fluoride in some groundwater (PCRWR, 2004).

Irrigation in Sindh

The total reported area for the left bank is about 10.3 million hectares (ha), out of which, about 5.8 million ha is arable. Of the available arable land, 4.3 million ha is under cultivation, while 0.6 million ha is under forest, and the remaining 0.9 million ha is culturable waste. The remaining 4.5 million ha is not available for cultivation, and mainly comprise of settlements, waterways, physical, social and physical infrastructure, mountains and rock outcrops, lakes, desert, etc. The actual irrigated area varies from year to year depending on the availability of canal water with an average of 1.8 million ha (Statistics of Sindh 2008). The irrigation system below the barrages (Guddu, Sukkur and Kotri barrages) comprises 14 feeders and main canals, and 1,462 branch canals, distributaries and minors.

Generation of Additional Water Resources

There is a need for generation of additional water resources both through conventional and non-conventional means including: i) water Conservation; ii) rainwater harvesting; iii) use of saline water for agriculture; iv) recycling of drainage effluent after treatment; v) desalination for urban use; vi) balanced conjunctive use of groundwater; vii) and crop substitution through introduction of biosaline agriculture (Azad, FAO 2003).

Water conservation measures through watercourse improvement, lining of distributaries and minors in saline groundwater areas, precision land leveling, and adoption of drip and sprinkler irrigation, where feasible can improve efficiency, the total losses will be reduced by about 5% making about 1.7 BCM of extra water available for crop use. By adopting these measures the cropped area can be increased by about 12% of the present area or by about 400 thousand ha.

Water table Depth in the project Area and extent of Waterlogging and salinity

Water table depth of the areas irrigated by three barrages for the last 30 years show that major part within different canal commands remained under 0-150cm depth during post monsoon season. This is because of the rainfall, flooding condition & simultaneously canals are running in full supply level in the kharif season, and water table rises at the peak before the start of the Rabi season. As the water table starts increasing soon after Rabi, the area covered by water logging is higher at the end of monsoon period. During the recent past drought conditions prevailed throughout the region during 1999 through 2009. This has lowered the water table depths remarkably to a larger extent, leaving a small area within 0-150 cm depth zone in the pre monsoon season, where as a decreasing trend has also been observed during post monsoon period.

Indus Ecosystem

Identified amongst the 40 biologically richest eco-regions in the world, the Indus Eco-region covers approximately 65% of the province of Sindh and occupies 18 districts of Sindh. Indus eco-region is characterized by diverse habitat consisting of coastal, freshwater and brackish wetlands, riverine

forests, a vast desert and irrigated plains. The area is rich in biodiversity of significant ecological and economic importance to the country in general and to the local communities in particular. The Indus Delta has one of the largest arid climate mangrove cover in the world. It includes 17 major creeks besides a large number of minor creeks and mud flats. In addition to eight species of mangroves, the main delta area harbors at least 34 animal species, 138 bird species, 24 reptile species and about 200 fish species (WWF Pakistan 2007 foreverindus). The coastal waters and associated wetlands attract a number of migratory birds. Some 56 bird species belonging to six orders and fourteen families have been reported in the Sindh coastal waters. The main river course is habitat of the blind Indus Dolphin. Moreover, a variety of fish species including Indus baril, Indus garua and the Golden mahasheer are found in the river. The riverine forests along the banks of the Indus support a variety of flora comprising of Acacia, Tamarix and Prosopis and fauna including Hog deer, Wild boar, Jackals and Foxes.

Freshwater Lakes

Sindh is home to the large freshwater lakes namely Keenjhar, Haleji, and Manchar which are also internationally recognized as important for a wide variety of breeding, staging, passage and wintering water birds. Some of the wintering birds that have been seen around these lakes include ducks and geese, shorebirds, flamingos, cormorants, herons and egrets, ibises, coots, gulls, terns etc. However, decrease inflow of water from River Indus is causing significant damage to these wetlands.

Brackish and Salt Lakes

The Indus eco-region is home to a number of brackish and salt lakes such as Drigh Lake, Jhubo and Nureri lagoons and a large number of seasonal or permanent lakes in Deh Akro-II wetlands complex.

Desert

The desert region in Sindh covers an area of approximately 68,000 km and comprises of Thar, Nara and Kohistan. The Thar region is mainly in the Tharparkar district and extends southwards along the Runn of Kutch. It extends over an area of 23 thousand square km and has a population of about one million people. The Nara region spans 22 thousand, square km and its upper portion lies in four districts: Sukkur, Nawabshah, Khairpur and Sanghar. Finally, Kohistan, with coverage of 23 thousand square km comprises of parts of Dadu, Larkana and Thatta (WWF Pakistan 2007 foreverindus).

Desert ecosystem:

The desert region in Sindh covers an area of approximately 68,000 km^2 and comprises of Thar, Nara and Kohistan. The Thar region is mainly in the Tharparkar district and extends southwards along the Runn of Kutch. It extends over an area of 23,000 km^2 and has a population of one million people. The Nara region spans 22,000 km^2 and its upper portion lies in four districts: Sukkar, Nawabshah, Khairpur and Sanghar. Finally, Kohistan, with coverage of 23,000 km^2 comprises of parts of Dadu, Larkana and Thatta. These areas are characterized by large tracts of barren land that receive very little rainfall leading to frequent drought-like conditions. The vegetation primarily comprises of stunted scrubs.

The desert areas are among the poorest in Pakistan, with lack of infrastructure facilities health, education etc. Majority of the people are involved in livestock production and cattle raising. However, due to limited or no access to resources, and lack of education and training, the locals are not able to maximize their economic potential. Traditional methods of livestock breeding are still being practiced and animal mortality rate remains quite high due to malnourishment during drought periods. Since rain is the main source of water and therefore agriculture and livestock activities are dependent on rainfall, the failure of monsoon means no fodder for the cattle and livestock. Further, to compound the

problem poor transportation links make transit of fodder from other areas quite expensive and therefore unaffordable for the locals.

Due to recurrent of drought conditions the settlements are forced to migrate to other areas of Sindh for their survival. This migration has been creating overload on cities and towns amenities. Migration itself is a big hindrance for indigenous peoples for their social development and livelihood.

Biological Resources of Sindh

Forests (mangroves, riverine and irrigated), wildlife, fisheries and livestock are the major biological resources in the project area. Mangroves and riverine and inland forests have been discussed in detail in paras 4.3.4 and 4.3.8 of this report. The coastal waters and associated wetlands attract a number of migratory birds. Some 56 bird species have been reported in the Sindh coastal waters. The main river course is habitat of the blind Indus Dolphin. The province holds a premier position in the fisheries sector of Pakistan. It commands almost 100 percent of brackish, 65 percent of freshwater, and 71 percent of marine fish resources of the entire country. These resources constitute about 350 species of marine, over 120 species of freshwater and 15 species of commercially important marine shrimp. Sindh contains a sizeable proportion of Pakistan's livestock and poultry. For example, 27 percent cattle, 28 percent buffalo and 40 percent of poultry are located in Sindh. The wetlands of Sindh serve as spawning, rearing and nursery grounds for the production of shrimps, lobsters and fish. Eight of the nineteen Ramsar wetland sites in Pakistan are located in Sindh. Wetlands are under stress for a variety of reasons main being freshwater scarcity and sea intrusion. The project area is rich in livestock especially buffaloes, cows, goats, sheep, camel, etc. and the main feeding/grazing grounds of livestock are forestlands, rangelands and wastelands. Livestock is the main livelihood source of rural populations but due to diminishing grazing grounds, high cost of feed and inadequate marketing opportunities the livestock has not remained economic source in rural areas of project area. The project area used to be rich in wildlife resources. There are several wildlife protected areas in the project area both aquatic and terrestrial, containing variety of wild animals, birds, mammals, reptiles etc. The types of protected areas include game reserves, wildlife sanctuaries and internationally recognized national parks. The management of wildlife is entrusted to an independent department namely Sindh Wildlife Department who is managing this resource through Sindh Wildlife Protection Ordinance, 1972. Wildlife resource is under pressures due to variety of factors such as illegal hunting and poaching, human population explosion, degradation of ecosystems, droughts, inadequate governance, pollution, and decline in wildlife habitats. All above issues have resulted in degradation of wildlife in the province and the project area.

4.3.6 Surface and Groundwater Quality…its impact on Ecosystem and Environment

The Pakistan Council of Research in Water Resources (PCRWR) launched “National Water Quality Monitoring Program” in 2002 through 2006 that aimed at undertaking water quality monitoring of major cities, rivers and storage reservoirs, canal, drains and natural lakes. Different organizations including Pakistan Council of Research in Water Resources (PCRWR), Water and Power Development Authority (WAPDA), Environmental Protection Authority (EPA) and some individual consultants have conducted short-term studies on water quality. Results from various investigations and from the studies carried by various organizations such as PCRWR, WAPDA, and EPA indicate that water pollution has increased. The pollution levels are higher particularly in and around the big cities where industrial estates are present. The water quality deterioration problems are caused by the discharge of hazardous industrial wastes including persistent toxic synthetic organic chemicals, heavy metals,

pesticide products, municipal wastes and untreated sewage water to natural water bodies. These substances mixed with water cause widespread water-borne and water related diseases.

The quality of water supplies in many cities is deteriorating at an alarming rate. The primary source of these supplies is groundwater. As a result, diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis, cryptosporidiosis and guinea worm infections are about 80% of all diseases, including diseases due to sanitation problem. All above mentioned diseases are responsible for 33% of deaths (UNICEF, 2009.).

Over pumping of groundwater due to extended drought has adversely affected the water quality. According to a recent study about 70% of the about 560 thousand tubewells in the Indus Basin are pumping sodic water (PCRWR Water Quality Monitoring Program). Such water is highly injurious to the soils resulting in reduced permeability and infiltration rates, particularly in the heavy textured soils. Surface-water from most of our rivers is also polluted due to dumping of solid wastes and industrial pollutants.

Due to industrial waste, heavy metals such as nickel, lead, zinc and cadmium have also been found in Indus water. Many water sources and watersheds are already of poor quality and require remediation and treatment. Both high-tech, energy-intensive technologies and low-tech, low-energy, ecologically focused approaches exist to treat contaminated water. Concerted efforts to widely adapt these technologies are needed; they need to be scaled up rapidly to deal with the tremendous amount of untreated wastes administered by city governments entering into waterways every day; and water and wastewater utilities need financial, administrative, and technical assistance to implement these approaches.

The Status of Drinking Water Sources

Pakistan Council of Research in Water Resources (PCRWR) generated the first detailed water quality profile of 23 major cities of the country. About 357 water samples from 364 selected water sources were collected adopting the uniform sampling criteria and analyzed for 79 physico-chemical parameters including, trace, ultra trace and bacterial indicators. The analytical findings were compared to the World Health Organization (WHO) guidelines and Pakistan Standards Quality Control Authority (PSQCA) standards for drinking water.

Analysis revealed the presence of four main water quality problems i.e. bacteriological (69%), arsenic (24%), nitrate (14%) and cities had a considerable percentage of bacteriological contamination (40-100%). A higher percentage of arsenic contamination was found in 9 cities, nitrate in 14 cities and fluoride in 4 cities. In Sindh province, all the 14 sources monitored in Hyderabad were found unfit mainly due to bacteriological contamination (93%), excessive levels of iron (47%), and turbidity (93%). Karachi the largest metropolitan city and capital of Sindh province revealed (93%) unsafe water sources due to bacteriological contamination, TDS and fluoride (4%), sodium, chlorides and sulphate (7%), nitrate (11%), and iron (18%); only 2 out of 28 samples were safe. In Sukkur, 11

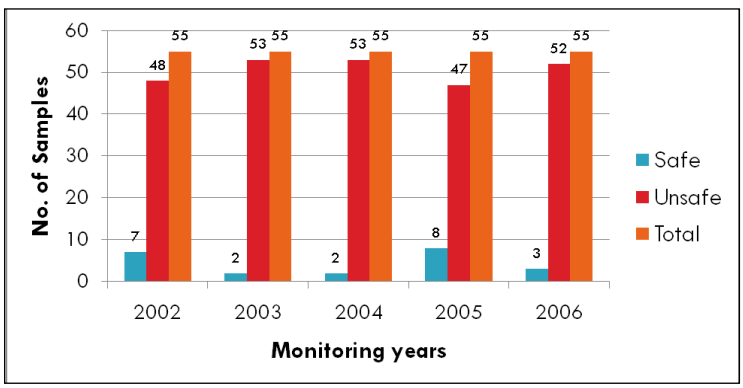


Figure 4.3.3 Water Quality of Sindh Province
(Source: PCRWR 2002-2006)

out of 12 sources were unfit because of bacteriological contamination, turbidity (50%), hardness, sodium, chlorides, potassium, arsenic and fluoride (8%), nitrate (25%), sulphate and TDS (17%). Twenty two water samples including 6 dams, 9 rivers, 2 canals, 4 lakes and 1 drain, LBOD and RBOD; all were found microbiologically contaminated. Main cause of microbiological contamination was due to the disposal of untreated sewage into water bodies.

Water Quality in Southern Sindh

About 300 water samples from water bodies of three southern districts Thatta, Badin and Tharparkar were tested measuring physical, chemical, and biological (total coliform) quality parameters. All four water bodies (dug wells, shallow pumps, canal water, and water supply schemes) exceeded World Health Organization (WHO) MPL for turbidity (24%, 28%, 96%, 69%), coliform (96%, 77%, 92%, 81%), and electrical conductivity (100%, 99%, 44%, 63%), respectively. Iron was major problem in all water bodies of district Badin ranging from 50% to 69%. Some common diseases found in the study area were gastroenteritis, diarrhea and vomiting, kidney, and skin problems (Memon and Soomro, 2010).

It is estimated that 20 million residents of Sindh depend on irrigation water for their domestic use, especially in areas where the groundwater is brackish. The contamination of irrigation water by coliform bacteria exceeds the limits set by WHO.

Water Quality of Surface Drains Outfalling in LBOD System

The data of the drainage effluent of the surface drains of the LBOD system from 2005-06 to 2007-08 (Annexure-4.3.7) indicated that the Total Dissolved Solids (TDS) of the drains outfalling in spinal drain from Shaheed Benazirabad onwards are in the range of 3,000 to 14,000 ppm. The SAR of the effluent ranges from 10 to 23. The allowable ranges for TDS are 2,000 ppm and SAR up to 18. The effluent shows higher values; therefore is not fit either for household use or for irrigation. However, if mixed with canal water can be used on marginal lands. Kotri Barrage surface drains including Tando Bago Drain, Lowari Drain, Serani Drain, Fuleli Guni Drain, Karo Gungro and other surface drains which carry only the drainage water from adjacent fields, and storm water of the monsoon rains is relatively better in terms of TDS and SAR within reasonable limits and therefore can be used for bio-saline agriculture or for irrigation of crops under severe water scarcity conditions.

Salinity and Water logging

In 1975 the proportion of the IBIS area with groundwater less than 3 meters from the surface was 42% and the area with groundwater less than 2 meters from the surface was 22%. In Sindh the area with a depth less than 3 meters was 57%. Although groundwater use has increased significantly, about 22% of the command area of IBIS has a water table of less than 1.5m (Asianics, 2000). In Sindh Province presently, a small component of potential groundwater resources is being exploited by public and private tube wells. Total groundwater extraction is about 3.5 MAF, which includes pumping by 25,000 private tube wells and 4,100 SCARP tube wells.

Extent of Arsenic Contamination in groundwater

Preliminary analysis of the freshwater samples collected from nine districts of Sindh including Jamshoro, Qambar-Shahdadkot, Matiari, Shaheed Benazirabad Naushero Feroze, Khairpur, Ghotki, Sukkur and Dadu districts and analyzed for total dissolved solids (TDS) and arsenic contamination. The results indicated that 10% of the samples had arsenic contamination of 100ppb or above. Use of the arsenic polluted water may cause skin cancer if used continuously (Khuhawar 2006).

Impact of water pollution

The high pollution level of rivers and groundwater lead to different environmental consequences such as reduction of biodiversity, increase in water related diseases and decrease in agricultural productivity. The health of rivers, lakes, estuaries, coastal systems as well as marine resources is threatened by water pollution issues, such as eutrophication, toxics pesticides, heavy metals, acidification and siltation. Their main effects are ecosystem dysfunction, loss of biological diversity, alteration of aquatic habitats and contamination of downstream and marine ecosystems. The cost of water pollution is higher than the cost of its prevention, and neglecting water pollution control entails high social and environmental costs. In rural areas of Sindh, due to consumption of polluted water for domestic use, 70% patients suffer from waterborne diseases. 3-4 million people die each year of waterborne diseases world-wide, including more than 2 million children who die from diarrhea (Bauder et al 2007). The degradation of water resources reduces social security. The impairment of water resources in regions where poverty already affects a great part of the population, can lead to greater social inequity and poverty intensification.

Women in Rural areas getting water from a watercourse for house hold use (Asian Water Development Outlook 2007)

Sources of Water pollution in Sindh

The main sources of water pollution include: i) disposal of untreated sewage and city garbage into canals and river; ii) disposal of untreated industrial effluents into freshwater bodies; iii) seepage of fertilizers and pesticides from agriculture fields and soil; iv) disposal of highly toxic and high BOD laden sugar mill effluents into surface drains of the main drainage system; v) seawater intrusion from the river mouth towards the land (upto Thatta-Sujawal Bridge) carrying hyper saline water that percolates from river bed into the deep aquifers rendering the groundwater saline and unsuitable for domestic use; and vi) effluents of Kotri industrial area into river and canals.

4.3.7 Flow downstream Kotri and Sustainability of Indus Ecosystem

Reduced river flows below Kotri barrage since last three decades have made the deltaic environment fragile and has resulted in quite unsustainable ecosystem endangering the fauna flora, forests and mangroves, fisheries directly affecting the livelihood of thousands of the populations residing in coastal areas. The Indus Delta is listed under the Ramsar Convention on Wetlands, 1971, and is classified as the fifth largest delta in the world (Pamela Stedman-Edwards).

The Indus Delta and surrounding habitats constitute diverse ecosystems including; riverine forests, irrigated plains, fresh water lakes and brackish wetlands. The land along the main course of River Indus is very fertile and supports a diversity of agricultural crops such as wheat, maize, cotton, sugarcane, rice and a variety of fruit orchards such as bananas, mangoes, date palm jujube and coconut palm. Significant fisheries resources include Indus Baril, Indus Garua, Golden Mahasheer and the famous Palla fish. Riverine forests along the banks of river provide sanctuary to a variety of birds, mammals, reptiles and amphibians. Keenjhar, Haleji and Hadero are three important fresh water lakes lying at the apex of the coastal region. The Delta is also home to a significant number of lagoons such as Jhubo and Nurari lagoons.

One of the paramount anthropogenic causes of ecological degradation in the Indus Delta is the reduction in fresh water flows. The survival of the Indus Delta is dependent on the silt-laden freshwater discharges from River Indus which has been curtailed due to diversion of water for primarily agricultural use and power generation in the upper reaches. Freshwater flow has been reduced from 150 million acre feet MAF) annually to 0.02 MAF in 2009-10. Release of freshwater into the delta in recent years has been inconsistent and below the minimum annual requirements to sustain the ecological health of the Delta.

The IPOE recommended a continuous flow of 5000 cusecs of water downstream Kotri throughout the year or 5 MAF in a year distributed as per need. According to the provisions of the 1991 Water Accord, 10 MAF is committed for downstream Kotri flows, however environmentalists believe this is insufficient. The IUCN Pakistan has calculated essential release of 27 MAF for the continued wellbeing of the Indus Delta. The reduction in water release has enhanced natural forces of degradation in the coastal areas such as the increase in salinity which creates unfavorable conditions for mangrove growth and associated biodiversity. Due to these stresses the catches of two commercially important (migratory) finfish species, Palla (Tenualosa ilisha) and Dangri (Cates alcrifer) have declined from 600 tons in 1986 to 200 tons in 1995. Palla used to dominate the fish catch of Sindh with a record catch of eight thousand mt in 1959 (Pamela *et al*)

Irrigation Infrastructure and Inefficiency

The 25 year average (1975-2000) rim station inflow of the Indus River and its tributaries is estimated to be approximately 154 MAF per year. However, the inflow of water varies drastically from year to year. The Water Accord of 1991 assumes 114.35 MAF per year plus a 3 MAF for ungauged civil canals, making a total of about 117 MAF. The provision for environmental flows for the downstream and delta of the Indus is mentioned in the Water Accord at 10 MAF as a demanded by, but these flows have not yet been finalized or included. In recent years, the annual supply of 114.35 MAF, as agreed in Accord is not being complied with. Water losses between canal heads and watercourses, and losses within water courses, are equal to one third of the total amount of water delivered. Another 25 percent is lost within the farms. Pakistan's crop productivity per unit of water is very low at 0.13 kilograms per cubic meter (Simi Kamal 2009 presentation at the University of Nebraska).

Environmental Repercussions of System Inefficiency

Due to water scarcity, the sixth biggest mangrove forest in the world has been reduced from 0.6 million to 0.25 million acres. Although the 1991 Water Accord recognizes a fixed quantum of environmental flows (39.5 MAF per year), these are not released in a consistent way each year (1991 Water Accord, Pakkissan.com)

Recent satellite images indicate that mangroves in the delta cover about 160 thousand ha. On the one hand these forests produce wood, provide habitat for wildlife, place for grazing animals and on the other hand supports fisheries and shrimps production, and earns about Rs. 4 billion annually from exports. About 100 thousand fishermen are engaged in fishing and shrimp industry. Factors responsible for the degradation of Indus delta mangroves are: i) reduced flow of fresh water and silt from river Indus, ii) inflow of pollutants from Industries, navigational activities and intermix of industrial effluents, iii) browsing or grazing by livestock, iv) over harvesting of wood and fodder causing meandering and erosion of creek banks, v) over fishing; and vi) gradual rise in the sea level (Amjad et al). The recommendations of the International Panel of Experts with respect to a bare minimum flow of 5 thousand cusecs are not being followed. For eight to ten months, the flows downstream of Kotri are almost negligible, causing devastation of the ecosystem in the area.

The economic significance of the Indus Delta

The human population on the coast of Pakistan is estimated to total 1.2 million people; of them nearly 900 thousand reside in the Indus Delta. More than 135 thousand people depend on mangrove resources for their livelihoods. An IUCN study (IUCN 2005) estimates the total value of losses at US$125 million.

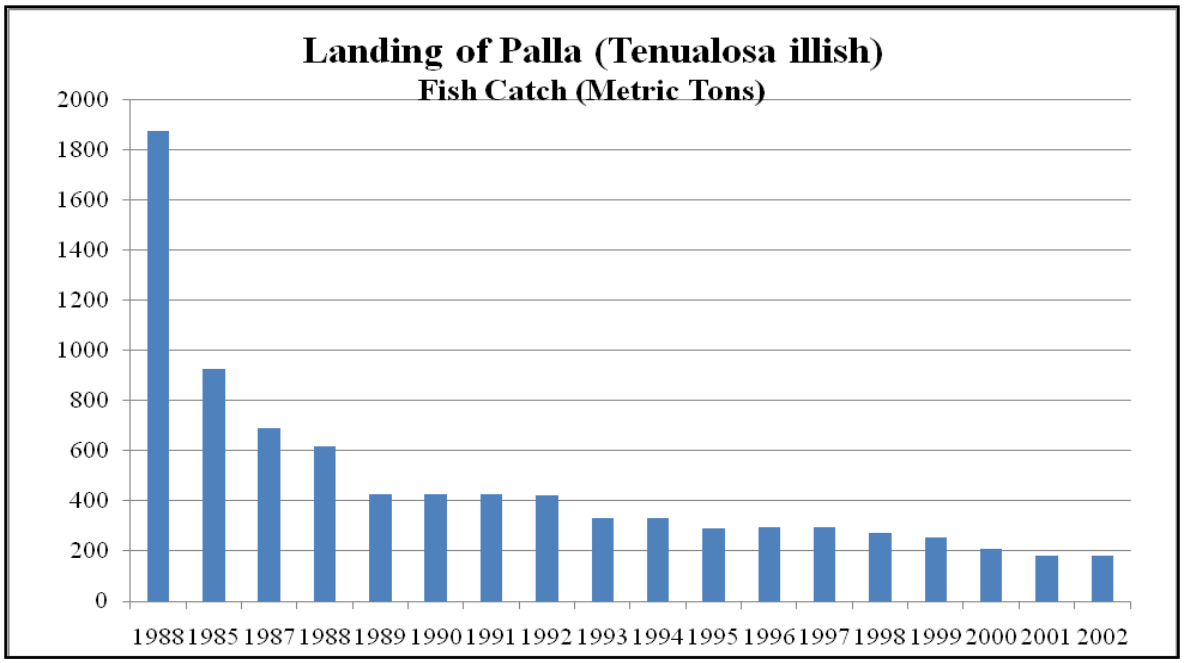
Environmental Impacts of Reduced Downstream flows include:

a) Ecological Impacts: The ecological impacts include disappearance of endangered fauna, reduction in riverine and mangrove forests, loss of biodiversity, gradual inland movement of the sea due to global warming, and increased marine and coastal pollution together with seawater intrusion.

b) Economic Impacts: There is a tremendous economic loss and as a result, unemployment, migration of people to other areas, and crime rate has grown exponentially in this region. Fertile lands have been turned into barren lands due to seawater intrusion. Results of the studies by the government of Sindh indicated that 480 thousand hectares (1.2 million acres) of the land is lost to the sea.

c) Social and Public Health Impacts: Water borne diseases have registered an increase of 200% in the last two decades. Due to the scarcity of water and resulting economic downturn, people of Sindh find it very hard to make the ends meet. Unemployment, poverty, crime rate, and other social problems are all on the rise. According to Asian Development Bank, 40 to 45% people in Sindh are below poverty line (Altaf A Memon World Water and Environment congress 2004). The rate of suicides in Sindh has sharply risen in the years after the water shortage started.

d) Decline in Palla Fish (Tenualosa ilisha): The famous Palla fish (Tenualosa ilisha) has migratory habits and for breeding it ascends upstream in River Indus from the Arabian Sea. Due to very low discharge of Indus and lack of flooding, the fish has been unable to migrate upstream for breeding and, hence, the stocks of Palla fish have depleted at an alarming pace during the last 15 years Figure 4.3.5. In the past, it reportedly comprised of 70% of the total catch. However, presently it hardly constitutes 15 % of the total catch. The decline in the catch of this fish can be visualized from the chart below.



(Source: WWF Pakistan Indus for All Program)

Figure 4.3.5 Decline in Pala Fish catch

Quantity of water essentially needed for sustenance of ecosystem

It is estimated that the losses in conveyance and in the field are to tune of 60% (Pakistan Water Sector Strategy 2002). Since the recommended deliveries do not account for these losses, therefore, if these losses are taken into account, then the minimum quantity of water needed as per the IPOE recommendations would be 12,500 cusecs (over 9.0 MAF per year) and as per study-II it will be 21MAF per year. Pamela Stedmans Edwards Pakistan Mangroves (WWF) Pakistan recommended about 6.8 MAF for sustaining mangroves. Waheed Bhutto[24] (2006) , Tahir Qureshi of IUCN, Zulfiquar Halepoto and Rajab Memon (no dates) quoting the study conducted by the IUCN experts have suggested that a discharge of 27 MAF of water is required to pass through Kotri barrage to prevent further damage to Indus delta. Various recommendations range from as low as 3.6 MAF to 40 MAF /year. From these findings, it is believed that quantity less than 21 MAF/year may not sustain the ecosystem which has been damaged to an extent that seems irreversible.

Studies undertaken by the Federal Flood Commission Pakistan in 2005 to ascertain the quantity of water to flow downstream Kotri are:

Study-I -Water escapages below Kotri Barrage to check seawater intrusion
Study-II-Water escapages downstream of the Kotri Barrage to address environmental
Study-III-Environmental concerns of all the four provinces. (Federal Flood Commission 2005)

a) **Study-I consultants recommended:**
The consultants recommended a minimum flow of 10,000 cusecs to stop seawater intrusion. Interface location with Option-2 (Q=10,000 cfs) is 35 km from the river mouth near Dandho (Sherazi Bander). The consultants noted that this option would eliminate seawater intrusion about 92% of the riverine area in the tidal reach. It is very strange to mention that the recommendations of 10,000 cusecs were kept aside and the openion of the IPOE were highlighted in the report.

Table 4.3.3: Recommendations of the Study-I Consultants

Season	Volume in MAF		
	Dry Year	Average Year	Wet Year
Rabi	0.53	2.11	3.61
Kharif	2.56	3.35	3.63
Annual	3.09	5.46	7.24

b) Study –II consultants recommended

Table 4.3.4: Minimum Water Requirements for various Interventions proposed by the Study-II

Discipline		Riverine Forests	Delta Mangroves	Agriculture	Palla fishery	Other fish species	Domestic use
Water Requirement	Main River Channel	-	4.7 MAF	0.62 MAF	0.30 MAF monthly 0.9 MAF for 3 months	0.20 MAPF Monthly 1.8 MAF for 9 months	0.000696 MAF
	Canals	0.40 MAF			Total water demand for fish: 2.7 MAF		0.000851 MAF
Season/Month		April September	April September	Round the Year	June - August	September - May	Year round

Proposed Total Flow Downstream Kotri: 8.42 MAF (equal to 21 MAF at 40% Efficiency)

Study-II consultants calculated the Kotri downstream flow requirements of riverine forests, mangroves, agriculture, fisheries, and domestic use. The total requirements came as 8.42 MAF. The water application efficiency as given by WAPDA (Water Sector Strategy Vol 5 2002) is 40%. As such total required flow downstream Kotri would be 21 MAF. This requirement would be distributed as per the water availability in the river. Following breakup of water flow is suggested round the year on 10 daily basis to meet the requirement of all sub-sectors. Normally the flows in river are better during four months (June-September) and less in the months (October-May). Table below gives the flow on 10 daily basis round the year:

Downstream Flow below Kotri Barrage recommended by Study-II consultants is 8.42MAF per year.
On 40% Water Application Efficiency, the actual requirement is calculated as 21.0 MAF per year
(Flow in cusecs)

Table 4.3.5: Suggested outflow downstream Kotri on 10 daily basis

Cusecs	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
I	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	100,000	280,000	280,000	100,000
II	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	100,000	280,000	280,000	100,000
III	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	100,000	280,000	280,000	100,000

Impact of the development interventions on the eco-system in the Indus downstream of Kotri

No development interventions took place with regard to the ecosystem development. Releases downstream Kotri have practically stopped during 8-10 months of the year. The rate of degradation of mangrove forests in the Indus Delta has been estimated at 6 percent between 1980 and 1995. At

present, only 15 percent of mangroves here are considered healthy. (Pamela Stedman-Edwards, WWF Pakistan).

Impact of Flow Downstream Kotri in the Light of Imagery of the last 21 years

Satellite imageries were obtained from the internet for the years 1989-90, 200-01 and 2006-07. These imageries were taken in the months of October-November (www.landcover.org). The flow in the river was 17.22 MAF in 1989-90, 0.74 MAF in the year 2001-02 and 0.12 MAF during the year 2006-07. Except in 2003-04, there existed drought conditions from 1999 till August 2010 where as in the decade 1989-90 to 1998-99 the flow downstream Kotri was adequate. Therefore, the imagery of 1989-90 showed dense vegetative growth and the covered area under vegetation was estimated 5800 sq.km. In 2001-02 there was drought and the flow downstream Kotri was just 0.74 MAF, reducing the vegetative area to about 3800 sq.km (65%). In 2006-07 vegetative cover increased to 5200 sq.km. This was due to better flows in 2003-04. This suggested a direct correlation between flows and vegetative cover.

4.3.8 Indus Delta and Mangroves

The Indus Delta is about 300 km long 50 km wide, a typical fan-shaped delta; build up by the discharge of large quantities of silt washed down the Indus River. The delta covers an area of 600,000 ha and is characterized by 17 major and minor creeks covering an area of 160 thousand ha and a large number of minor sandbars and mudflats spread over an area of 40 thousand ha (Forestry Sector Master Plan, 1991). The Indus delta mangroves are unique, being the largest area of arid climate mangroves and is 7th largest block in the world.

Area

Total area of Mangrove Forests was 345 thousand ha. Out of this, about 64.5 thousand ha area was transferred to Port Qasim Authority in 1973. Sindh Forest Department at present manages about 281 thousand ha mangrove area. Recent satellite images indicate that about 160 thousand ha of delta is covered by mangroves. The predominant species of Indus Delta is *Avicennia marina* locally known as 'Timer' which covers 97% of the area. Other species are; *Rhizophora mucronata, Aegicerus corniculatum and Ceriops tagal.* The satellite imagery produced by SUPARCO shows that about 36 thousand ha is covered with dense mangrove growth, about 54.4 thousand ha of moderate canopy mangroves, and bout 49.4 thousand ha have sparse vegetation. Another estimates estimated that the area under dense mangroves is 73 thousand ha. Due to launching of local and foreign funded projects in last 15 years by Sindh Forest Department indicate that the area under mangroves have increased from 93 to 160 thousand hectares due to implementation of replanting projects (Sindh Forest Department Estimates, 2009).

Importance of Mangroves

There are very few tree species globally which could adapted to hostile environment marred with water logging, poor soils, soil salinity, saline water, tidal force, hurricanes, and high humidity- as is found in delta and estuaries. The mangroves are a highly productive environment and ecosystem, both economically and ecologically. Mangroves play an important role beneficial to man and nature, and at the same time these forests are a rich storehouse of countless useful products. Mangroves also act as a natural repository of varied and unique biological diversity. Mangroves reduce wave action and help stabilize coastlines, assimilate sewage water, heavy metals from industrial plants, protect seaports from siltation, reduce the intensity of cyclones, support livelihood to a population living along the coastline, and is a source of wood for heating and cooking and fodder for livestock

Management Objectives

The general objectives of management of Indus delta mangroves are to i) conserve, protect and extend the growing stock by proper *silvicultural* systems and treatments; ii) introduce commercially valuable species in order to improve the economic viability of the present mangrove forests; iii) ensure sustained quantities of forest products to meet the demands of the dependent population iv) protect the coastline from erosion and the cultivated fields along the coastal belt from severe winds and storms and sea intrusion; and vi) provide sustainable livelihood for local communities.

Major issues Causing Degradation and Deforestation of Indus Delta Mangroves

The major issues responsible for degradation of mangroves resulting in resource base reduction are as under:

Reduced flow of fresh water: The mangrove forests thrived on when fresh water from river Indus was adequate. In the recent years the mangroves of deltaic region have suffered greatly due to extensive changes in the fresh water regime of Indus hydrological system.

***Reduced silt from Indus*:** Reduced freshwater has resulted in reduced silt load necessary for growth and establishment of mangroves and delta. IUCN-Pakistan has given a historical discharge volumes and silt load from 1880 to 1992 onwards (Table 3.7.1), which suggests the reduction in flows and silt load has not only degraded the development and health of mangroves but has facilitated the sea intrusion in the Indus delta to the extent of 900 thousand ha (Board of Revenue Estimates, 2006).

Table 4.3.6: Historical discharge volumes and silt load from 1880 to 1992 onwards

Period	Discharge Volume MAF	Percent Reduction	Silt Load (mt)
1880-92	150	10	400
1940-54	84.7	12.9	225
1955-65	79.9	45.7	220
1966-76	46.0	58.4	133
1977-92	35.2	10	100
1992 onwards	10.0	12.9	30

Source: IUCN-Pakistan, 2000

***Inflow of pollutants from industries and intermix of industrial effluents**:* Industries located in the delta and major cities dump their polluted effluents to flow into the coastal area. The industrial pollution, particularly from sugar mills through LBOD system and Kotri drainage system has adversely affected the growth of mangroves.

***Over browsing by camels, and grazing by large ruminants*:** In the coastal belt fodder from mangroves support about 6,000 camels and 3,200 buffalo and cows (Socio-economic Survey 2001 by Sindh Forest Department). The fodder requirement is more than its carrying capacity and over grazing and browsing is also adversely affected the growth of mangroves.

***Illicit wood and fodder harvesting*:** The coastal populations have been over exploiting the mangrove forests for their timber, fuel wood and fodder requirements. The encroachments by

unauthorized wood cutters, entering through small creeks, are damaging the growth of mangroves. This is a serious issue and has resulted in the degradation of mangrove ecosystem, coastal erosion, sea intrusion loss of biodiversity and valuable habitats, and associated social, economic and environmental problems.

The Way Forward for Mangroves

Following activities are suggested for the mangroves:

- to improve the understandings of the mangroves ecosystem in the context of achieving effective management practices and improving the well being of dwellers of the coastal zone region.
- to introduce "Participatory Approach" (Bottom-up approach) by involving local communities and stakeholders in development, process conservation, protection and benefit sharing.
- to provide alternative sources of wood, firewood and fodder to local communities so that their dependence on mangroves should be reduced.
- to provide alternative sources of livelihood to local communities to alleviate poverty which at present in above 70% in the coastal areas-54% being the poorest (ADB estimates, 2006).
- strengthen the capability of stakeholders especially government agencies and communities.
- to organize and implement major multi and inter-disciplinary research, extension and training programs on the mangrove ecosystem and its interaction with relevant coastal system.
- to support applied research and demonstration site-specific pilot projects for rational management of the mangroves along Indus delta and coast.
- to rationalize the exploitation, management and conservation of mangroves and related coastal systems for high level of production on sustained yield basis, including the conservation of coastal areas and to other land and water uses, where and when advisable.

Strategies for Development

***Protection*:** For self-generating and self-supporting ecosystem, protection is the main tool, if development of forests is required. Priority needs to be given to potential sites with rich regeneration. These areas needs to be protected against all human and animal entry for a period of 10 years so that the tree growth attains a reasonable height to stand the pressures. Similarly, replanted areas should also be protected to achieve the progress desired.

Restocking: Sizeable gaps in *Avicennia* growth over extended areas have developed on many islands due to over-exploitation. Due to tidal currents seeding is not an option; hence restocking is the potential option. This needs to be supported by establishing nurseries multiplying seeds off economic species, such as *Rhizophora mucronata.*

***New Planting*:** The Sindh Forest Department with the financial assistance from development partners and funding from PSDP and ADP has launched several projects covering about 106 thousand ha, during the last seven years. Recently, Asian Development Bank (ADB) and Government of Sindh have launched "Sindh Coastal Community Development Project" to support promote mangrove plantation by communities on 5.5 thousand ha in the Keti Bunder area. More recently, SFD in association with IUCN has also launched a project on mangroves over an area of about 100 thousand ha during 2011-2017.

Re-introduction of mangroves in Tidal Link and Wetland areas: The mangroves along the coast line of Badin were significantly damaged by the 1999 cyclone. It is proposed that mangroves are reintroduced in the area, particularly along tidal link and wetland areas to enrich biodiversity in wetlands, and to protect structures from wave wash, and to and to act as a biological wall to check the sea intrusion.

Incentive mechanism to conserve mangroves

Participatory approach is an effective tool to develop and conserve Indus delta mangroves. Under this approach the local communities are involved in planning, execution, protection and benefit sharing processes. This approach will create a sense of ownership of mangrove resource and the local communities will be provided incentives in cash and kind from this resource and they will not harm it but protect it being the share holders in the benefits.

4.3.9 Wetlands

Wetlands are among the world's most productive environments and are essential part of our landscape. They are the cradle of biodiversity and a vital component of the freshwater cycle. Wetlands provide numerous benefits that include rich floral and faunal habitat, improved water quality, flood abatement, water storage and groundwater recharge, support for fisheries, and opportunities for education and recreation. Wetlands are dynamic ecosystems with complex interrelationships of hydrology, soils and vegetation. In Pakistan, wetlands cover approximately 9.7% (78,000 sq.km.) of its total area (Kazmi et al 2006). However like other green areas these wetlands are also under tremendous environmental degradation. As a result, this important environmental source is depleting at an alarming rate. Therefore, an internationally acceptable up to date scientific technology is required to monitor wetlands effectively. It has established that the satellite remote sensing (SRS) and geographical information systems (GIS) are the state-of-the-art technologies for mapping, monitoring, and management of huge wetlands.

Wetlands are key natural resources providing livelihood opportunities for the local communities. However, unsustainable methods of exploitation of these resources coupled with lack of sustainable and participatory policies and planning to conserve such resources have resulted degradation of such resources and threatened the very survival of the communities dependent on such resources (Sangatsindh.org).

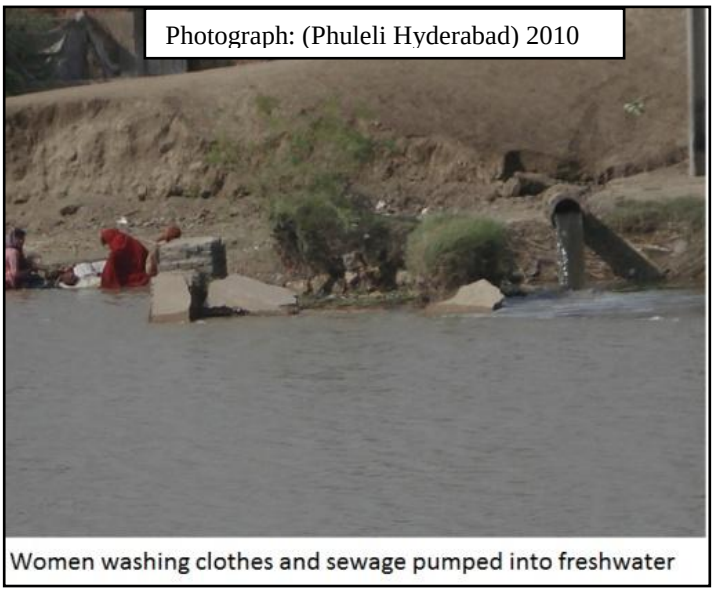
In Sindh there are more than 100 wetlands of which about 90% fall on the left bank of Indus and the rest are located on right bank of Indus. They range from coast, river, lake, marsh, pond and channels to lagoons. There are three wetland complexes namely Deh Akro II (32 dhandhs) located in district Benazirabad, Chotiari (22 dhandhs located in Sanghar district and Indus delta/coastal wetlands (15 wetlands) located in Badin and Thatta districts. Rest of the wetlands are located in other districts of Sindh. Wetlands of Sindh declared as Ramsar Sites are i) Haleji lake ii) Keenjhar lake iii) Drigh lake iv) Indus dolphin Reserve v) Deh Akro II wetlands complex vi) Indus delta vii) Rann of Kutch viii) Nureri lagoon ix) Jabbo lagoon x) Hub dam. All wetlands are storehouses of biodiversity and sources of livelihood of majority of population. Biodiversity found in these wetlands are wetland vegetation, plants fish, birds, wildlife and other aquatic life.

Major issues causing threats to wetlands are; droughts, eutrophication, bad agricultural practices and agricultural run off, release of untreated industrial effluents, coastal and estuarine habitat loss due to sea intrusion, shortage of freshwater in Indus and wetlands, species loss, habitat shrinkage, disposal of saline drainage water of drainage systems, increase in salinity levels, extraction of groundwater and development projects without EIA (Rahat Jabeen, 2004).

All these factors individually and collectively have emerged in significant degradation of wetland ecosystems in Sindh. There is urgent need to take steps to revive wetlands by preparing wetland management plan focusing on development, conservation, structural and non-structural interventions and strict protection through participatory approaches involving stakeholders' especially local communities.

4.3.10. Sources of Water Pollution

Pollutants enter the river Indus at different locations throughout its 3180 km length. These include municipal, industrial and agricultural wastes from Punjab reaching at Guddu and Sukkur. Municipal and industrial effluents of Sukkur and Rohri are added in the river. The water from Manchar lake, containing pesticides, nitrates, nitrites, chromium, lead, copper, zinc, hazardous chemicals from pharmaceutical, power plants, and coal industries also join the river upstream of Kotri,. Downstream of Kotri, the main source of pollution is untreated sewage and industrial effluents from urban areas of Hyderabad and Kotri. (Panhwar, 2002)


Photograph: (Phuleli Hyderabad) 2010

Women washing clothes and sewage pumped into freshwater

Quantum of Industrial and Municipal Effluents

The total annual quantity of wastewater produced in Pakistan is 4369 MCM including 3060 MCM from municipal and 1309 MCM from industrial use. The total wastewater discharged to the major rivers is 1782 MCM and 1/3rd of all wastewater, which includes 1,438 MCM of municipal and 344 MCM of industrial effluents. Municipal wastewater is normally not treated and none of the cities have any biological treatment process except Islamabad and Karachi, and even these cities treat only a small proportion of their wastewater before disposal. It is estimated that only about 1% of municipal wastewater is treated before disposal. Disposal of untreated industrial and municipal wastewater has become one of the largest environmental problems in Pakistan (Pakistan Water Sector Strategy 2002)

Municipal Effluent

Municipal effluent is the Principal Source of Water Pollution. Most of the surface water pollution is associated with urban centers. Typically, nullahs and storm water drains collect and carry untreated sewage which then flows into streams, rivers and irrigation canals, resulting in widespread bacteriological and other contamination (Annexure 4.3.8).

Although treatment facilities exist in major urban areas, in some cases these have been built without the completion of associated sewerage networks, and the plants are often either underutilized or are dysfunctional. Of the total night soil and solid wastes generated at urban centers, about 50% finds its way to water bodies (World Bank 2006).

Almost entire municipal wastewater of major cities namely Karachi, Hyderabad, Sukkur and all other cities located on/near irrigation system is disposed off in the nearest water bodies. Dumping of untreated municipal and industrial wastes have caused contamination of surface and groundwater sources and threatened the aquatic life. Since the groundwater is the main source of water in some of the cities, there is great stress on this source and its excessive use

has seriously affected its quality and incidences of water-borne diseases (ASSESS-HKH 2005).

The Hyderabad city disposes wastewater both in the fuleli canal and the river Indus. The populations which depend on fuleli canal for drinking water get polluted water. Similarly, Karachi city water is disposed through Liyari and Malir rivers, which pollute the sea water with adverse effects on mangroves, fish, and other sea fauna.

Agricultural Runoff

The quantity or quality of agricultural runoff has not been measured or tested at the national level but with an estimated 5.6 million tones of fertilizer and some 70 thousand mt of pesticides used annually. In 107 samples of groundwater collected from various locations in the country between 1988 and 2000, 31 samples were reported to have concentrations of pesticides beyond FAO/WHO safety limits.

Concerns related to water pollution

Keeping in mind the continuous increase of the human population and the unprecedented urbanization and industrialization of the province of Sindh, pollution of freshwater is bound to accelerate. The main chemical, physical and microbial factors negatively affecting water quality include: i) organic pollutants: ii) agrochemicals; iii) heavy metals: iv) microbial contamination; v) toxic organic compounds: vi) traces of chemicals and pharmaceutical drugs Suspended particles: vii) nuclear waste; and: secondary Stalinization and acidification. Obviously, there is a diverse range of water pollutants, each of which is hazardous in different concentrations. Nevertheless, water bodies, have their own self-purification capacity, which depends on a variety of factors such as water volume, flow speed, and chemical composition.

4.3.11 Pollution of Surface and Groundwater by Industrial Effluents

Sindh is facing environmental problems of both green and brown nature. The green issues mainly include environmental problems of irrigated agriculture, rain-fed agriculture, forests, and rangelands. In irrigated agriculture, water logging and salinity dominate the environmental agenda. Brown environmental problems are categorized in five main groups: industrial wastewater pollution, domestic wastewater pollution, motor vehicle emissions, urban and industrial air pollution, and marine and coastal zone pollution. Industrial pollution is increasing at a very rapid pace in left bank, delta and coastal areas and the health and productivity impacts on population and natural resources are significant.

***a) Industrial Estates*:** Main industrial estates of Karachi, Kotri, Hyderabad and Sukkur are recognized as key sources of increasing pollution in natural streams, rivers and sea. In Karachi alone, more than 6,000 industrial enterprises, some 60% of the country's industry, are located along the coastal belt. With the exception of only a few units, most of the industries discharge their untreated effluent containing heavy metals and their compounds, detergents, lubricating oils, chlorine and various organic and inorganic toxic compounds into the sewers or directly into the Liyari River, the Malir River, and the sea. Only 1% of wastewater is treated before being discharged directly into rivers and drains. In terms of the generating environmentally damaging pollutants, textile processing industry is at the top of the list due to its size, followed by leather tanning, cement, chemicals and paper and pulp industries (http://www.environment.gov.pk Brief on Water Pollution).

***b) Sugar Mills*:** Out of 33 sugar mills in Sindh, 30 are located on left bank of Indus. Three out of 33 sugar mills use the molasses to produce industrial alcohol (ethyl alcohol) a significant

quantity of which is exported. Mills in Sindh have crushing capacity ranging from 4-9,000 metric tons per day. It is estimated that these mills discharge untreated effluents of about 25 million cubic meters per year in the irrigation and drainage systems (SDPI 2006). This untreated effluent have high BOD, COD and TDS levels which pollute the water and are hazardous for humans and other biotic life. The sugar mills in Sindh mostly dispose off their effluents into the LBOD drainage system that kills the fish and induce toxic chemicals in the drainage system

The Consultants have analyzed water samples from various sugar industries to estimate the physico-chemical parameters to assess the quality of the effluent. Research has indicated that the parameters such as pH, EC, TDS, DO, BOD, COD significantly exceeded the permissible limits, indicating the need of proper treatment of waste water before discharge into water bodies (Kumari *et al* 2006).

Impacts on population of left bank, delta and coastal areas

Impacts of industrial and municipal pollutants are directly affecting people, wildlife, flora, ecosystems and natural resources in various forms such as polluted drinking water, reduced productivity of productive lands, degraded ecosystems and reduced flora and fauna in the left bank, delta and coastal areas. The foul-smell of septic conditions renders the water body a nuisance for local residents and spoils any aesthetic value of the natural environment. High TSS levels further endanger aquatic life as they limit light penetration causing clogging of fish gills. Under the Environmental Protection Act-1997, it is mandatory upon every industry and city government to have a pre-treatment plant at their premises. There are well defined procedures and techniques being practiced all over the world for treating the industrial and municipal effluents before disposing off or using for agriculture / lawn/parks irrigation etc. These include: i) physical treatment; ii) chemical treatment; and biological treatment. (Wastewater Annexure-4.3.11)

4.3.12 Issues and Problems – Environment and Biodiversity

Sea water intrusion

1. Sea has intruded in the inland areas Issues concerned with sea intrusion, water logging and salinity are brought up at each community consultation, particularly in coastal areas
2. The productive lands have been converted into un-productive lands in the coastal belt of Sindh.
3. Arable land has become salty and unsuitable for cultivating any crops
4. Fresh water wetlands have been converted into brackish water areas.
5. Due to saline water, fish cannot get enough food and fish reproduction is decreasing as a consequence
6. The livelihood of coastal communities especially fishermen have been decreased resulting in increase in poverty.
7. Mangroves and riverine forests in the coastal belt and along Indus have been degraded due to saline water.
8. Coastal ecosystems and their natural resources have been denuded.

9. Migration of local population have taken place due to limited livelihood sources, unemployment and denuded natural resources.
10. The damages to Tidal link, KPOD and other drainage disposal systems have paved a way to sea intrusion.
11. Sea intrusion has resulted in changing the quality of underground water and aquifer.
12. Salt water intrusion in freshwater irrigation and drainage systems has limited the only source of domestic water for coastal communities.
13. No corrective measures have been initiated by the government to control the problem of sea intrusion.

Mangroves

1. Overexploitation of mangrove forests is on-going due to over grazing, extraction of wood for meeting the wood requirements of coastal villages, excessive fodder requirements for livestock.
2. Decrease in freshwater flow to the delta results in a decrease in mangrove cover.
3. Decrease in sediment from the Indus River causes coastal erosion and accelerated loss of mangrove cover
4. Loss of biodiversity and valuable habitats (such as feeding and breeding grounds) following the reduction in mangrove cover is potentially a cause for the collapse of delta and coastal fisheries
5. Mangrove forest development and management strategies are not participatory but are top down approach with respect to protection, restocking, management and replanting mangroves in the Indus Delta.
6. The discharge of untreated industrial effluent in the river and LBOD system has further accentuated the situation.
7. The water quality of surface water is generally deteriorating resulting the biological and bacteriological contamination is wide spread.
8. The salinity and bacterial contamination of the groundwater is increasing especially in delta area.
9. The wastewater treatment before it is disposed off into the river, sea and irrigation systems is not done.

Physical water resources affecting water quality in the study area

Sindh is a sub-tropical region having low rainfall from 15-18 cm per year and annual evaporation of 150-200 cm. Sindh solely depends on the waters of the Indus because its groundwater sources are very limited and its rainfall is erratic. Following issues came out during the consultative process:

1. People argue that the LBOD was not constructed properly so the drainage effluent does not flow into the sea
2. Fresh water from the Indus River was the main source/force for pushing back the sea tides and flow in the Indus is not enough

3. For the last 10 years, Sindh has not received its allocated quantum of water as defined in the 1991 accord between the provinces
4. Low water flows in the Indus are resulting in extended periods of drought and low water periods
5. Rainwater harvesting has not been given proper attention, although there is good potential for water conservation through rainwater harvesting techniques

Ground water and surface water quality

1. Out of a population of 41,246,000 in Sindh province (2009 census projection), 92% of the population is using polluted drinking water (PCRWR, 2008)
2. Disastrous levels of ground and surface water pollution and contamination exist everywhere in the study area due to uncontrolled, improper and un-treated disposal of municipal, industrial and drainage effluents in fresh water bodies. Severe levels of water pollution exist in some areas due to unchecked release of industrial pollutants; such as from sugar mills
3. Weak mechanisms exist for monitoring and protecting the quality of surface and ground water resources in the study area
4. Unchecked introduction of hazardous chemical effluents to ground water and surface water is occurring through extensive use of fertilizer and pesticide agro-chemicals
5. Degraded groundwater quality exists due to un-controlled pumping of groundwater
6. Although the National Environmental Protection Act and its implementing agencies are in place, actual control of water pollution is not yet effective
7. Unified national water quality standards have not yet been implemented in the study area
8. Many laws and regulations exist to address specific issues of water pollution; however, there is lack of harmony and integration between the various legal instruments
9. Maintaining water quality is hampered by failure to enforce pollution control at the source due to inadequacy of sanitation systems and water pollution disposal networks
10. Mechanisms for monitoring water quality are weak due to inadequate mechanisms for collection and analysis of data and information

Sources of ground water and surface water pollution

1. Clean water is not provided to the majority of the population in Sindh Province
2. Sewage is commonly discharged directly into water bodies being used as the sole source of water for domestic use
3. Industrial effluent carrying a heavy load of toxic pollutants is disposed off into water bodies used for domestic purposes
4. Communities located adjacent to irrigation channels and drains dispose off their sewage directly into the irrigation channels and drains causing severe levels of pollution
5. Monitoring of the water bodies both in cities and rural area is not performed regularly resulting in countless water pollution point sources throughout the study area. Confusing statement

Impact of industrial effluent and poor water quality on the population

1. Domestic sewage is not treated in the project area and is disposed of into drains and water courses
2. Industries have severely contaminated surface and groundwater sources, and have badly polluted the coastal and marine environment
3. Domestic sewage and industrial effluents in most places are jointly disposed of into fresh water bodies causing severe microbiological contamination from sewage and heavy metal loading from industrial activities
4. Sugar mill pollution of surface water is prevalent from the discharge of mill effluent directly into the drainage system resulting in health problems of the population and damage to the ecology of the delta and coastal zone
5. Well defined procedures and techniques are available for treating and safely disposing of industrial and municipal effluents; but implementation of the methods is not practiced

Forests

Sindh has riverine forests along the Indus River and irrigated plantations in the command area of Guddu, Sukkur and Kotri barrages. Analysis of these forests during the process of consultation and literature review revealed that these forests have been degraded due to variety of social, economic and environmental problems. The issues and problems identified during phase I study revealed as under:

1. Continuous reduction in annual inundation in Indus has emerged in severe droughts resulting in degradation of riverine forests.
2. The productivity and composition of riverine forests has significantly declined.
3. Riverine ecosystem which used to be rich in biodiversity is now poor in biotic life thereby significant imbalances in ecosystem functions and structures.
4. The regular features of regeneration of riverine forests through seed broadcasting during inundation have been disturbed.
5. The tree resource and other associated natural resources have been reduced.
6. Due to droughts the trees have dried and have become vulnerable to illicit cutting causing wide spread deforestation.
7. The virgin forest lands have been encroached by the land grabbers.
8. Irrigated plantations are not receiving their irrigation water allocations thereby resulting in serious environmental problems due to reduced productivity, enhanced salinity, poor growth of economic species and deforestation.
9. Deteriorating law and order in the forests have made the forests inaccessible and un-manageable.
10. Inadequate governance and protection issues in the Forest department staff have emerged in deforestation and environmental problems.
11. The policies of agro-forestry leases for raising trees on 25% of leased area are not being implemented in most of the cases resulting in negative impacts.
12. There is lack of participatory approach in the department which keeps the communities away in planning, management, development decision making and benefit sharing.

13. Monitoring and evaluation mechanisms are inadequate in the department.
14. Due devolution of social forestry to district governments the provincial forest department has been kept away from seeding production, technical know how and extension services resulting in reduction in tree resource on the farm lands.

Wetlands

1. LBOD/KPOD Tidal Link have paved a way to sea water intrusion in wetlands of Badin and Thatta districts.
2. Freshwater wetlands/dhands have been converted to brackish water dhands in coastal area.
3. Untreated effluents of sugar mills are disposed off in irrigation and drainage channels which ultimately reach to wetlands and enhance the NEQS levels.
4. Eutrophication in wetlands is a detrimental factor for fish and other biodiversity.
5. EIA is not conducted before launching of projects around the wetlands.
6. There is continuous increase in salinity due to saline water intrusion from sea and disposal from drainage projects.
7. Inland freshwater wetlands have been degraded due to reduced flows in river and consistent drought conditions. Steps need to be taken to ensure adequate river flows to rehabilitate these wetlands.

Other – Environmental Issues and Problems

1. Stakeholders are very much aware of the condition of their environment.
2. People consider that nobody takes care of the environment and the Government's allocation of funds for this purpose is meaningless
3. Several endangered species have vanished
4. Fish cannot survive in the contaminated water
5. Local lakes are dead
6. Migratory birds do not visit lakes anymore and the indigenous bird population has diminished considerably
7. During the rainy season (July-August), water overflows from the LBOD and floods villages with toxic water
8. Agro-chemical nutrients N and P released to water bodies cause eutrophication of wetlands seriously affecting fish and other biodiversity
9. Agricultural land adjacent to sugar mills has been destroyed and the eco system is badly affected
10. The natural drain of Dhoro Puran is clogged with mud and is connected with the LBOD that transports contaminated water
11. Big sugar industries drain poisonous waste into the LBOD and pose a particular threat to the environment, livelihoods and health of villagers
12. Communities allege that some sugar mills have established wine factories within the sugar mill boundaries which release toxic waste water into the natural drainage of the Dhoro Puran

13. Encroachment of forest land by land grabbers is at its peak
14. Many affected communities demand that sugar mills immediately stop discharging poisonous chemical water into the natural Dhoro Puran which was the only and last source of their livelihood.

Way forward for Envirinment and Wetlands

1. Water requirements for delta and coastal zone as recommended by Study II Consultants that a minimum of 21 MAF water need to be released for sustenance of the delta.
2. Due to flat topography of coastal areas, there exists a very mild slope of 2-3 inches a mile. This favors the inland intrusion of sea at the rate of 2 km per century. The option of coastal highway (now under execution) or use of injection wells may be considered to stop landward movement of sea.
3. Keeping in view the water release position, both the structural and non-structural options may be studied to find a sustainable solution of the problem of sea intrusion and ecosystem stability.
4. Silt laden flow of river water for sustainability of mangroves and biodiversity may be prioritized.
5. Sindh is the home of freshwater and brackish water wetlands. It is pity that these treasures are not being managed properly. Some of these are Ramsar sites and internationally important. It is proposed to establish a high powered Wetland Management Authority with technocrats from all allied departments for proper management of the wetlands of Sindh.
6. Biodiversity and ecosystem thrives only when the required habitats are provided. Wherever, the habitats are destroyed, it needs revival to attract the wild life and other biodiversity to flourish under the required environment.
7. Preventive measures to keep the freshwater resources clean need to be taken at all levels as the first line of defense. Providing safe drinking water to people is the domain of city governments and regular monitoring of the water bodies through a third party organization may improve the situation.
8. All offenders of Environmental Protection Act 1997 must be dealt with as per the provisions of the EPA Act without discrimination and status.
9. All industrial units should change their effluent disposal system from End-of-Pipe to Cleaner Production Technology.
10. All city governments and Industrialists must prepare their plan to go for the installation of the treatment plants before disposing their effluent for use in agriculture after it meets the required guidelines
11. Capacity building of the WASA staff needs to be carried out. All district governments may have a standard laboratory for scheduled checking of water bodies and further reporting to the provincial as well as the federal body.
12. Appropriate methodology should be designed for monitoring and surveillance of water quality. All critical parameters should be monitored.
13. All personnel responsible for monitoring the quality of water should be professionals and provided in-service training on a regular basis.

14. A critical and objective review of existing national research data on the quality of drinking water should be conducted on a regular basis.
15. Extensive resources should be devoted to upgrade existing water distribution infrastructure.
16. The hygiene of water reservoirs/tanks of users must be mandatory.
17. Public awareness their responsibility towards establishment and maintenance of drinking water quality standards. In this view low cost measures to be applied at a household level (use of lemon juice, SODIS and chlorination etc.) should be applied.
18. In any disaster or epidemic outbreak, the decontamination of affected water resources to be carried out at national level on war footing to check further spread of the contamination. Awareness campaign through electronic media may reduce the panic
19. The aquatic ecosystems revival can be achieved not only through pollution control measures but also through the ecological restoration of habitats and floodplains, which can significantly contribute to boosting self-purification and improving water quality.

4.4 FLOODING, DISASTER MANAGEMENT AND MITIGATION

4.4.1. Background to the flooding disaster thematic area study

Management of flooding and water disasters, including encroachment of sea water, have been studied nationally with emphasis of the impacts in Sindh Province along the left bank of the Indus River and in the Coastal Zone and Delta. To identify the relevant issues and problems, the subjects and tasks listed in Table 4.4.1 were studied in detail.

Table 4.4.1: Topic Outline for Summary of the Thematic Area 4 Study

Topic of Concerns for Phase-I Task Studies	
Subjects Covered	**Phase-I Tasks Included**
IV – Flooding, Disaster Management and Mitigation	
✓ Climate, hydrology and meteorology	T-6: Document and review climatic conditions, hydrological and meteorological conditions
✓ Water disaster and flood management	T-21: Document, review and evaluate methods and planning for flood management
✓ Disaster management	T-22: Review and evaluate current methods for disaster management
✓ Year 2010 super-flood lessons learned	T-30: Study the impact of faulting and earthquakes on the study area
✓ Earthquakes and faulting	

Climatic regions of Sindh

Sindh is divided into three climatic regions: Siro (the upper region, centered on Jacobabad), Wicholo (the middle region, centered on Hyderabad), and Lar (the lower region, centered on Karachi). The thermal equator passes through upper Sindh, where the air is generally very dry. Central Sindh's temperatures are generally lower than those of upper Sindh but higher than those of lower Sindh. Dry hot days and cool nights are typical during the summer. Central Sindh's maximum temperature typically reaches 43–44 °C (109–111°F). Lower Sindh has a damper and humid maritime climate affected by the southwestern winds in summer and northeastern winds in winter, with lower rainfall than Central Sindh. Lower Sindh's maximum temperature reaches about 35–38 °C (95–100 F). In the Khirthar range at 1,800 m (5,900 ft) and higher at Gorakh Hill and other peaks in Dadu District temperatures near freezing have been recorded and brief snowfall is received in the winters.

Delta and Coastal Zone in Sindh

The Sindh coastal region is located in the south-eastern part of the country between the Indian border along the Sir Creek on the east, and the Hub River along the Balochistan coast on the west. The Sindh coast can be subdivided into the Indus Delta/creek system and the Karachi coast. The Indus Delta (2,560 sq. km) is the most prominent ecological feature of the coast and covers 85 percent of the coastal belt. The coastal morphology is characterized by a network of tidal creeks and several small islands with scattered mangrove vegetation.

Situated between the Indus Delta on the southeast and Hub River on the west, the Karachi coastal belt is about 100 km in length. Most of which, with the exception of scattered patches of mangroves, is devoid of any kind of vegetation and consists of shallow lagoons, sea cliffs, stacks and terraces, wave cut platforms, sea caves and notches.

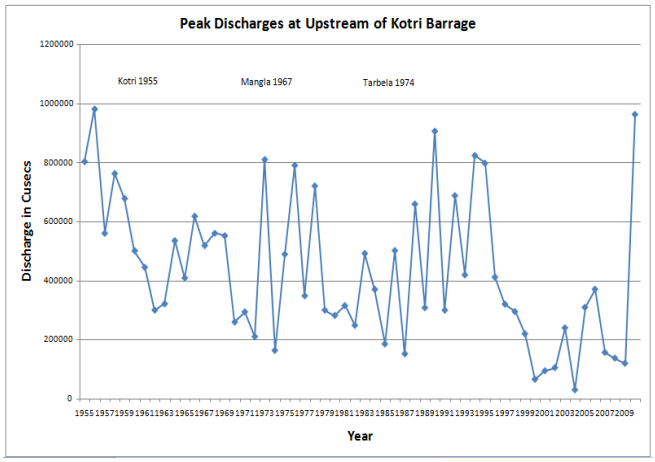
The coastal waters have high salinity (Hein Van Gils, 2006) due to high evaporation rates, combined with negligible rainfall. Oxygen-poor water layers sometimes rise to the surface along the coast, leading to fish mortality. The wildlife along the Pakistani coast consists of both marine and terrestrial species.

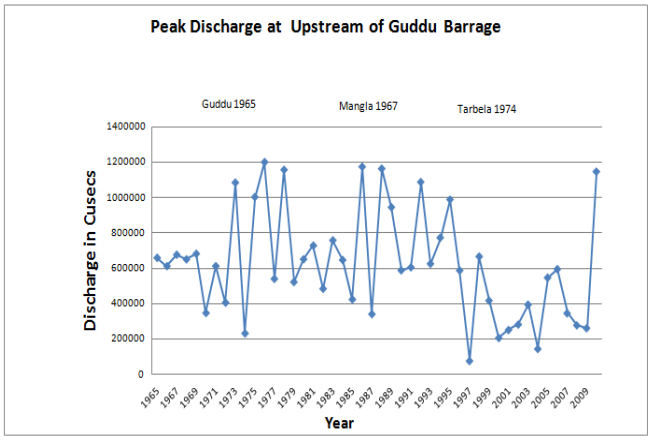
Cyclones on the Sindh coast are not common but do occur periodically causing considerable damage to coastal villages. After 1947 (post partition), major cyclones occurred in June 1948, November 1993, and in May 1999. The Indus is one of the few rivers in the world that exhibits a tidal bore which has impact on the Lower Indus Basin in Sindh.

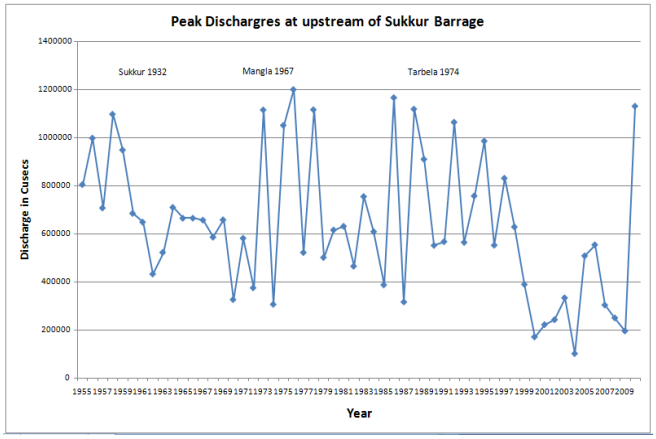
4.4.1.1 Climate Change and Potential Impacts on Water Disasters

Based on observations of the WWF in Pakistan, global warming is causing damage to Pakistan's environment (WWF 2004). Among the impacts felt and seen are biodiversity loss, shifts in weather patterns and changes in fresh water supply. Each of these impacts will change depending on changes of the global climate and the magnitude, intensity and return period of water disasters and floods.

Figure 4.4.1 Peak Discharges at Sindh Barrages







A study carried out by GTZ for WAPDA to analyze trends in temperature and precipitation in the Northern Areas for the last century (Archer, *et. al*, 2001) found that at Skardu, seasonal and annual temperatures have risen over the last century. Mean annual temperature has increased by 1.4 ^{o}C with the mean annual daily maximum rising more than 2.35 ^{o}C. The winter temperatures, since 1961, have risen far more than those of summer with an increase of winter maxima up to 0.51 ^{o} C per decade. Such temperature increases could cause an upward shift of almost 400 meters in the frost line. This might impact the snow and rain patterns, including the availability of snow for melt during summer, which are major sources of water in many rivers and sometimes are the causes of severe super-floods.

Observations of the World Glacier Monitoring Service based in Switzerland indicate that mountain glaciers in the Karakoram have been diminishing for the last 30 years. There are indications that the flow of water in rivers increased during the decade of 1990-2000 in comparison to 1975-1990, which in the absence of increased precipitation, could mean melting of more ice (glacier retreat) upstream. By way of confirmation, documented research indicates that some of the Glaciers in Pakistan have retreated significantly in the recent past. Scientists believe this is an indicator of climate change, resulting in earlier snow melt.

Changes in the climate suggest that the incidence of flash flooding and extreme flooding could increase during the next few decades. Studies conducted also indicate that with a doubling of CO_2 in the atmosphere, average rainfall in South Asia could increase between 17 to 59 %. Such an increase of CO_2, by some projections, could be associated with a doubling in the frequency of high rainfall events. Variable monsoons, also anticipated, could mean more droughts. Observers also suggest that further desiccation of arid areas due to warming could endanger food production in the plains unless significant numbers of trees are planted.

In conclusion, climate change may increase the frequency and intensity of storms and could cause changes of storm tracks. Although the frequency of cyclones along Pakistani coast is low, they cause considerable damage when they occur, and it is important that a disaster management unit be tasked with tracking of data and researches that provide indications of whether forecasted trends are being confirmed. Another critical conclusion is the likely increase both in droughts and in frequency of high rainfall events (triggering extreme floods).

Indus River

Sindh survives almost entirely on the water of the River Indus as there is very limited groundwater available.

The situation worsens during periods of drought. The yearly average availability of water in the province, computed from the data, 1970 to 1997, is 45 MAF. This information helps us to evaluate the water security of Sindh. According to the Water Accord of 1991, Sindh is awarded 48.76 MAF for both Kharif and Rabi seasons. The worst ever drought conditions in Sindh, experienced from 1998 to 2002, show that the province received less water than allocated in the Water Accord.

Before 1973, floods at Sukkur exceeding 900,000 cusecs occurred in the year 1914 and 1958. The discharge recorded (preliminary estimate) at Sukkur exceeded 1,117,000 cusecs on 21st August 2010, which broke all previous records on the score of peak and duration.

The history of the Indus River in the province of Sindh shows that up to year 1942, the damage and devastation through breaches or erosion was almost a regular feature. The earliest record of a breach is at Jamshoro front Bund near Hyderabad in the year 1903. From then on, the tale of destruction was repeated almost every year at one or another point of the river course. This phenomenon did not depend on the magnitude of high floods.

In the year 1941, even when the discharge was as low as 407,000 cusecs (ft^3s^{-1}) floods occurred. It is of interest to mention that, with this low flood, the river eroded away parts of the same Sukkur - Larkana Bund, almost adjoining the reach where breaches occurred during the 1973 floods. Therefore, even floods which are considered to be of low or medium magnitude by present day standards, can lead to a serious situation in Sind, unless of course, a continuous line of reliable flood embankment bunds is maintained in breach-proof condition.

Eighteen major floods that have affected Pakistan since 1947 have caused economic losses and damage worth USD 6 billion (Table 4.4.2). This historical damage was overwhelmed by the super-flood of year 2010 that is estimated to have caused economic losses and damage worth USD 10.05 billion.

Table 4.4.2: Major Flood Events in Pakistan Compared to the Year 2010 Super-flood

Year	Lives Lost	Villages Affected	Estimated damage (USD)
1950	2,910	10,000	
1955	679	6,945	
1956	160	11,609	
1973	474	9,719	
1975	126	8,628	
1976	425	9,150	
1978	393	9,200	
1988	508	1,000	
1992	1008	13,208	$6 billion
1995	591	6,852	
1998	47	161	
2001	201	0.4 million[1]	
2003	230	1.266 million[1]	
2004	85	47	
2005	59	1,931	
2006	523	2,477	
2007	586	6,498	
2010[2]	**1980**	**62,000 sq miles[3]**	**10.05 billion**

1 Number of persons affected
2 World Bank & ADB Preliminary damage and Need assessment report November 2010
3 Area of Great Briton

In assessing the location, duration and impact of flooding in the Lower Indus Basin, it was found that the SIDA Geographic Information System (GIS) and Remote Sensing (RS) Cell did not have a comprehensive GIS data base or GIS based map of historical water disaster and flood events for the Basin. The creation of such a data base is a fundamental first step to improve water disaster and flood risk assessment and management in the project area.

4.4.1.2 Peak Flood Flow in the Indus Main Stem from July to September 2010

A flood peak flow analysis was conducted by the Pakistan Agricultural Research Council (PARC) for the Indus River to assess river flows and hydrologic features of the Indus Main Stem at Rim Stations and at various barrages (PARC, 2010). Flood flows on the main stem of the River were in the range of 527,000 to 1,148,000 cusecs (ft^3s^{-1}). The peak started at the Tarbela Rim Station on 30 July 2010 and reached Kotri Barrage on 27 August. It thus took 29 days for the flood peak to travel from Tarbela to Kotri. This is longer than usual for many past floods because the peak flow continued to change at different nodes due to inflow of floodwater from various tributaries into the Indus Main stem river (Figure 4.4.2).

The extreme peak flood flows shown in Figure 4.4.2 represent discharge flowing below each barrage, even after considering that large quantities of flood discharge were diverted before the barrage by breaching or by overtopping of flood protection bunds. In reality, the flood flows would have been much higher if flood water was fully allowed to reach and flow passed from barrages. For safety of the barrages, large quantities of floodwater were diverted upstream of the barrage so that barrages were not placed at risk of failure or excessive damage from large volumes of discharge passing through the barrages.

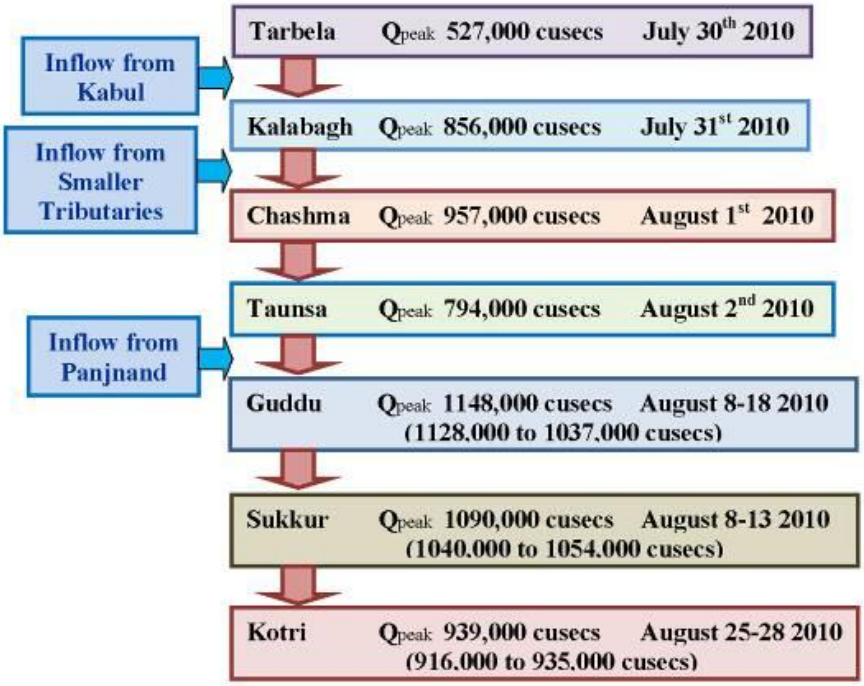


Figure 4.4.2: Flood Peak Flows on Indus Main at Rim Stations and Barrages during Year 2010 Super-Flood (PARC)

Flood Discharge and Frequency Analysis of the Super-flood

As discussed and illustrated above, the first high flood peak at Tarbela was 527,000 cubic feet per second (ft^3s^{-1}) on 30 July. This peak increased to 957,000 ft^3s^{-1} at Chashma Barrage on 01 August due to the inflows from the Kabul River.

At the Taunsa Barrage, the flood peak was observed as 794,000 ft^3s^{-1}. This peak moved downstream to the Guddu and Sukkur Barrages on 9 and 10 August and increased to around 1,128,000 ft^3s^{-1} as the western hill torrents poured more water into the Indus River. The highest peak at Kotri – the most downstream barrage on the Indus River, was 939,000 ft^3s^{-1}.

The two highest flood peaks reached the Taunsa Barrage from Tarbela in 12 days time and remained high for 3-4 days for each flood peak. The flood peaks at Guddu and Sukkur Barrages remained high for more than 10 days. High flood peaks, multiple flood peaks and long peak values over time combined together caused high damage to the irrigation and drainage infrastructure of Sindh.

Most of the barrages in Sindh experienced their near highest or highest historic flood peaks; which in many cases was above their design discharge values. These high flood values were in spite of large scale upstream flooding due to breaching of bunds (dikes) in the upper reaches of the Lower Indus Basin in Sindh. Without this breaching of the bunds, the flood levels at the barrages in Sindh would

have been even higher and would have certainly severely damaged the already flood impacted barrages.

Flood frequency analysis estimated by PARC showed that Tarbela Dam inflows were of very high frequency (3,461 year return period) followed by Chashma (216 year return period), Taunsa (146 year return period) and Kotri (102 year return period) (ADB-WB, 2010). The Tarbela flood peak (835,000 cusecs) was the highest value in its history (682,159 cusecs), but lower than its design flood (1,500,000 cusecs). The flood peak at Chashma (1,036,673 cusecs) was also the highest on record (1,028,723 cusecs) and higher than the design capacity of the barrage (950,000 cusecs; 9% higher).

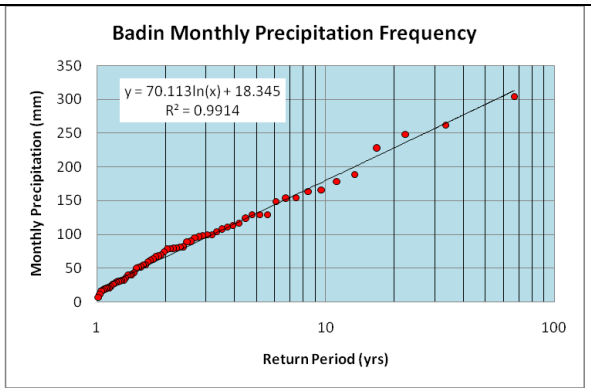
The flood peak at Kotri was also very high (964,897 cusecs) and higher than its design capacity (875,000 cusecs); but the year 2010 flood peak was lower than the historical flood peak (981,000 cusecs; 10% higher). The year 2010flood peaks at Kalabagh, Guddu and Sukkur were lower than their historical peaks, as well as lower than their design capacity (Table 4.4.3).

Table 4.4.3: Historical and 2010 Flood Peaks and Return Period for Barrages on Indus (PARC[1])

Locations	Design Discharge (cusecs)	100 -yr Flood (cusecs)	2010 Flood		Historic Peak	
			Peak	Return Period		
			Cusecs	Years	Year	Cusecs
Tarbela Inflows	1,500,000	653,000	835,000	3,461	1929	682,159
Kalabagh	950,000	1,091,000	937,453	42	1929	1,200,000
Chashma	950,000	934,000	1,036,673	216	1929	1,028,723
Taunsa	1,100,000	911,000	959,999	146	1929	999,920
Guddu	1,200,000	1,332,000	1,148,738	34	1976	1,176,150
Sukkur	(1.5 million as originally designed; reduced to 900,000	1,290,000	1,130,995	39	1976	1,161,472
Kotri	875,000	962,000	964,897	102	1956	981,000

[1] *Also reported by the Federal Flood Commission*

Badin area has always been affected by floods due to high precipitation and lack of drainage. It has been reported that the major events in recent history took place in 1959, 1961, 1962, 1964, 1970, 1976 and 1979 when the annual precipitation events were reported to be within 203 mm to 609 mm. The July 2003 precipitation (303.9 mm) was estimated to have a 66 years return period.



Cyclones are common in the coastal zone and according to the National Institute of Oceanography their return interval is about ten years.

4.4.1.3 Historical Earthquakes Affecting Sindh Province

Three significant data bases are available for mapping of historical earthquakes in Pakistan and Sindh:

1. USGS NEIC (GPE) Database of earthquakes – 1973 to 2010
2. NGID Significant Earthquake Database – 2150 BC to present
3. India Database – 1063 to 1984

The Significant Earthquake Database contains information on destructive earthquakes from 2150 B.C. to the present that meet at least one of the following criteria: Moderate damage (approximately $1 million or more), 10 or more deaths, Magnitude 7.5 or greater, Modified Mercalli Intensity X or greater, or the earthquake generated a tsunami. The data base contains earthquakes with known magnitude values between 0.1 and 9.9. Earthquakes that have no computed magnitude values are also included in the data base. This data plotted as epicenters for earthquakes in all of Pakistan are shown for in Sindh Province in Figure 4.4.3.

Seismic Hazard for Sindh

Estimation of the seismic hazard for the coastal area of Sindh was carried out using deterministic and probabilistic approaches for the Pakistan Atomic Energy Commission for the sitting of nuclear power plants on the southern coast of the country (Khan, Dhad and Qaisar, 2003). On the basis of seism tectonics and geology, eleven faults were recognized in seismic districts as potential hazard sources. Maximum magnitude potential for each of these sources was calculated. Peak ground acceleration (PGA) values at the seven coastal cities due to the maximum credible earthquake on the relevant causative fault source were also obtained and are given in Table 4.4.4.

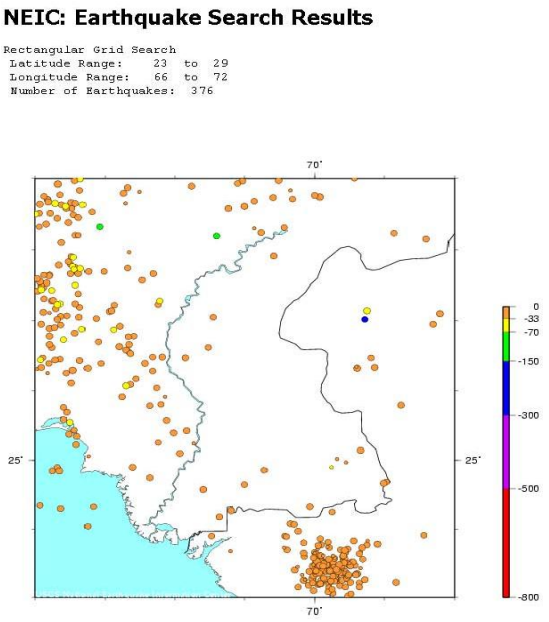


Figure 4.4.3: Recent Earthquake Events (2150 BC to present) Recorded for Sindh (USGS)
http://earthquake.usgs.gov/earthquakes/eqarchives/epic/

Table 4.4.4: Peak Ground Acceleration at Various Coastal Cities of Pakistan

Coastal cities	Causative fault	Credible magnitude	Closest distance (km)	Peak ground acceleration (Ambraseys, 1991)
Jiwani	*West Makran fault*	*7.2*	*25*	*0.16g*
Gwader	*Main Makran coast*	*8.0*	*30*	*0.21g*
Pasni	*Main Makran coast*	*8.0*	*40*	*0.16g*
Ormara	*Main Makran coast*	*8.0*	*25*	*0.25g*
Turbat	*Hoshab fault*	*7.6*	*60*	*0.08g*
Hub	*Sonmiani fault*	*7.1*	*20*	*0.19g*
Karachi	*Sonmiani fault*	*7.1*	*45*	*0.08g*

The cities of Gwadar and Ormara with acceleration values of 0.21g and 0.25g fall in the high seismic risk area. The cities of Turbat and Karachi lie in low seismic risk area with acceleration values of less than 0.1g. Probabilistic PGA maps with contour interval of 0.05g for 100 years return period with 90% probability of non-exceedance were also compiled.

Ffigure 4.4.4 shows the expected peak ground acceleration for a recurrence period of 100 years, with the contour interval of 0.05g for the southern coast of Sindh and Balochistan. The results shown indicate that the region surrounding Makran coast can be regarded as a high seismic risk region. Also the region near Hub can be regarded as a hazardous region.

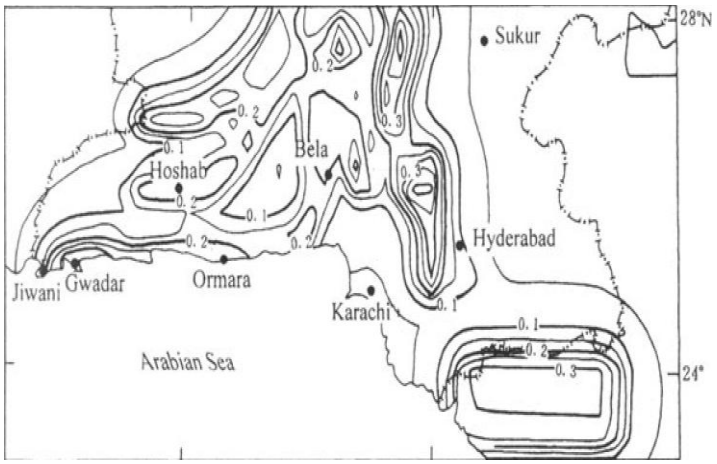


Figure 4.4.4 Peak Ground Acceleration g 100 yrs Return Period

On the other hand, Karachi lies at a relatively stable location. Sukkur and Hyderabad are also in seismically stable locations. But some of the project area along the Indus River Channel could be considered to be more prone to seismic risk.

Tsunami Disaster Potential for Sindh

The significant tsunami associated with the Makran earthquake of 1945 clearly shows the potential for tsunami disasters on the Sindh coast in the project area. Tsunami safety in the form of public awareness programmes and tsunami warning instrumentation and warning systems are well developed in the region as a result of the Christmas 2004 tsunami that struck Sri Lanka, Bangladesh and India. These tsunami disaster mitigation technologies are not well developed or implemented in Pakistan.

As discussed previously in this chapter, archival records of Pakistan Meteorological Department (PMD) show that 4,000 people were killed by the combined effects of an earthquake and tsunami off the Makran coast on Nov 28, 1945, with the tsunami responsible for most deaths. Further records reveal that most tectonic activity takes place along the boundaries of the Indian tectonic plate and the Iranian and Afghan micro-plates. At least 28 earthquakes with magnitudes close to 7.0 or above are known to have occurred in this region since 1668, making the region extremely vulnerable to tsunamis as well as tidal waves.

There is another tsunamigenic factor to take into account. It is the enormous pile of sediment that has accumulated since the last glaciation at the top of the underwater canyon that materialize the former course of the Indus River. It will one day collapse into a sudden and massive underwater landslide (with or without an earthquake) that has the potential of generating a highly damaging tsunami.

After the destructive tsunami in December 2004, a network of different countries including Sri Lanka, Pakistan, India, Oman, Iran and several other countries was formed to exchange the early warning. The UN has established early warning tsunami centres in countries located in the North-east Atlantic Ocean, Indian Ocean and Pacific Ocean. They are also training authorities and stakeholders to improve the communication methods for timely delivery of warnings to all concerned.

A tsunami warning system also requires accurate bathymetrical and topographical surveys to know water levels at different positions and to understand the ocean physics to know what is lying in the sea bed to diminish or to amplify tsunami wave energy. The absence of topographical and bathymetric data and tsunami preparedness and warning for the cities lying in the coastal belt of Sindh and the sea can result in heavy losses.

It is understood that the Pakistan government has neither installed tide gauges on the coastal belt nor conducted any topographical or bathymetrical surveys of the Arabian Sea.

4.4.1.4 Legal Framework for Water Hazard and Flood Management

An understanding of the legal framework for water disaster and flood management in Pakistan and Sindh is an important point of departure for understanding how the flood management system works - or does not work. A summary of the major forms of disaster legislation in Pakistan is given in Table 4.4.5.

Table 4.4.5: Principal Legal Instruments Concerned With Disaster Management and Disaster Risk Reduction in Pakistan

Year	Name of Legal Instrument	Emphasis
Pre-1947	Indian Famine Codes	Relief
1952 (Amended 1993)	The Civil Defence Act, 1952 As Amended in 1993	Response
1958	The West Pakistan National Calamities (Prevention and Relief) Act, 1958	Response and relief
2001	Local Government Ordinance (LGO)	Response and relief
2002	Emergency Services Ordinance (ESO)	Response
2002	Sindh Water Management Ordinance, 2002 (SWMO)	Preparedness and mitigation
2007	National Disaster Management Ordinance, 2007	Disaster Risk Management
2010	National disaster management Act 2010	Disaster Risk Management

Pre-Independence Era

The Indian Famine Codes, developed by the colonial British in the 1880s, were one of the earliest forms of disaster management legislation. The Famine Codes defined three levels of food insecurity: near-scarcity, scarcity and famine. *Scarcity* was defined as three successive

years of crop failure, crop yields of one-third or one-half normal and large populations in distress. *Famine* further included a rise in food prices above 140% of *normal*, the movement of people in search of food, and widespread mortality. This was possibly the earliest recorded form of disaster risk assessment.

In order to address the issues of famine in India the British Government created an Indian Famine commission to create ways to prevent and avoid future famine in India. In 1880 the secretary of the commission wrote a draft of the Indian Famine Code. This famine code, successively updated, became the basis of famine prevention until the 1970s. The Indian famine codes were one of the first attempts to predict famine, and since they could predict it, they could also prevent it or mitigate it.

Modern Era

Emergency response has remained a predominant approach in Pakistan to deal with disasters until recently (Table 4.4.5).

The Civil Defence Act, 1952 -As Amended in 1993

The Civil Defense Act of 1952 established legislation to respond to disasters and emergencies related to war and civil disturbance. In 1993, as a result of the fall of Communism, the law was amended to include response to disasters and emergencies related to natural disasters.

The National Calamities (Prevention and Relief) Act, 1958

The *Calamity Act of 1958*, the major national policy for disaster management for almost 50 years prior to the passing of the *National Disaster Management Ordinance of 2007*, was mainly concerned with emergency response and relief. Pakistan Civil Defence was the focal agency for responding to disasters till 1970. In the aftermath of 1970 cyclone in the then East Pakistan (now Bangladesh), the Emergency Relief Cell (ERC) was established, which became the government's focal point for emergency flood relief in disaster hit areas. The reasons behind this reactive approach by policy makers might have been related to the relatively lower socio-economic impact of water disasters in the past; and the now discredited concept of disaster relief versus the current concept of disaster risk reduction.

The Calamity Act, 1958 provided for the maintenance and restoration of order in areas affected by certain calamities and for the prevention and control of and relief against such calamities. Provincial Relief Commissioners (who also are Senior Members of the Provincial Board of Revenue) were given the responsibility of relief. The calamities most concerned with in the act were the water disasters of floods and drought.

Local Government Ordinance (LGO) 2001

The Local Government Ordinance (LGO), provided new avenues for effective and context-specific disaster management, but there also existed a few legal and administrative inconsistencies in relation to disaster response at provincial and district levels. Functions and powers related to emergency response and disaster management at District, Tehsil and Union level provided in the act included:

1. **Zila Nazim**: Being the head of the District, the Zila Nazim is responsible to "*take charge, organize and prepare for relief activities in disasters or natural calamities*".
2. **Zila Council**: The Zila (District) Council is to "*make recommendations to the District Government for enhancement of the care of disabled persons, paupers, aged, sick, persons of unsound mind, abandoned minors, juvenile delinquents, drug dependents, abused children, needy and disadvantaged person*".

3. **Zila Council in a City District**: In case of a City District, the Zila Council has the responsibility and powers to (a) approve master plans, zoning, land use plans, including classification and reclassification of land, environment control, urban design, urban renewal and ecological balances; (b) review implementation of rules and bye-laws governing land use, housing, markets, zoning, environment, roads, traffic, tax, infrastructure and public utilities; and (c) review development of integrated system of water reservoirs, water sources, treatment plants, drainage, liquid and solid waster disposal, sanitation and other municipal services.
4. **Tehsil Municipal Administration (TMA):** Under the LGO, the TMA is to provide, manage, operate, maintain and improve the municipal infrastructure and services, including the water related activities of:
    - Water supply and control and development of water sources, other than systems maintained by the Union and Village Council
    - Sewerage, sewage and sewage treatment and disposal
    - Storm water drainage
5. **Tehsil Council:** The Tehsil Council was to approve land use, zoning and master planning of the Tehsil development and maintenance programs or projects proposed by the Tehsil Municipal Administration. The Town Council has also got similar powers and responsibilities to be executed under the LGO.
6. **Union Council Administration**: The Union Council Administration was to assist the relevant authorities in disasters and natural calamities and assist in relief activities, including de-silting of canals
7. **Union Council Nazim**: The Union Council Nazim is to report to the concerned authorities in respect of:
    - Encroachment on State and local government property and violation of land use and building laws, rules and bye-laws
    - Environmental and health hazards
8. **Union Council (UC)**: The Union Council is to promote plantation of trees, landscaping and beautification of public places in the Union.
9. **Village Council (VC):** The Village Council is responsible to (a) develop and improve water supply sources; (b) make arrangements for sanitation, cleanliness and disposal of garbage and carcasses; and (c) take measures to prevent contamination of water

The LGO further states that the City District Government may set up district municipal offices for integrated development and management of the following water resource related services:

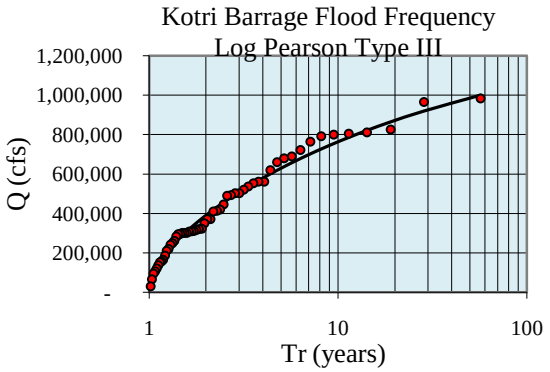
1. Water source development and management, storage, treatment plants, and macro-distribution
2. Sewage tertiary and secondary network, treatment plants, and disposal
3. Storm water drainage network and disposal
4. Flood control protection and rapid response contingency plans
5. Natural disaster and civil defence planning
6. Solid waste management, treatment and disposal, including land fill sites and recycling plants
7. Industrial and hospital hazardous and toxic waste treatment and disposal

Several sections and clauses of the LGO have continued to create confusion that has resulted in the clash between the District Nazims and District Coordination Officers (DCOs). For instance, in the case of relief distribution Clause (k) of Section 18 of the LGO empowers the district Nazim to take charge of relief activities while in Schedule 2 of the Ordinance, Clause 6 empowers the DCO to do the same; but Clause 6 is further backed by the National Calamities (Prevention and Relief) Act, 1958, and thus is considered to have precedence.

Emergency Services Ordinance (ESO), 2002

The Emergency Services Ordinance (ESO) established emergency service to deal with emergencies in an effective manner and to combat threats to the public from modern warfare, terrorism and disasters; and defines responsibilities at each level of government. A National Council was established to regularly monitor the performance of this service and ensure continuity in the process of rule making in the management of emergencies and disasters during peace time.

According to the ESO, provincial governments have the effective administrative power to implement emergency service. Likewise, the District Emergency Officer was made responsible for the functional management of the emergency service.



The Federal government was mainly responsible for ensuring uniform standards for the emergency service throughout the country; to provide advance training to officers through a National Academy; and to oversee the performance of provinces. The ESO includes definitions of disaster related terms such as natural versus man-made disasters, emergency, preparedness, response and support services and others. Under the ESO, the Federal, Provincial and District Governments were required to set-up Emergency Services, which were to be responsible for preparedness and rapid response to emergencies and disasters of any scale. The National and Provincial Crises Management Cells of the Ministry of Interior and Home Departments respectively, were responsible to coordinate the activities of all emergency services at the national and provincial levels.

Sindh Water Management Ordinance of 2002 (SWMO 2002)

The Sindh Water Management Ordinance of 2002 (SWMO, 2002) establishes The Sindh Irrigation and Drainage Authority (SIDA) as an instrument of change for the management and financing of the irrigation and drainage infrastructure of the Lower Indus Basin in Sindh.

The relevant sections of the Ordinance and identifies the relevant disaster management responsibility assigned to SIDA is presented in Vol–II Thematic Area 4.4.

4.4.2. Key Findings of the Thematic Assessment

4.4.2.1 Finds Related to the 2010 Super Flood

Flowrates return period estimated for the 2010 flooding event

The Pakistan Agricultural Research Council (PARC) estimated the 2010 flood recorded (964,897 cusecs) at Kotri Barrage as having 102 years return period, as

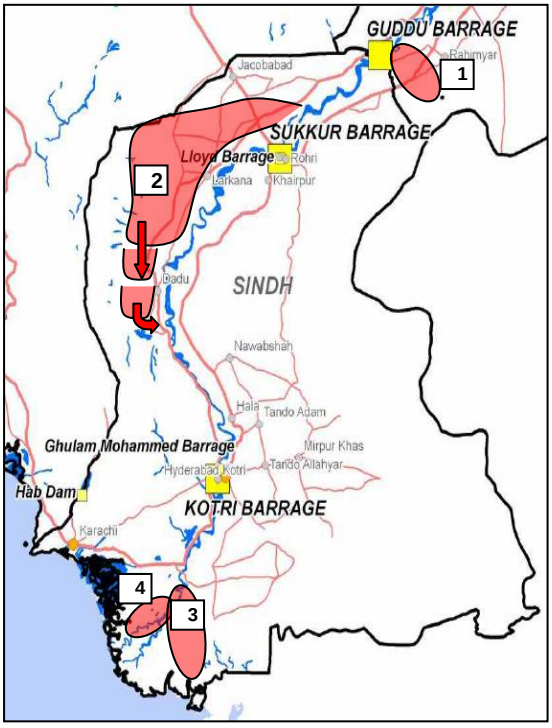


Figure 4.4.5 Flooded Area due to Bund Breaches

indicated in the background section above. The 56 annual peak discharges' data reported at Kotri Barrage (please refer to Vol–II Thematic Area 4.1) were analyzed in the present study to determine the return period of the 2010 flowrate. The present study used the log- Pearson Type III prediction to estimate the flood frequency for Kotri Barrage. It may be noted that the values obtained by different methods will render different results. The present study concluded that the 2010 flood at Kotri Barrage corresponds to a 42 years return period flow, in clear disagreement with the 102 years estimated by PARC.

2010 River Bund Breaches in Sindh

Four breaches in flood protection embankments on the left Marginal Bund of the Guddu Barrage, Tori, MS and PB bunds caused main damages. The first breach occurred in left Marginal bund of Guddu Barrage, second breach occurred in the Tori Bund in the Guddu-Sukkur reach on the right bank of the Indus River. The caused flood water overtopped the Beghari feeder canal and inundated its corresponding irrigation systems under 3 to 4 m deep water on the Indus Right Bank in downstream areas. It further inundated almost the entire NW canal command area and approximately 50% of the Beghari Feeder command area.

The third breach occurred in the MS Bund along the left bank of the Indus River downstream of Kotri Barrage. This breach damaged the Pinyari canal system and inundated irrigation and drainage facilities in about a 50 km long area. This breach was 250-300 m wide and passed a significant volume of flood water.

The fourth breach occurred in the Indus right bank flood protection embankment also downstream of the Kotri Barrage and inundated areas of Thatta District. Flooded area of the breaches is shown in Figure 4.4.5.

Assessment of the Cause of Breach of MS Bund

An assessment of the cause of failure of the MS Bund was made based on an inspection field trip to the site of the failure after the flood waters had receded but before repair of the bund. Since the failed section of the bund had washed away and could not be inspected, the assessment of the cause of the failure relied on an inspection of the remaining sections of bund upstream and downstream of the breach. The assessment was also made based on observations of the Indus River morphology in the area of the breach.

It was postulated that the following were potential causes of the failure of the bund:

1. Inadequate design of the bund
2. Improper alignment of the bund
3. Poor construction of the bund
4. Poor maintenance of the bund
5. Unique river morphology at the failed section
6. Poor performance of river training
7. Other factors

An assessment of the potential for each of these postulated failure mechanisms is presented in Table 4.4.6

Table 4.4.6: Assessment of Failure Mechanism of the MS Flood Protection Bund in Sindh

Assessed contribution to bund failure	Postulated bund failure mechanism	Observed condition	Assessment
Low	Inadequate design	The section of failed bund appeared to have the standard section; and the same as upstream and downstream sections	It is assumed that the standard Sindh bund section has a long history and has been developed over time to be a good compromise between safety, construction economy and O&M realities
Moderate	Improper alignment	The failed section has a dog-leg alignment; upstream and downstream sections are straight	The failed section alignment may have contributed to the breaching
Low	Poor construction	The failed section and its upstream section appeared to have the same level of average construction; the downstream section had new better bank protection pitching	The construction soils at the failure section (and upstream and downstream) was almost pure silt that is likely to be erosive when exposed to fast flowing water. The pitching was placed directly against the bank section without geotextile separation fabric
Moderate	Poor maintenance	The failed section and its upstream section did not appear to be well maintained	Their appeared to be a general lack of maintenance in the bund section inspected
None	Performance of existing river training	There is no river training works at the failed section; or upstream or downstream of the failed section	The absence of river training may have contributed to the failure
High	River morphology	The river channel in front of the failed section was aligned directly toward the failed section. There is a sharp river bend away from the bund	It is assessed that the river morphology was the main cause of the bund failure. At high flood flows the river channel was directed directly at the location of the failed section. Spurs are a possible repair requirement.
Low to none	Other cause	None observed	No other potential condition making the failed bund section unsafe was noted

Lessons Learned from the Year 2010 Super-flood

The major lesson learned from the year 2010 super-flood is that the institutions envisioned under the National Disaster management Ordinance, 2007 and the modalities called for from the National Disaster Management Plan are not functioning.

1. Natural flood retardation basins can be used instead of breaching of bunds to protect barrages from damage or failure from extreme values of flood water flows.

2. It is considered by many knowledgeable flood management experts that it is politically and socially impossible to intentionally breach bunds during the height of a flood if a preparedness plan based on community consultations has not been prepared before the flood event. Also as a minimum, the breaching plan must break bunds on both sides of the river to show the local population that the breaching is not done to favour any one landowner or community

There exists a competent plan. It is assessed that the National Disaster Management Strategy is clear, compressive and right-thinking. However, there is a clear need for a new approach to water disaster and flood management in the country, in the Lower Indus River Basin; and in Sindh. This perception of need is present at all levels of government and within all classes of society.

It is not clear that there is sufficient, or any political will, to implement the National Disaster Management Ordinance or establish the methodologies called for in the National Disaster Management Framework. Even at the height of the recent national grief resulting from the year 2010 super-flooding not spokesperson was heard to say that the dis-functionality of the present disaster management system will be fixed.

4.4.2.2 Water Disaster and Flood Management Scenario

Legal framework

The current legal framework for disaster management in Pakistan is the National Disaster Management Ordinance (NDMO) of 2007. The Ordinance introduces the concept of Disaster Risk Reduction under the Hyogo Framework of Action (HFA) 2005-2015 which is the modern internationally agreed to focus of current disaster management practice.

Unfortunately the ordinance does not modify other water disaster management legislation going back to the early days of the country to the time of its independence. The result is a confusing miss-match of old and new legal institutions and modalities.

1. The NDMO may be too complex to implement and administer for a country like Pakistan with limited financial and human resources
2. The current status of old, but not repealed, legislation is not known. But it is sensed that the old and new legislation are in conflict with the lack of a clear political mandate as to what system of disaster management is to be followed
3. It is not know if there is sufficient budget allocated to make the new Ordinance operational. But experience with the introduction of other similar levels of legislation suggests that financial resources are not available to implement the new Ordinance.
4. SIDA is not mentioned in the National Disaster Management Ordinance (NDMO, 2007) or the National Disaster Management Framework (NDMF) – Even though the Sindh Water Management Ordinance of 2002 (SWMO, 2002) legally gives the Sindh Irrigation and Drainage Authority (SIDA) authority to practice flood management.

Institutional framework

The institutional framework clearly sets out the management structure for the new institutions legislated by the National Disaster Ordinance of 2007; but fails to show any linkage to the historical appendages of the older pre-existing legal framework. The result is lack of coordination and cooperation between agencies and work often performed at cross-purposes.

In addition, while the development of new disaster risk management institutions has progressed at the national level, there is lack of progress to develop these same institutions at the province and lower levels of government. The result is a non-functional institutional system with vestiges of the old programme vying with the new institutions established by the new programme fighting over insufficient financial and human resources.

1. There is no historical culture of disaster risk management in Pakistan – Disaster Management is not a career in Pakistan or in Sindh
2. The current status of old disaster management institutions, established under old, but not repealed legislation is not known. But it is sensed that the old no longer needed institutions are still in place using much needed financial and human resources.

Technical and social framework

The new legal framework and institutional framework for disaster risk management in Pakistan and in the Lower Indus Basin is based on a new National Disaster Management Strategy (NDMS). It is assessed that the strategy is well thought out and comprehensive. Detailed work plans and strategies have been developed with comprehensive lists of action items and deliverables. Lacking however is an understanding of the significant cost of the preparation of the plans and strategies; and an understanding of the quantity and quality of the human resources needed for the work.

Also, the NDMS has no reference to participation of SIDA in the national or provincial water disaster management Framework or Strategy.

4.4.2.3 Current Approach to Disasters and Flood Management

Up until 2005 it is possible to trace only fragmented and isolated efforts for developing a national level interest in disaster risk management. But year 2005 proved to be a watershed in the context of disaster management. Pakistan faced a devastating earthquake in October 2005 which exposed the vulnerability of the existing emergency and disaster response system and capabilities. The 2005 earthquake changed Pakistan's perceptions about how to manage disasters. Besides this horrific event, Pakistan also became a signatory of the international disaster risk reduction protocol – the Hyogo Framework for Action 2005-15. Both these developments worked as a catalyst leading to the promulgation of National Disaster Management Ordinance in and the adoption of the National Disaster Management Strategy in 2007.

Increased Vulnerabilities to Water Hazards and Floods in Sind

The main causes of vulnerability to water hazards and floods in Sindh include: poor quality construction of housing, buildings and infrastructure (particularly rural); fragile natural environment; poor agriculture and irrigation management practices; weak early warning systems; lack of awareness; poor education; and high levels of poverty. Lack of communications infrastructure and critical facilities further aggravate vulnerabilities of communities in post-water disaster situations.

Much of the rural housing in Pakistan is adobe, which is extremely vulnerable to hazards like water disasters and floods. The indigenous practice of light-weight, timber-laced construction has given way to more massive masonry and reinforced concrete construction; this construction provides adequate protection against weather but is often poorly constructed to withstand flooding. Also, urban housing and infrastructure suffers from lack of implementation of building codes. The growth of slums and urban poverty has further compounded unsafe construction practices in Karachi and possibly in Hyderabad. Even a relatively prosperous city like Karachi does not follow safe construction practices.

Reasons lie in lack of political will, business interests, corruption, lack of information and lack of trained man-power.

Fragility of natural environment in areas of the Indus River Basin has also exacerbated conditions of vulnerability. Due to massive deforestation, the rate of soil erosion is very high in the Northern region for the Indus River Basin. Pakistan has been left with only 4 % forest and vegetative cover, in contrast to the required 25 % percent, thereby experiencing an intense and uninterrupted discharge of flood water, especially during monsoon seasons. This coupled with increasing snowmelt in the Himalayan glaciers has intensified flood risks.

Pressures upon forests and other natural resources need to be released in order to reduce water disaster vulnerabilities. This is especially true in the delta and coastal zone of Sindh where the loss of mangrove forests has opened large tracks of land to storm and cyclone damage and salt water intrusion.

Overgrazing of marginal lands in Sindh and cultivation of water-intensive crops, such as rice and sugar cane, has worsened drought conditions. A many-fold increase in livestock population in arid zones has led to overexploitation of range-lands without providing them the time to recover. Simultaneously, extensive installation of tube-wells in Sindh has accelerated extraction of ground water, which is lowering the water table quickly. Solutions to drought and water shortage problems in arid zones require modifications in agricultural and livestock management practices; including reduction in the size of livestock population to make it compatible with carrying capacity of rangelands and replacement of water-intensive crop varieties with drought resistant crops.

A little less than one-third of Pakistani people are living under the poverty-line, many of whom inhabit water hazard prone areas. This social segment which struggles to cope with daily life risks cannot be expected to make water disaster risk reduction a priority, and therefore suffers severely from water disasters.

Seisms

The major issues that have been concluded from the major findings related to seisms are the following:

1. The potential seismicity of Sindh is very high, and has not been properly considered in the development and implementation of previous Master Plans
2. Sophisticated analysis of the seismicity of Sindh has been recently completed; but has not yet been incorporated into the water resources management planning or implementation process
3. Tsunami disasters are a real threat to the people and infrastructure of the Delta and Coastal Zone of Sindh; but little to preparedness or planning is currently in place to mitigate or manage the risk of tsunamis striking the coast of Sindh
4. Modern concepts of seismic risk management are just now being introduced into Sindh; but little practical experience currently exists

Sufficient knowledge is currently available to assess the seismic risk to all elements of a new Water Resources Master Plan for the Left Bank Indus, Delta and Coastal Zone. It is however considered necessary to introduce modern aspects of seismic risk management into the design, analysis and implementation of the new Master Plan so that the people of Sindh can mitigate the seismic risk to all new and existing water resource management and development in their region.

4.4.3. Issues and problems

Detail discussions about the issues and problems identified have been presented under *Findings* above. These can be broadly resumed into the following:

Issues

- ✓ Natural bund breaches occur due to poor performance of river training, which are caused by inadequate design, poor construction and lack of maintenance. Lack of trained staff in the government agencies is one of the causes of bund breaches.
- ✓ Lack of natural flood retardation basins to be used to protect barrages from damage instead of breaching of bunds.
- ✓ The breaching plan to break bunds on only one side of the river (this is perceived by the local population that the breaching is done to favour a specific landowner or community) without a preparedness plan based on community consultations before the flood event.
- ✓ The National Disaster Management Strategy (NDMS) is well thought out and comprehensive. Detailed work plans and strategies have been developed with comprehensive lists of action items and deliverables. However it is not implemented.
- ✓ There is no historical culture of disaster risk management in Pakistan.
- ✓ The main causes of vulnerability to water hazards and floods in Sindh include: poor quality construction of housing, buildings and infrastructure (particularly rural); fragile natural environment; weak early warning systems; lack of awareness; poor education; and high levels of poverty.
- ✓ Deforestation of the watershed is a major cause of flooding
- ✓ The potential seismicity of Sindh is very high, and has not been properly considered in the development and implementation of previous Master Plans
- ✓ Tsunami disasters are a real threat to the people and infrastructure of the Delta and Coastal Zone of Sindh; but little to preparedness or planning is currently in place to mitigate or manage the risk of tsunamis striking the coast of Sindh.

4.5 STRUCTURES FOR IRRIGATION DRAINAGE AND FLOOD PROTECTION

4.5.1 Background

In order to meet the scope of the Phase-I study, being mainly an inventory and assessment of existing conditions and the identification of issues and problems related to drainage and flooding, the topics related to the structures for irrigation drainage and flood protection in the area on intervention were studied using the tasks listed in Table 4.5.1.

Table 4.5.1: Topic Outline for Summary of the Thematic Area 5 Study

Topic of Concerns for Phase-I Task Studies	
Subjects Covered	**Phase-I Tasks Included**
V – Structures for Drainage and Flood Protection	
✓ Irrigation structures ✓ Drainage structures ✓ Flood protection structures ✓ Operation and maintenance (O&M)	T-7: Review water structures and drainage structures planning and management T-10: Document extent and adequacy of infrastructure T-13: Review and evaluate the performance of existing and on-going structures

Sindh has three major barrages on the Indus river that divert approximately 45 to 48 MAF (55.5 to 59 billion m3) of water annually to the 14 Canal Commands in Sindh. These systems have aggregate length of Main, Branch Canals and Distributaries and Minors 19066 km.

There are about 42,000 water courses which have an aggregate length of 120,000 km. The irrigation supplies are augmented with the pumping from fresh water tube wells installed in the fresh ground water areas along River Indus.

Irrigation water in the study area is diverted from the Indus River through. Ghotki Feeder Canal off taking from Guddu Barrage. Khairpur East Canal, Khairpur West Canal, Rohri Canal and Nara Canal off taking from Sukkur Barrage. Akram Wah, Fuleli Canal and Pinyari Canal off take from Kotri Barrage. Salient features of irrigation network Barrages and Canals which supply water in the study area is presented in following Table 4.5.2. Total Gross Command Area of 8 Canals is 9.75 MA and Cultivable Command Area 8.58 MA.

Annual Water entitlement of Ghotki Feeder Canal is 3.484 MAF Khairpur West is 1.148 MAF, Khairpur East 1.319 MAF, Nara Canal 7.803 MAF, Rohri Canal 8.297MAF, Fuleli Canal 3.280 MAF, Pinyari Canal 2.593 MAF and Akram Wah 1.786 MAF with total annual entitlement of all 8 Canals is 29.562 MA. Annual withdrawals of 8 Canals for years 2004-05, 2005-06, 2006-07, 2007-08, 2008-09 and 2009-10 were 26.7, 29.0, 24.8, 25.199, 22.02 and 23.696 MAF. The withdrawals are within entitlements as presented in Table 4.5.3 below.

The withdrawals in the canals were allowed by the authorities as per water availability at the barrages. The data indicate that water has been released in the respective canal on the ratio of shortages in the quantum of water available at barrages during shortage periods. Major Irrigation structures in the Study area are Guddu, Sukkur and Kotri barrages, head regulators and cross-regulators in the irrigation networks.

Table 4.5.2: Irrigation Network in Study Area Barrages & Main Canals

Barrage	Canal	Year of Commissioning	Canal Classification	Water Allowance (DES) Per 1000 acres (Cusecs)	Intensity of Cultivation		Design Discharge (Cusecs)	Maximum Authorized Discharge (Cusecs)	Length (miles)	GCA (Million Acres)	CCA (Million Acres)
					Kharif	Rabi					
Guddu	Ghotki Feeder	1962	Non-Perennial	6.0	60	-	8490	11670	79.6	1.017	0.855
Sukkur	Khairpur East	1932	Perennial	3.2	32	48	2094	2550	58.6	0.570	0.369
	Khairpur West	1932	Perennial	3.2	32	48	1940	2150	41.9	0.424	0.322
	Rohri	1932	Perennial	2.7	27	54	10887	16936	208	2.667	2.601
	Nara	1932	Perennial	2.8	28	53	13649	13861	226	2.502	2.240
Kotri	Akram Wah(Lined Channel)	1955	Perennial	6.1	44.5	35	4100	3770	76	0.518	0.487
	Fuleli	1955	Non- Perennial	14.0	71	-	14859	14330	60	1.111	0.929
	Pinyari	1955	Non- Perennial	4.44	71	-	13636	10490	56	0.948	0.786

Source: History and Irrigation Practices IPD April 1993

Table 4.5.3: Entitlement and Canal Withdrawals in Guddu, Sukkur and Kotri barrage Sub-regions in Study Area

Subregions/Canal	GCA (MA)	CCA (MA)	Entitlement (MAF)	2004/05 (MAF)	2005/06 (MAF)	2006/07 (MAF)	2007/08 (MAF)	2008/09 (MAF)	2009/10 (MAF)
Ghotki Canal	1.017	0.855	3.484	2.6	3.1	3.3	3.32	2.92	2.68
Guddu Subregion	**1.017**	**0.855**	**3.484**	**2.6**	**3.1**	**3.3**	**3.32**	**2.92**	**2.68**
Khairpur Feeder (West)	0.424	0.322	1.148	0.9	0.8	0.8	0.832	0.844	0.856
Khairpur Feeder (East)	0.570	0.369	1.319	1.0	1.1	1.1	1.18	1.21	1.24
Nara Canal	2.502	2.240	7.803	7.0	8.0	7.2	7.25	8.58	7.43
Rohri Canal	2.667	2.601	8.297	6.1	7.2	5.9	6.5	6.26	6.39
Sukkur Subregion	**6.163**	**5.532**	**17.419**	**15.0**	**17.1**	**15.0**	**15.762**	**16.849**	**15.916**
Fuleli Canal	1.111	0.929	3.280	4.7	4.6	3.3	3.08	3.67	3.43
Pinyari Canal	0.948	0.786	2.593	3.3	2.7	2.2	2.06	2.3	1.87
Akram Wah	0.518	0.487	1.786	1.1	1.5	1.0	0.977	1.29	1.04
Kotri Subregion	**2.577**	**2.202**	**7.659**	**9.1**	**8.8**	**6.5**	**6.117**	**7.26**	**6.34**
Total Left Bank	9.757	8.589	28.562	26.7	29.0	24.8	25.199	27.074	24.936

Source: Development Statistics of Sindh 2008 for years (2004-05, 2005-06, 2006-07)
IPD for years (2007-08, 2008-09, 2009-10)

4.5.1.1 Barrages

Guddu Barrage

Guddu Barrage is located on the River Indus approximately 8 miles north east of Kashmore, in upper Sindh having longitude coordinate at 69° 45' E and latitude coordinate at 28° 25' N. It is the first Barrage on the River Indus in Sindh Province downstream of Taunsa Barrage, located in Punjab Province.

The construction of the barrage started in 1955 and was completed in 1962. The total width of the barrage between two abutments is 4,445 ft, comprising of 54 river sluices, 7 right pocket bays, and 4 left pocket bays, one of which is a navigation lock. All bays are 60 feet wide except the navigation lock which is 50 feet wide. Gates are of the vertical lift type, suspended by chains mounted on an overhead platform. The pockets are separated from the river bays by divide walls, each incorporating a fish ladder. Both pocket bays are under sluices to serve the purpose of silt exclusion from the pockets. A road bridge spans the river immediately downstream side of the gate line, supported on the barrage piers. Regulator gates are counterbalanced and of the vertical lift type, each of 24 feet span 9 spans in Desert Pat Feeder, 10 in the B.S. Feeder, and 6 spans in the Ghotki Feeder, which offtakes on the Left Bank side of Guddu Barrage and supply water to its command area. Detailed feasibility is required in view of various problems faced in operation of the barrage side such as centralization of main current and addition of Rainee Canal head regulator on upstream of barrage. Under WSIP detailed feasibility studies will be conducted for improvement/ rehabilitation of the barrage.

Sukkur Barrage

Sukkur Barrage is located on the Indus River in Sindh at about 480 km (300 miles) north East of Karachi having longitude coordinate of 68°33' E and latitude coordinate of 27°47' N. The Barrage is situated 160km (100 miles) from Guddu Barrage and about 320 km (200 miles) from Kotri Barrage. Sukkur Barrage is the first barrage constructed in Sindh province on River Indus. The Construction of the Barrage started on 1st July 1923 and was completed by 31th December 1931. The Barrage was commissioned on 13th January 1932 and water started flowing in 7 main Canals off taking on Right and Left sides of Barrage.

Seven canal systems were constructed for supply of irrigation water out of which 3 canal systems are on the right bank of the Barrage and 4 canal systems comprising of Khairpur West Canal, Rohri Canal Khairpur East Canal and Nara Canal are on left bank of the Barrage, supplying irrigation water in the study area under Sukkur Barrage command.

The total width of the barrage between two abutments is 4,725 ft. Comprising 66 bays each divided into three sections: the right under sluices, the central weir portion and the left under sluices. The right and left under sluices have 5 and 7 bays respectively and are separated from the main weir by right and left divide walls. The central section is divided into 6 compartments each of 9 spans each. These compartments are separated from one another and from the under sluices by 25 ft wide and 97 ft long abutment piers and ordinary piers between the spans are 10 ft wide and 77 ft long.

Operational efficiency of the barrage was affected due to silt entry problem in the canals off taking on the right bank side of the Barrage. Based on the result of the model studies 10 bays of the barrage, 9 adjacent to the right under sluices 6 to 14 and 23 were closed and river training works were carried out for smooth operation of the barrage. However, the flood passing capacity of the barrage was reduced from 1.5 million cusecs to 0.9 million cusecs. Several floods exceeding 0.9 million cusecs and including a maximum 1.2 million cusecs passed in 1976 seriously threatening safety of the

barrage. During floods 2010 discharge 1.129 million cusecs passed through barrage threatening safety of the Barrage. A comprehensive study is required for rehabilitation / improvement of the Barrage.

Kotri Barrage

Kotri Barrage was sanctioned by the Government of Sindh in September, 1954. Construction of the Barrage was completed in 1955 and constructions of all main canals were completed in 1962. The Barrage is the last barrage on River Indus located near Hyderabad and 72 miles (120 km) North East of Karachi and 200 miles downstream of Sukkur Barrage. The Barrage length is 3,020 ft between abutments; it incorporates a road bridge, a lock channel for river traffic, two fish ladders and 44 bays. The Barrage was constructed primarily to irrigate 2.806 MA of lower Sindh. The Barrage also provides facility for supply of water to Karachi through Kalri Lake fed by Kalri Beghari Feeder off taking from the right side of the Barrage.

The main Canals Akram Wah, Fuleli and Pinyari supply water to left bank command of Kotri Barrage which is part of the study area. Akram Wah is perennial and Fuleli and Pinyari Canals are non-perennial.

Kotri Barrage is very important major structure in the study area for diversion of Indus water in the study area which supports the cultivation of lands and also meeting requirements of drinking water to the population, livestock and wild life in the area, as the ground water quality in the command of the left bank area is ultra saline and not fit for drinking purposes.

4.5.1.2 Canals

Ghotki Feeder Canal System

Ghotki Feeder Canal system (GFCS) has a gross command area of 0.412 million ha (1.01 million acres). The Canal off takes from the left bank of Guddu Barrage on the Indus River with a design discharge of 8,400 cusec and a maximum authorized discharge of 11,670. The length of the main canal is about 127 km. There are one head regulator and 8 cross – regulators on the Ghotki Feeder Canal. There are no accurate flow measurement devices throughout Feeder Canal system.

Khairpur East Canal System

Khairpur East Canal System off takes from Left Bank of Sukkur Barrage, with design discharge 2094 cusec and maximum authorized discharge 2600 cusecs. Length of Canal is 58.6 miles (94.51 km).It has Gross command Area (GCA) 0.57 MA. Khairpur East Canal System Comprises of 3 Branch Canals GCA 84253 acres CCA 79274 acres and total Length of Branch Canals is 78.2 miles, 8 Distributaries GCA 21,062 acres CCA 117,536 acres and total Length 144.91 miles and 43 minors, total Length 180.52 miles GCA 24,952 acres and CCA 155,277 acres and 203 direct outlets off taking from main and branch Canals with GCA 40844 acres and CCA 34,179 acres. Major structure head regulators and cross-regulators in East Khairpur Canal are presented in Table 4.5.4.

Khairpur West Canal System

Khairpur West Canal off takes from the left bank of River Indus at Sukkur Barrage with a design discharge of 1,940 cusecs and a maximum authorized discharge of 2,200 cusecs. The length of the Canal is 41.9 miles. Khairpur West Canal System comprise of 2 branch canals with total length of 47.48 miles; GCA 42,413 acres CCA 41,219 acres; 5 distributaries with total length 59.61 miles, GCA 35,135 acres, CCA 35,007 acres and; 68 minors with total length 267.2 miles, GCA 206,893 acres and CCA 198,121 acres and 62 outlets directly takeoff from canals. Major structures in Khairpur West Canal are presented in Appendix Table 4.5.4.

Rohri Canal System

Rohri Canal off takes on the left bank of Indus at Sukkur Barrage with design discharge 10,887 cusecs and maximum authorized discharge of 16,963 cusecs. The length of the Canal is 208 miles (335.48 km). Rohri Canal System comprised of 16 branch canals with total length 294.07 miles; GCA 191,244 acres and CCA 186,337 acres; 60 distributaries with total length 794.64 miles, GCA 1,194,993 acres CCA 1,143,401 acres and; 207 minors with total length 841.2 miles, GCA 1,202,975 acres and CCA 1,152,255 acres; 57 outlets directly off take from main Rohri Canal with GCA 38,359 acres and CCA 37,420 acres.

Rohri Canal has gross command area (GCA) 2.667 MA and cultivable command area (CCA) 2.601 MA. Canal operation is critical due to bank spillage and erosion of canal banks. There are over head regulator 15 cross regulator and 3 fall structures on the Canal which play important role in supply and distribution of water to the irrigation network in the Rohri Canal command. Some time conflict arises between the farmers of downstream and upstream Cross regulators on the operation of gates of the regulators, which directly affect the quantum of discharge division between upstream and downstream channels. Major Structures on the Rohri Canal are presented in Table 4.5.5.

Nara Canal System

The Nara Canal system is one of the largest irrigation systems in the world covering command area of 1.01 MHA (2.502 million acres). The Nara Canal off takes on the left bank of River Indus from Sukkur Barrage with a design discharge capacity of 13,649 cusecs. The maximum authorized discharge is 13,750 cusecs however maximum inflow up to 17,000 cusecs has been conveyed from the canal. The system was constructed in 1930s and it was designed to irrigate about 30% of cultivable command Area (CCA). Water allowance for Nara Canal 2.8 cusec / 000 acres, however the irrigated area has increased substantially. The Nara irrigation system is divided into two distinct sections.

- Upper Nara between Sukkur Barrage and Jamrao Weir (11% of total CCA).
- Lower Nara below Jamrao Weir (89% of total CCA).

The first 155 km of the Nara Canal serves approximately 27,000 acres (109312 ha) which is 11% of the total CCA of the Nara System. The Nara System below Jamrao weir constitutes 89% of the total CCA of the Nara System. The area below Jamrao weir (RD 575 of Nara Canal) is served by 4 main canal systems Jamrao, Mithrao Khipro and Lower Nara Canal.

- The Jamrao system consist of the Jamrao Canal length 77 miles (129km) 3 Branch Canals (west Branch, Dim Branch and Shahu Branch) 16 distributaries serving 290,000 acres (117,060 ha) and 58 minors serving 368,000 acres (149,053 ha) and (total) 126,500 acres (51,200 ha) are served by direct off takes.
- The Mithrao System Consist of Mithrao Canal length 77 miles (129 km) 2 Branch Canals Nabisar Branch and Naukot Branch, 15 distributaries serving 288,500 acres (116,776 ha) and 33 minors serving 206,375 acres (83,553 ha). A total of 92,500 acres (37,463 ha) area is served by direct off takes.
- The Khipro system consists of Khipro Canal length 47 miles (79 km). One Branch Canal Samarjo Branch, 7 distributaries serving 132,000 acres (53,441 ha) and 15 minors serving 70,000 acres (28,374 ha) and 35,700 acres (14,446 ha) are served by direct off takes.
- The Lower Nara Canal consists of Lower Nara Canal from Jamrao weir length 116 miles (194 km) and Thar Canal length 13.8 miles (23 km) system consists of 14 distributaries

serving 209,160 acres (84,679 ha) and 9 minors serving 38,887 acres (19,832 ha) on the Thar Canal 96,000 acres (38,886 ha), are served by direct off – takes.

- Major structures in the Nara Canal System are presented in Table 4.5.5

Akram Wah System

The Akram Wah is a perennial canal. It off takes on left bank of Kotri Barrage constructed to overcome this deficiency for supplying water in tail reaches. Gross command Area (GCA) of Akram wah is 0.518 m acres (0.209 m ha) and cultivable command Are 0.487 million acres (0.197 m ha). Length of the Canal is 76 miles (122 km). Canal supply water to Gaja Branch at RD 110 and in the tail area situated in the south East of Tando Bago and Badin. The intermittent area along 200 RD is irrigated by Fuleli Canal. Akram wah is Cement Concrete lined from the head to RD 110 and from RD 130 to RD 190 and the section from RD 110 to RD 130 in brick lined. The design discharge of Akram Wah is 4100 cusecs and maximum authorized Discharge is 3,770 cusecs. Designed water allowance for Akram Wah is 6.1 cusecs / 000 acres. The Fuleli Gaja link (Capacity 300 cusecs) has been constructed to feed Akram Wah. Akram Wah supply water to 5 Branch Canal systems. Comprising of 4 distributaries and 37 minors. The major structures on this Canal are presented in Table 4.5.4

Fuleli Canal System

The Fuleli Canal is non perennial off takes on left bank of River Indus from Kotri barrage. Gross Command Area (GCA) 1.01 MA (0.449 MHA) and cultivable command Area (CCA) 1.01 MA (0.449 MHA), Design discharge of canal is 14,859 cusecs with water allowance 14.0 cusecs / 000 acres. Length of canal is 60 miles. Maximum authorized discharge of canal is 14330 cusecs.

Fuleli Canal Supply Water to Branch Canal Systems comprising of Guni, Murad Wah, Matli Wah, Sultani Wah and Nasir Wah on left bank side and Pandhi wah, Imam wah Jagir and Mir wah Talhar on its right bank side. The length of branches is 419 miles. Branch Canals supply water to 53 distributaries and 10 minors. The total Length of distributaries is 164.8 miles and total length of minors is 81 miles. Major Structures on Fuleli Canal are presented in Appendix Table 4.5.4.

Pinyari Canal System

Pinyari Feeder Canal (old Fuleli) is a non perennial Canal which off takes from Left Bank side of Kotri barrage. Its design discharge is 13,636 cusecs and maximum authorized discharge 10,490 cusecs. Gross Command Area (GCA) of Pinyari Feeder Canal is 0.948 MA and cultivable command Area 0.786 MA. Pinyari Canal System comprises 10 branches, 49 distributaries and 50 minors. Canal System is designed on 71% cropping intensity with water allowance of 4.44 cusecs / 000 acres. Major Structures on Pinyari Canal are presented in 4.5.4.

4.5.1.3 Irrigation Structures

Barrages

Irrigation Water in the study area is diverted through Guddu, Sukkur and Kotri barrages. Over all (as mentioned above), the operational efficiency of the barrages need improvement due to various problems in each barrage such as centralization of flow silt removal from upstream side near Canal head regulators, Structural weaknesses and flood passing capacity. Feasibility is required for all three barrages for improvement /Rehabilitation of barrages.

Head Regulator and Cross-Regulators

On all canal systems the water supply from barrages to a canal is regulated through head regulator and water distribution is controlled through cross-regulators. The head regulators and cross regulators are major irrigation structures are presented in the Table 4.5.4 and Table 4.5.5.

Water distribution in a canal system has been designed for manual upstream control. Cross- regulators on main canals are either redial or sluice type gates. The operation of cross-regulators is based on the target gauge reading on the downstream side of cross-regulator

The instruction to the gate operator is usually increase the water level by 1 decimal which means, for example 10.5 to 10.6 feet reading on downstream gauge. The gate operator adjusts the cross-regulator gates to set the target level of the downstream gauge. If the gates are already above the water level this is accomplished by reducing the flow rate closing head gate at the adjacent off taking channel. Operators record reading of the staff gauges located upstream and downstream of the cross-regulator and intimate the in-charge officer. The operators are not supposed to make any adjustments without permission.

The cross-regulators are not operated properly to provide a steady and reliable flow to the water users at distributaries level and maintain upstream water levels, instead the operators are maintaining a variable target water level downstream of the cross-regulators for proxy flow rate control. This causes significant fluctuation in water level upstream, causing flow rate variability into the turnouts.

Condition survey of all cross-Regulators on main and branches canals in the study area is required for smooth operation, efficient and reliable water distribution in the 8 canal systems.

Table 4.5.4: Major Structures in Ghotki, (Guddu Barrage), Khairpur East, Khairpur West (Sukkur Barrage), Pinyari, Fuleli and Akram Wah (Kotri Barrage) Canals

Ghotki Feeder Canal		**Pinyari Canal**		**Fuleli Canal**		**Akram Wah**		**Khairpur East Canal**		**Khairpur West Canal**	
Structure	**RD**	**Structure**	**RD**	**Structure**	**RD**	**Structure**	**RD**	**Structure**	**RD**	**Structure**	**RD**
HEAD REGULATOR ex: River	0	Head Regulator	0	Head Regulator	0	Head Regulator	00	Head Regulator	0	Head Regulator	0
Cross Regulator	43	Fall Regulator	32	Old Gaja Regulator	116	X - Regulator	70th Mile	Patni X-Regulator	12.8	Beberloi X-Regulator	6.8
Cross Regulator	63	Dino Shah X-Regulator	114	Cross-Regulator on fulleli Canal	30th Miles	Kazia Branch X-Regulator	350	Mir Wah X-Regulator	42.8	Rameja X-Regulator	36
Cross Regulator	177	Daro Branch Head Regulator	0	Imam Wah Head Regulator	170	Akram Wah Escape head Regulator	3381	Bhurgari X-regulator	78.6	Jamsher X-Regulator	62.1
Cross Regulator	220	Balo X-Regulator	5	Akram Wah Sluices	230			Rajpari X-Regulator	40.4	Bhatti Fall X-Regulator	102.8
Cross Regulator	269	Sujawal X-Regulator	9	Sluice No.1				Kot Diji X-Regulator	158.2	Ahmed Pur X-Regulator	113.8
Cross Regulator	322	Chhto X-Regulator	108	Sluice No.5				Thekratho X-Regulator	188.4	Ripri X-Regulator	141.8
Cross Regulator	335	Munarki X-Regulator	125	Akram Wah Sluices	229			Jalalani X-REgulator	216.7	Sial X-Regulator	166.8
Cross Regulator	345	Pinyari Branch Head Regulator	0	Sluice No.2				Shar X-Regulator	247.5	Setherja X-Regulator	214
Cross Regulator	352	Darro X-Regulator	6	Sluice No.3				Tri-Junction X-Regulator	293.6	Jadi X-Regulator	228
Cross Regulator	373	Darri X-Regulator	-	Sluice No.4							
		Bhudhu X-Regulator	-	Ali Pur Cross-Regulator	241						
		Mirkhana X – regulator	-								
		Begnah X - Regulator	-								
Head Regulator	**1**		**1**		**1**		**1**		**1**		**1**
X-Regulator	**10**		**10**		**2**		**2**		**9**		**9**
Other Structures	**-**		**3**		**4**		**1**		**-**		**-**
Total	**11**		**14**		**7**		**4**		**10**		**10**

Table 4.5.5: Major Structures in Rohri and Nara Canals (Sukkur Barrage)

Rohri Canal		Nara Canal											
		Nara Canal		Lower Nara Canal		Mithrao Canal		Khipro Canal		Jamrao Canal		Jamrao West Branch	
Structure	**RD**	**Structure**	**RD**	**Structure**	**RD**	**Structure**	**RD**	**Structure**	**RD**	**Structure**	**RD**	**Structure**	**RD**
Head Regulator Ex: River	0	Head Regulator	0	Makhi Weir	150	Head Regulator	0	Head Regulator	0	Head Regulator	0	Jhano Mari	8th Mile
Tan Do Masti Fall	118	Fall Structure	26	Farash Weir	530	Bakhoro Cross regulator	18.5	Cross Regulator	3rd Mile	Cross Regulator	17th Mile	Cross Regulator	10th Mile
Naulakhi x-regulator	205	Fall Structure	135			Kanhar Cross Regulator	65	Cross Regulator	11th Mile	Bhagi Regulator	33rd Mile	Cross Regulator	22 Mile
Mehrabpur x-regulator	264	Ranto Head Regulator	0.6			Valwari Cross Regulator	136.5	Cross Regulator	14th Mile	Dalore Regulator	49th Mile	Cross Regulator	30th Mile
Kandiaro x-regulator	328					Dhararo Cross Regulator	175	Cross Regulator	18th Mile	Mitho Machi Regulator	59th Mile	Cross Regulator (Dhoro Regulator)	33 Mile
Naushero x-regulator	425					Baraji Cross Regulator	252	Cross Regulator	28th Mile-	Miro Mari Regulator	69th Mile	Dambalo Regulator	45th Mile
Phullfall x-regulator	442					Ram Jago Cross Regulator	315	Cross Regulator	35th Mile	Cross Regulator	77th Mile	Cross Regulator	50th Mile
Yousaf dahri x-regulator	469					Khani Jogo Cross Regulator	335	Cross Regulator	39th Mile	Cross Regulator	82th Mile	Cross Regulator	6th Mile
Durofall regulator	522					Samaro Jogo Cross Regulator	353	Escape Structure	195	Jhulari Regulator	89th Mile		
Jamal shah x-regulator	578					Sunthi Jogo Cross Regulator	382			Cross Regulator	101 Mile		
Mirza baig fall	587					Escape Structure	332			Cross Regulator	111 Mile		
Chanesar x-regulator	617									Cross Regulator	116 Mile		
Sakrad x-regulator	646									Cross Regulator	120 Mile		
Kumblima x-regulator	705									Cross Regulator	124 Mile		
Zerpir Fall	764												
Kumbdaru x-regulator	807												
Odero lal x-regulator	890												
Palejani x-regulator	929												

Khesanox - regulator	970												
Almani x- regulator	1038												
Head Regulator	**1**		**1**		**1**		**1**		**1**		**1**		**1**
X-Regulator	**15**		**-**		**-**		**9**		**7**		**13**		**7**
Other Structures	**4**		**4**		**3**		**1**		**1**		**-**		**-**
Total	**20**		**5**		**4**		**11**		**9**		**14**		**8**

4.5.1.4 Drainage Structures

Lower Indus Project investigations were started in 1959 to provide a plan for the optimal development of the water resources in Lower Indus Region. As a result of these investigations extending over a period of six years, the Lower Indus Report was prepared in 1966 by Hunting Technical Services Ltd and Sir M. MacDonald & Partners for WAPDA which provided benchmark data as well as comprehensive plan of intensive development of the land and water resources of the province to ensure that agricultural production meet the growing internal demands and export targets. The plan envisaged interrelated projects for both additional water supplies and drainage to be carried out in a program, phased over a period of 25 years. The Lower Indus Report covers the irrigated area of three barrages of Sindh viz. Guddu, Sukkur and Kotri. The whole area is divided into four parts in following categories:

I. Perennial fresh ground water.

II. Non-perennial fresh ground water.

III. Perennial saline ground water.

IV. Non-perennial saline ground water.

Priority was recommended for the projects in fresh ground water areas, where tube wells could be easily installed to provide both increased irrigation water and providing drainage and can bring about large and early increase in agriculture production.

Drainage facilities in Sindh have been provided over a gross command Area of 5.3 Mha. These facilities include installation of 5,835 tube wells (3,697 FGW and 1,777 SGW) 365 Scavenger wells. Construction of 8,200 km surface drains. 565 km interceptor drain 0.1 MA covered with tile drain.

Under Salinity Control and Reclamation Projects (SCARPS) the sub-surface drainage systems of tube wells on the Left Bank of River Indus has been completed on Gross Command area 3.685 MA where various drainage technologies have been adopted for water table and salinity control. The drainage facility comprises of 3170 fresh Ground Water tube wells, 2168 saline ground water tube wells, 365 scavenger wells, tile drains over an area of 0.1 MA and 4,458 KM surface drains under other surface drainage projects. The operational status of the tube wells in each SCARP Project is as under.

Ghotki Fresh Ground Water Project

The project is located in Ghotki district, the GCA of project is 0.178 million hectares (0.44 MA) and CCA is 0.162 Mha (0.400 MA). A total of 1015 fresh ground water tube wells of total capacity of 2070 cusecs were installed. The capacity of individual tube wells vary from 1.5 cusecs to 2.5 cusecs depending upon the aquifer conditions. This project has been framed to increase its cropping intensities (Base year) from 95% to 150% at ultimate development. The tube well pumpage in addition to irrigation supply through Ghotki canal (Non perennial) will result continuous assured supply of water throughout year.

Additional tube wells were installed as such total number of tube wells in the project area is 1,092 out of which 875 are operational and 217 are non-operational due to various reasons. As such the pumping capacity has been reduced by 19.87 percent. Defects are due to 88 transformers burnt/theft, 31 11 KVA line defect, 18 bore failure, 47 due to defect in motor and 33 due to pump defects.

Khairpur SCARP Project

Project is located in District Khairpur the GCA of the project is 0.178 Mha (0.44 million acres) of which 0.15 Mha (0.380 million acres) is cultivable under command of Khairpur Feeder East and

Khairpur Feeder West both canals are perennial. The project is essentially a drainage project. A total of 540 tube wells of various capacities were installed to control the ground water table at 7ft below the natural surface level. Out of total number 540 tube wells, 175 pump ground water of acceptable (fresh water) quality which is directly utilized in the field channels for augmenting the existing irrigation supplies on full development. Base year cropping intensities were 91 percent in1966-67, will ultimately attain a level of 165 percent. For disposal of saline effluent 550 km of surface drains were constructed and five pumping stations with an installed capacity of 855 cusecs to dispose off the saline effluent into the Rohri Canal. Additional 105 tube wells were installed under Khairpur SCARP extension program, accordingly the total number of tube wells in Khairpur SCARP has increased to 645.

The operational status of tube wells indicates that 289 tube wells are operational and 356 tube wells are non operational due to various reasons. Tube wells are non-operational due to 182 transformers theft/burnt, 39 11 KVA line defect, 61 Bore failure 41 Motor defects, 12 pump defect and 15 control panel defects.

SCARP North Rohri Fresh Ground Water Project.

The project is located in Districts of Khairpur and Naushero Feroze. The GCA is 0.32 Mha (0.793 MAa) and CCA is 0.278 Mha (0.69 MAa). A total of 581 tube wells of various capacities between 1.5 cfs and 5.0 cfs have been installed. Annual pumpage of fresh ground water is about 1.08 MAF to supplement the irrigation supplies. The cropping intensity during base year was 98% and with target of 150 percent. The project was completed during 1969-1979.

Out of 581 tube wells of Naushero Division 259 are non-operational, 114 due to transformer theft/burnt 1 11 KVA line fault, 110 bore failure, 27 motor defect, 5 pump defect and 2 control panel defect.

SCARP South Rohri Fresh Ground Water Project.

The project is located in districts of Nawabshah and Hyderabad. GCA is 0.22 Mha (0.541 Ma) and CCA is 0.152 Mha (0.375 Ma). The project receives perennial irrigation supplies from Rohri Canal system supplemented by the additional of 1,214 fresh ground water tube wells with designed capacity of 1 to 2 cusecs. The cropping intensities during base year were 88 percent which is planned to increase upto 110 percent.

1,214 tube wells were constructed in the priority area providing a discharge capacity of 1 to 2 cusecs of individual tube wells. Additional 8 tube wells were installed as such total number of tube wells is 1,222.

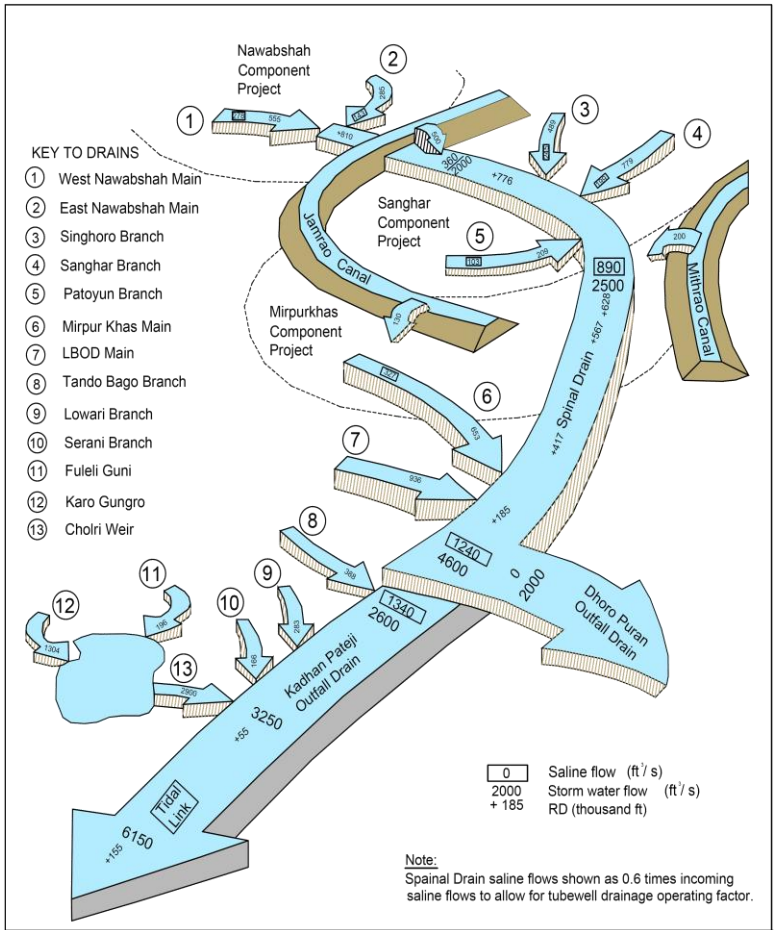
The operational status of the Tube wells indicate that 860 tube wells are operational and remaining 362 tube wells are non-operational as such the pumping capacity of Tube wells has been reduced from 2,660 to 1,873 cusecs which have direct impact on the agricultural production due to reduction in pumpage from tube wells. Non-operational Tube wells are 205 due to transformer theft/ Burnt, 44 Motor burnt, 69 pump defect, 34 bore failure 7 control panel and 3, 11 KVA line defect.

LBOD Stage – 1

LBOD Stage - 1 project was prepared is November 1983. PC-1 was submitted to Government of Pakistan is Feb 1984, approved by ECNEC in August 1984 and construction of LBOD Stage-1 project started in 1985-86 and completed in 1997 except Chotiari Reservoir, which was completed in 2002 and handed over to SIDA. Total area served by the three component projects Nawabshah, Sanghar

and Mirpurkhas is over Gross Command Area (GCA) 1.426 MA and Cultural Command Area (CCA) 1.276 MA.

The System comprising three components Nawabshah, Sanghar and Mirpurkhas LBOD Branch Drain and outfall System were handed over to Irrigation Department/ Sindh Irrigation & Drainage Authority upto 2002. The management transfer process was initiated in 1998 and completed on January 2002. WAPDA Operated System for one year before management transfer to IPD/ SIDA. The Drainage facilities of LBOD Stage 1 project are presented in Table 4.5.6.



LBOD Schematic Diagram

Nawabshah Component

Nawabshah component provides drainage facility on gross area of 0.626 MA with a network of main branch and sub-drains totaling 323 km. Subsurface drainage comprises 274 Tube wells and scavenger wells 191and 225 km of interceptor drains. The tube wells have been designed to operate at 60% efficiency and maintain Water table at 7ft below ground Surface. Storm Drainage disposal has been provided through network of Surface drains and inlets for evacuation of 50 percent component of rainfall and 50 percent allowed for deep percolation. Surface drainage network will provide evacuation of storm runoff within 2 days to 3 days through network of inlets. Tube wells are non-operational due to various reasons, 100 due transformers theft/burnt, 133, 11 KVA line defect, 26 motor defect and 33 pump defect.

Sanghar component

Sanghar project provide drainage facility over a gross area of 0.424 MA with network of main, branch and Sub – drains. 93.8%of this area has been provided with Sub-Surface drainage by 642 tube wells and 175 scavenger wells, 122 km of interceptor drains are provided for seepage control along main canals. The Tube wells have been designed to operate at 60% efficiency and maintain Water table at 7 ft below ground surface. The project has been designed to reduce flood damage by lowering high Water table to provide more capacity for infiltration of excess irrigation applications and part of storm water. Surface drainage network will provide evacuation of surface runoff within 2 and 3 days. 572 tube wells are operational and 224 tube wells are non-operational due to various reasons. Tube wells are non-operational due to 75 transformers burnt/theft, 70 11 KVA line fault, 5 bore failure, 48 motor burnt defect, 11 pump defects and 6 control panel defect.

Mirpurkhas Component

Mirpurkhas project provide drainage facility over a gross area 0.376 MA, with network of main branch and Sub-drains Main drain following the approximate course of existing Doro Purim. Most of the project area (77.1%) has been provided with Sub-surface drainage by 752 tube wells, tile drains on 0.55 MA. The project has been designed to reduce flood damage by lowering water table to 7 feet´ depths for enhancing infiltration of excess irrigation application and Storm Water. Surface drainage network will provide evacuation of Storm runoff within 14 ½ days to 3 days through network of inlets. There are 188 operational and 172 non-operational tube wells. The tube wells are non-operational due to various reasons. 36 due to transformers theft/burnt, 100 11 KVA line fault, 27 motor defect, 9 pump defect and 16 control panel defect.

Table 4.5.6: Drainage facilities of the LBOD Stage-1 Project.

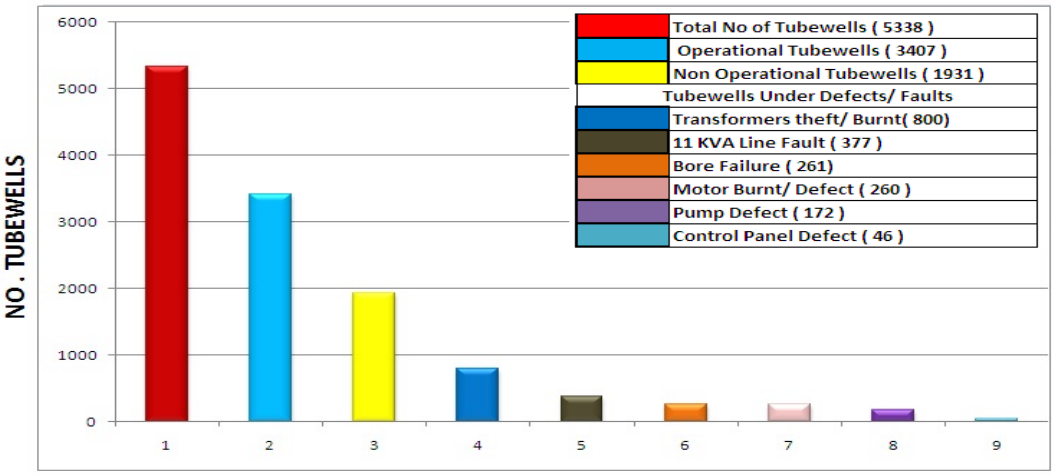
Component	Gross area 000 acres.	Culturable command area (CCA) 000 acres.	Length of surface drains km	Length of disposal channel (saline) km.	No. of drainage tube wells	No. of Scavenger wells	Interceptor Drains		Tile Drains		No. of storm water inlets.
							Length km	No. of pumping stations	Area served in 000 acres	No. of pumping stations.	
Nawabshah	626	555	323	602	274	191	225	53	-	-	435
Sanghar	424	632	554	913	642	175	122	122	-	-	566
Mirpurkhas	376	359	326	876	752	-	235	75	55	68	590
Total Project	1426	1276	1203	2391	1668	365	582	250	55	68	1581

Overall Operational Status of Tube wells in Study area

There are 5,338 tube wells in Study are out of which 1931 tube wells are non-operational and 3407 are operational tube wells. Non-operational tube wells have been abandoned or closed due to various reasons. Nearly 36.17 percent tube wells are ineffective which indicate poor management of operating agencies. The major constraint is the insufficient funds for operation and maintenance of the drainage systems. Due to non-operation of the tube wells the withdrawal capacity has been reduced particularly in fresh ground water areas which have direct impact on agricultural production. Rectification of this situation is utmost essential for optimal development of land and water resource in the study area

Over all operational status of tube wells in study is presented in Figure 4.5.1**.** The Status indicate that 800 tube wells are closed due to theft/ burning of transformers, 377 due to fault in 11 KVA line, 261 due to bore failure, 260 due to motor defect, 172 due to pump defect and 46 due to control panel defect

Figure 4.5.1: Overall Tubewells Operational Status of Projects in Study Area



Water logging Status in the Study area

Irrigated area on the Left Bank of Indus is served by eight major perennial & non perennial canals off taking from three barrages of Indus on Left bank. Irrigation system of Sukkur barrage is in effect from 1932 to date. After the construction, it was advised by the British Engineers that the canals of barrage should be lined in near future (LIP report) as operating levels of the canals are above the land surface, and can create the water logging problem due to seepage from the canal. Prior to construction of Sukkur barrage the water table depth in the Lower Indus region was below the range of 30 to 40ft (LIP) even after the commissioning of two other barrages i.e. Kotri & Guddu respectively, the water table depth range remained within safe limits. Later on with the passage of time, slowly & gradually water table started rising due to the seepage effect, excess irrigation applications and mismanagement of irrigation system, and ultimately twin menace of water logging & salinity emerged in the irrigated areas.

Under the present situation, depth to water table has been raised to an alarming extent &is out of safe limits. The data collected from SCARP Monitoring Organization WAPDA (Water Wing) south for the period 1979 to 2009 has been processed and presented in Figure 4.5.2.

Water logging trend in the Study area

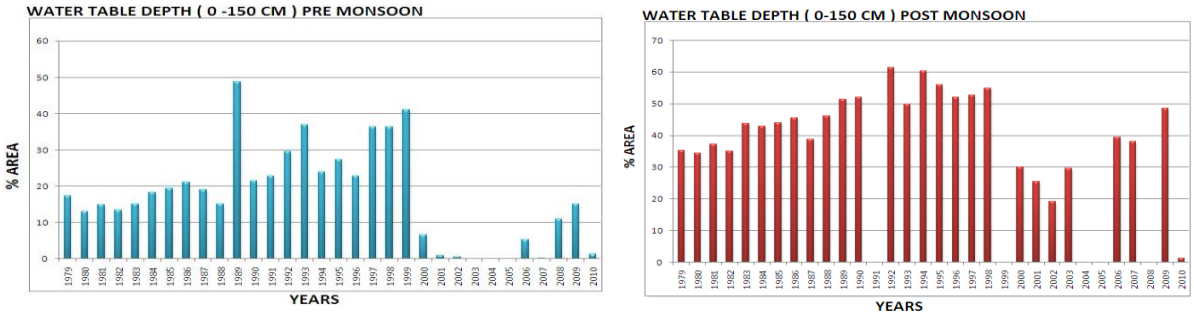
The Study area as already mentioned is irrigated by the left bank a canal of three barrages of lower Indus region, surveyed area is in each canal command. Within this area the water table trend is based on the available data of 30 years for two periods i.e. the Pre monsoon (April) & Post monsoon (October) seasons of each year. However, somewhere the data is missing due to lack of funds, which were not provided at proper time to the concerned organization (SMO south) & because of that survey of the area could not be conducted within a scheduled time. The data collected so far has been processed and interpreted and percent wise area falling within danger zone of 0-150 cm depth.

It is obvious from the two different categories of pre monsoon & post monsoon seasons for the period of 30 years (1979-2009); the water table trend remained at highest level (0-150 cm) in both seasons. In general, the high water table conditions have clearly been observed in the post-monsoon (October) as compared to the pre-monsoon (April) period. The percent wise area covered on bi-annual survey basis indicate that major part within different Canal Commands remained under 0-150cm water table depth during post monsoon season. This is because of the rainfall, flooding condition & simultaneously canals are running in full swing for supplying irrigation water during the Kharif

season, and water table rises at the peak before the start of the Rabi season. After that decreasing trend of water table starts, that is why the area covered by water logging is more during the post monsoon period.

Further it is pertinent to note that during the recent past drought conditions prevailed throughout the region i.e. from 1999 till the end of 2009 because of this the water table depths were remarkably lowered down to a larger extent, leaving a small area within 0-150 cm depth zone in pre monsoon season, where as a decreasing trend has also been observed during post monsoon period. Water table depth in pre-monsoon and post-monsoon from study area for period 1979 to 2010 is presented in Fig 4.5.2.

Figure 4.5.2: Pre monsoon (April) and Post monsoon (October) Water Logged Area in Study area



Source: SMO South WAPDA

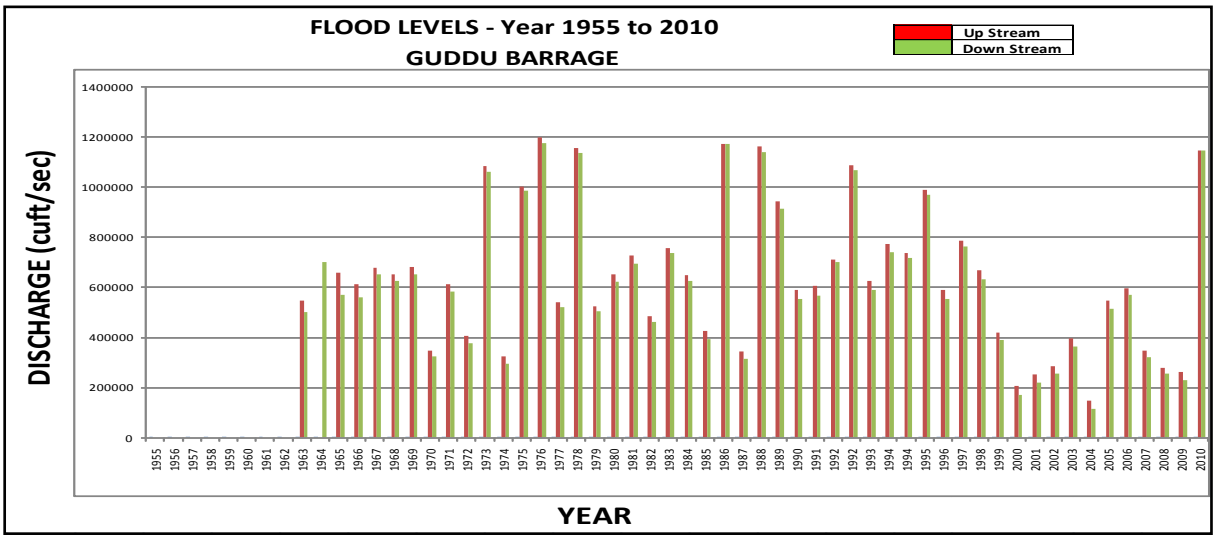
Flood Protection Structures

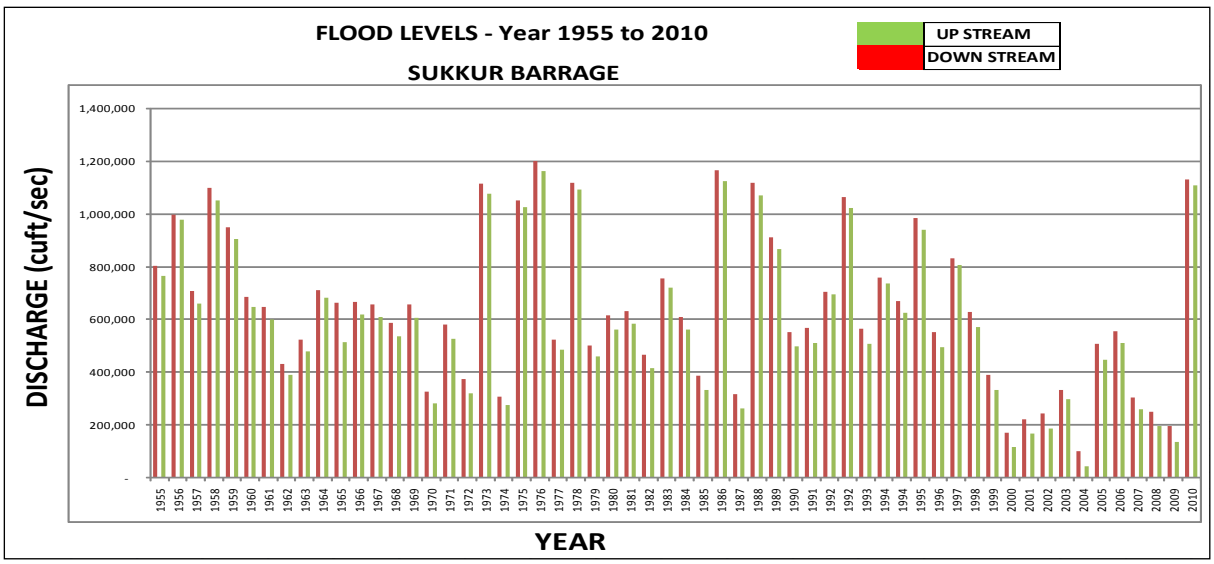
A "floodplain" is the lowland adjacent to a river, lake or sea. Floodplains are designated by the frequency of the flood that is large enough to cover them. For example, the 10-year floodplain will be covered by the 10-year flood and the 100-year floodplain by the 100-year flood. Flood frequencies, such as the "100-year flood," are determined by plotting a graph of the size of all known floods for an area and determining how often floods of a particular size occur. Another way of expressing the flood frequency is the chance of occurrence in a given year, which is the percentage of the probability of flood. For example, the 100-year flood has a 1% chance of occurring in any given year.

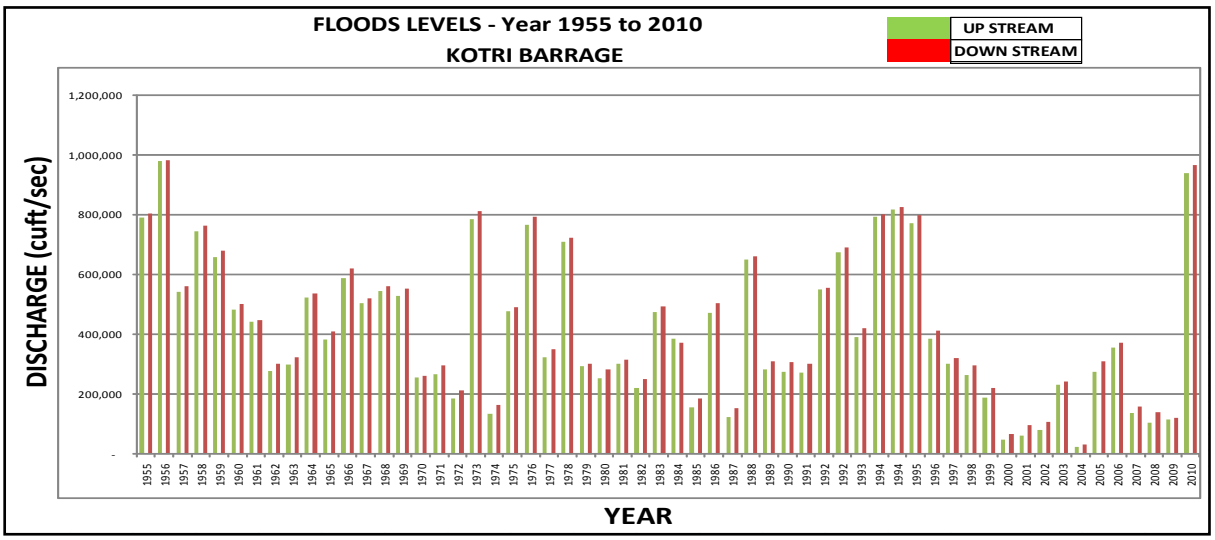
Dams, embankments, and other protective works are designed to provide protection against some specific level of flooding. The "level of protection" is selected based on cost, desire of the community, potential damage, environmental impact, and other factors. Engineers can design and construct embankments, dams and other measures providing a very high level of protection. Communities tend to choose lower levels of protection because of the initial financial cost rather than overall costs and benefits.

Flood Protection Embankments may be either "engineered" or “non-engineered”. Engineered embankments are those in which professional consideration has been given to the underlying soil conditions, the kind of earth used in building the embankment, proper compaction of the embankment materials, armoring of the embankment face if needed and other factors. Non-engineered embankments are basically long piles of earth pushed up along a river. Engineered embankments have a far lower rate of failure than non-engineered embankments.

Figure 4.5.3: Flood Discharges upstream and downstream of Guddu, Sukkur and Kotri Barrages







There is a wide range of measures that can be used to protect against flooding. They may be grouped in various ways, such as - "Structural" and "non-structural" measures whether they are most suitable for protecting a) individual structures or b) areas containing multiple structures and communities Whether their purpose is to: a) modify the flood; b) reduce susceptibility to flooding; and/or c) reduce the impact of flooding. Multiple measures are usually needed to provide protection to an area. Flood Protection embankments have been provided on the both sides Left Bank and Right Bank of River Indus for safe passage of Flood water towards final outfall in Arabian Sea. The intensity of flood discharges upstream and downstream of Guddu Barrage, Sukkur Barrage and Kotri Barrage (1955 to 2010) is presented in Figure 4.5.3.

Main Bunds and loop Bunds have been provided on the Left Bank of River Indus from Guddu to the Arabian Sea for Safe disposal of flood water and protection of Left Bank Command areas under Guddu, Sukkur and Kotri barrages.

These bunds are major structures in the study area for flood protection. Irrigation & Power Department is responsible for construction and maintenance of Bunds as per Bund Manual. Main Bunds and Loop Bunds along Left Bank side of River Indus are presented in Table 4.5.7 and vulnerable points of bunds are presented in Table 4.5.8.

2010 Floods

During 2010 Floods three major breaches occurred in the River Flood protection embankments in Sindh. The first breach occurred in Tori Bund on the right side River Indus in the reach between Guddu and Sukkur Barrage. Second breach occurred in M.S Bund along Left Side downstream of Kotri Barrage and inundated vast area which caused severe damages in the Study area. Third breach occurred on the right flood protection embankment at downstream of Kotri Barrage and inundated Thatta District area. The breach was timely closed.

Table 4.5.7-A: Major Structures Flood Protection Main Bunds and Loop Bunds along Left Bank River Indus

Ghotki AWB				Khairpur Circle				Rohri Circle			
Main Bunds		Loop Bunds		Main Bunds		Loop Bunds		Main Bunds		Loop Bunds	
Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F
Machka Bund Mile 0/0 to 3/0	3-00	Qadirpur Loop Bund Mile 0/0 to 8/4	8-4	Khairpur Feeder West Bund	4-0	Loop Bund Behind Garho (LBBG)	0-5	**Rohri Division MORO**			
Dilwaro Bund Mile 0/0 to 7/0	7-00	Dilwaro Loop Bund Mile 7/0 to 8/0	1-00	Link Bund	0-4	New Narejo Loop Bund	6-5	S.M Bund Mile 0/0 to 3/2	3-2	Sagyoon Loop Mile 0/0 to 1/2	1-2
Ranwati Bund Mile 0/0 to 11/7	11-7	Garkino Loop Bund Mile 0/0 to 1/1+580ft	1-2	Ring Bund	1-4	Ulra Loop Bund	3-5	Front Bund Mile 0/0 to 3/7	3-7	Kharal Loop Mile 0/0 to 2/3	2-3
L.M Bund (Old) Mile 0/0 to 6/7	6-7	R.N Loop Bund Mile 0/0 to 3/0	3-0	Main River Bund	1-0	New Mahesar Loop Bund	0-6	S.M Bund Mile 7/4 to 12/7	5-3	New Morio Loop Mile 0/0 to 4/1	4-1
Qadirpur Bund Mile 0/0 to 1/2	1-2			Ulra Jagir Bund	2-2	Jamsher Loop Bund	2-2	Bakhri Loop Mile 0/0 to 2/5	2-5	Haji Shah Loop Mile 0/0 to 2/3	2-3
Qadirpur Shank Bund Mile 0/0 to 2/4+2500	3-1			Ulra Jasir Bund	3-3			S.M Bund Mile 16/0 to 19/1	3-1	Darbello Loop Mile 0/0 to 2/4	2-4
Gemro Bund Mile 10/6 to 14/4	3-6			Fareedabad Bund	0-4			Morio Loop Mile 0/0 to 1/4	1-4	Abji Loop Mile 0/0 to 7/4	7-4
R.N Bund Mile 5/1 to 13/44-0	8-3			Bhatti Pir Bund	12-0			Pipri Loop Mile 0/6 to 3/5	2-7	Jatoi X - Bund Mile 0/0 to 7/4	7-4
Budhka Cross Bund Mile 22/4 to 26/4	4-0			Baro Bund	2-7			Bhagu Dero Mile 0/0 to 1/6	1-6	Gadahero Loop Mile 0/0 to 0/4	0-4
Baiji Bund Mile 0/0 to 10/3	10-3			Razi Daro Bund	4-7			S.M Bund Mile 28/4 to 33/4	5-0	S.M Bund Mile 0/0 to 0/4	0-4

Table 4.5.7-A: Major Structures Flood Protection Main Bunds and Loop Bunds along Left Bank River Indus

Ghotki AWB				Khairpur Circle				Rohri Circle			
Main Bunds		Loop Bunds		Main Bunds		Loop Bunds		Main Bunds		Loop Bunds	
Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F
R.N Bund Mile 3/1 to 12/0	9-4			Agra Ring Bund	0-3			Manjath Bund Mile 0/0 to 1/5	1-5	S.M Bund Mile 0/0 to 7/4	4-2
R.N Mangli Bund Mile 0/0 to 1/1	1-1			Faiz Maher Bund	5-1			S.M Bund Mile 35/4 to 75/1	39-5	Bakhri Trench Loop Bund Mile 0/0 to 3/7	3-7
R.N Link Bund Mile 0/0 to 0/2	0-2			Gerkino Bund	4-7			Daualatpur Loop Mile 0/0 to 1/5	1-5	J - Spur Mile 0/0 to 3/2	3-0
R.N Bund Mile 0/0 to 1/1	0-7							S.M Bund Mile 76/2 to 80/0	3-6		
Front Bund Mile 0/0 to 0/7	0-7							Kandiaro Escapes Mile 0/0 to 12/2	12-2		
L.M Bund (New) Mile 2/4 to 13/6								**DADU DIVISION Nawabshah**			
L.M Bund (Old) Mile 6/7 to 13/2	6-3							S.M Bund Mile 80/0 to 99/0	19-0	Chattean Shah Loop Mile 0/0 to 4/4	1-2
Germo Bund Mile 0/0 to 5/1	5-1							S.M Bund Mile 104/6 to 123/0	18-2	Rahib Shah Mile 0/0 to 2/7	2-3
R.N Bund (Old) Mile 12/5 to 22/4	9-7							Old Bund Mile 0/0 to 2/2	2-2	Jiand Loop Mile 0/0 to 1/0	4-1
R.N Bund Mile 1/1 to 2/3	1-2							New Mud Loop Mile 0/0 to 2/1	2-1		

Table 4.5.7-A: Major Structures Flood Protection Main Bunds and Loop Bunds along Left Bank River Indus

Ghotki AWB				Khairpur Circle				Rohri Circle			
Main Bunds		Loop Bunds		Main Bunds		Loop Bunds		Main Bunds		Loop Bunds	
Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F
								HALA DIVISION			
								S.M Bund Mile 123/0 to 137/6	14-6	Kurejo Loop Mile 0/0 to 1/5	1-5
								New Fatehpur Mile 0/0 to 4/4	4-4	Hala Loop Mile 0/0 to 4/1	4-1
								Old Fatehpur Mile 1/1 to 2/0	0-7	Old Fatehpur Mile 2/0 to 4/2	2-2
								Cross Bund Mile 0/0 to 0/7	0-7	Matiari Loop Mile 0/0 to 2/6	2-6
								S.M Bund Mile 142/0 to 172/0	29-6	Hala Cross Bund Mile 0/0 to 0/7	0-7

Table – 4.5.7 Continued...

Left Bank AWB				Pinyari Circle			
Main Bunds		Loop Bunds		Main Bunds		Loop Bunds	
Name	Length M-F	Name	Length M-F	Name	Length	Name	Length
Ghallani Front Bund	12-7	Ghallani Loop Bund	12-7	H.P.Bund Mile 0/0 to 20/2	20-2	1st Mile Loop Bund Mile 0/0 to 2/6	2-6
Jamshoro Front Bund	4-6	Jamshoro Loop Bund	4-4	M.S.Bund Mile 0/0 to 20/2	24-7	Jones Wah Cross Bund Mile 0/0 to 0/6	0-6
Gidu Mal Front Bund	4-3	Gidu Mal Loop Bund	1-4	1st Surjani Bund Mile 0/0 to 3/1+300	3-7+300	Wasi Loop Bund Mile 0/0 to 1/6	1-6
Extension Mal Bund	7-0			2st Surjani Bund Mile 0/0 to 1/5	1-5	Wasi Cross Bund Mile 0/0 to 0/6	0-6
Kotri Protective Bund	2-6			M.S.Bund Mile 29/2 to 58/2	29-0	Wasing Wah Bund Mile 0/0 to 0/6	0-6
				Gungri Chord Bund Mile 0/0 to 0/7	0-7	Katiar Loop Bund Mile 0/0 to 3/1	3-1
				Kuka Link Bund Mile 0/0 to 20/6	20-6	Miran Pur Loop Bund Mile 0/0 to 1/3	1-3
				Kuka Wari Bund Mile 3/4 to 7/4	4-0	8th Mile Loop Bund Mile 0/0 to 2/2	2-0
				Kuka Wari Retarding Bund Mile 3/4 to 7/4	3-0	12th Mile Loop Bund Mile 0/0 to 5/1	5-1
						Budhka Cross Bund Mile 0/0 to 0/6	0-6
						2nd Kot Almo Bund Mile 0/0 to 3/2	3-2
						Bano Wakri Bund Mile 0/0 to 1/5	1-5
						Ranto Loop Bund Mile 0/0 to 0/7	0-7
						New Loop Bund Mile 0/0 to 2/3	2-3

Table 4.5.8: (B) Major Structures Flood Protection Vulnerable Points of Bunds

Ghotki AWB		Pinyari Circle		Rohri Circle		LBCAWB		Khairpur	
Main Bunds		Main Bunds		Main Bunds		Main Bunds		Main Bunds	
Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F	Name	Length M-F
L.M Bund (Old)	Mile 0/0 to 3/1	Haji Pur Bund	Mile 0/0 to 0/5	**Rohri Division Moro**		Ghallian Front Bund Distt: (Hyderabad)	Mile 3/0 to 5/2	Ulra Jagi Bund	2/ , 5/2
Qadirpur Loop Bund	Mile 5/0 to 7/2	Haji Pur Bund	Mile 3/7	S.M Bund (Old)		Ghallian Front Bund Distt: (Hyderabad			
Gamero Bund	Mile 12/0 to 13/0	Haji Pur Bund	Mile 6/0 to 6/6	S.M Bund (Old)	Mile 3/2	Ghallian Front Bund Distt: (Hyderabad)	Mile 7/0 to 9/0		
		Haji Pur Bund	Mile 8/0 to 8/4	L.M Bund (Bakhri)	Mile 12/4	Jamshoro Front Bund (Hyderabad)	Mile 10/0 to 12/7		
		Haji Pur Bund	Mile 12/4 to 13/5	Bakhri Loop Bund	Mile 0/0 to 2/5	Gidumal Front Bund Distt: (T.M.Khan)	Mile 1/0 to 2/0		
		M.S Bund	Mile 3/2	Manjuth Loop Bund	Mile 0/0 to 1/5		Mile 1/5 to 4/4		
		M.S Bund	Mile 5/7	S.M Bund	Mile 33/0				
		M.S Bund	Mile 18/3	S.M Bund (Bhorti Site)	Mile 37/4				
		1st Surjani Bund	Mile 0/0 to 1/5	S.M Bund	Mile 47/0 to 48/5				
		2st Surjani Bund	Mile 0/0 to 1/5	S.M Bund	Mile 54/0				
		M.S Bund	Mile 42/5 to 44/3	Right Guide Bank	Mile 0 to 3420 Ft				
		M.S Bund	Mile 43/5 to 44/0+200	Left Guide Bank	Mile o to 3000 ft U/S & o to 800 ft U/S				
		Gungri Chord Bund	Mile 0/0 to 0/7	J-Spur Dadu Moro Bridge	Mile o to 3280 ft D/S				
		Kaka Link Bund	Mile 6/0 to 7/0	**DAD Division Nawabshah**					
		Kaka Link Bund	Mile 9/4 to 20/6	New Mud Loop Bund	Mile 1/3 to 2/1				
		Kaka Wari Retarded Bund	Mile 0/0 to 3/0	S.M Bund	Mile 104/6 to 107/6				
				S.M Bund	Mile 105/4 to 106+400				
				S.M Bund	Mile 107/7				
				S.M Bund	Mile 109/2				
				Hala Division					
				S.M Bund	Mile 129/4				
				S.M Bund	Mile 135/6 to 137/0				
				S.M Bund	Mile 142/5				
				S.M Bund	Mile 152/0				
				S.M Bund	Mile 155/5				
				S.M Bund	Mile 158/0				
				S.M Bund	Mile 161/0				
				S.M Bund	Mile 162/2				
				S.M Bund	Mile 166/4				

4.5.1.5 Adequacy of Infrastructures

Health

Health plays the main role in the lives of human beings; it is famous proverb that health is the wealth. According to the 1948 universal declaration of Human Rights every one has the right to a standard of living adequate to health and well-being of himself/ herself and his / her family. As it is correct to say that human development is a basic right of an individual and health is its pre requisite for its development. Poor health of any one can directly influence on his opportunities, earning capacity, performance at school, ability to care for children, participation in community activities and so on.

Present Status

In the perspective of above facts it is observed that health indicators of Study area and over all Sindh lag behind those of many low- income countries. According to analysis done in the late 1990s, applicable to this province also suggested that priority should be given to the basic preventable and readily treatable diseases. In recent past. Government of Sindh (GOS) has taken the lead in preparing and announcing a comprehensive Health Policy covering both short & long term targets and addressing all the impediments hampering progress. The Government is committed to continue all efforts including the following.

- Implementation of the health policy.
- Re- Invigorating the Immunization and tuberculosis programmes.
- Improving health sector governance,
- Promoting public -private partnership by inviting NGOs.

Health Organization

The health Institutions are administratively governed by Director General Health services in the province and maintains the records of Hospitals, Health Centers provided by subordinate office of the District Health office. The Health is institutions functioning on district basis furnished by office of DG Health Government of Sindh Hyderabad are listed in Table 4.5.9.

Table 4.5.9: List of different Health Institutions on Small/ Large Scale in Left Bank Study area

S. No	Name of District	Total Institution/ Health Center
1.	Hyderabad	476
2.	Matiari	166
3.	Tando Muhammad Khan	91
4.	Tando Allahyar	49
5.	Thatta	610
6.	Badin	717
7.	Mirpurkhas	738
8.	Umerkot	520
9.	Tharparkar	829
10.	Sanghar	888
11.	Sukkur	393
12.	Ghotki	341
13.	Khairpur	1769
14.	Naushero Feroze	952
15.	Nawabshah	855

Adequacy

It is obvious from the available information that number of health institutions/ Hospitals and Health centers in the different districts are more or less sufficient in different district of Study area. However some parts of remote areas are lacking health facilities, therefore from adequacy point of view, the concerned authorities have to consider the difficulties faced by the poor people of area. Especially the people settled in coastal zone & adjacent to Thar Desert should be facilitated for providing Health Units.

Schools

Parents play the main role in developing the mentality and behavior of their children, next to that is role of a school teacher who grooms and polishes the child by providing a good education and better atmosphere.

Therefore, after home the next nest of child is the school which plays the important role in development of the human dignity, personality, vision, life stability with his strong economy by using his knowledge for his earnings in applying his physical / mental role within the different sectors of life

Performance of Schools

Due to the poor governance, still the education sector is in state of crises. The factors responsible include lack of access to education facilities & by poverty that prevents families from bearing the cost of education. Moreover, unsatisfactory quality of education arising from absent or poorly trained teachers, dearth of school supplies and inadequate infrastructure, (Shelter less school 1-2 room schools, school without drinking waters & sanitation facilities); there is a lack of accountability of school management to communities and service users, weak monitoring & evaluation of performance.

Status of School in Left Bank Study Area

For obtaining the status of the Left Bank (Study area), the available information is collected and based on the Development Statistics of Sindh 2008, Bureau of Statistics P&D Department Government of Sindh. According to this Primary, Middle and Secondary Schools in different district falling in left bank of Indus River on district basis are presented in Table 4.5.10.

Table 4.5.10: District Wise Number of Schools in Left Bank Study Area

Province/ District	Primary Schools		Middle Schools		Higher Secondary Schools	
	2007		2007		2007	
	Male	Female	Male	Female	Male	Female
Khairpur	2,873	564	145	63	93	23
Sukkur	978	207	56	34	44	15
Ghotki	1,064	233	71	26	32	4
Naushero Feroze	1,873	372	117	53	55	17
Nawabshah	2,111	417	79	27	47	11
Sanghar	2,678	378	120	47	62	19
Mirpurkhas	1,706	381	65	42	50	19
Tharparkar @ Mithi	3,175	585	275	18	28	4
Umerkot	1,779	444	74	27	30	8
Hyderabad	638	248	51	27	54	40
Tando Allahyar	624	121	37	10	20	5
Tando Muhammad Khan	870	124	18	8	18	5
Matiari	786	154	48	6	24	10
Badin	2,567	456	115	43	46	13
Thatta	2,688	407	60	35	55	17

Adequacy

Still the education at primary level requires changes to develop their status on national and international level. Moreover, it is necessary to open the new schools in rural villages and all prevailing schools within the area should be monitored with good governance & management. Recently literacy rate was 58.6 percent for male and 36.3 for female during the period 2007-2008. It is obvious that literacy rate and enrolment are very low to meet challenge of the province for poverty alleviation and social Welfare.

Roads

Background

Road and railways are the main source of communication in the Study area. During past days long before the partition of Indo-Pak the main source for transport and trade was the Indus which provided the main communication and trade route between the hinterland and parts of the Arabian Sea. With the passage of time and development of Karachi as a port and the buildup of Railway facilities, the Indus river route declined in usefulness and as the Barrages were built, it ceased to be important.

Development & Extent of Roads

After Indo-Pak partition, National Highway was the only source of main transport within the province which served as a trunk road connected with the small metalled / weathered roads of major cities on Left bank like Hyderabad, Nawabshah, Mirpurkhas, Sanghar, Khairpur, Pano Akil and Ghotki etc. Later on with the passage of time the network of roads (Farm to Market Roads) have been developed and linked with the remaining cities, towns and major villages of the study area (Ref Atlas Fig road map of the area). Now these roads have provided the major facilities for transporting agriculture commodities to the nearest markets as well as to the Agro-Industrial areas like Sugar Mill Industries etc.

Adequacy

Over all the network of Roads is still in need of development for connecting further with the remote area villages and towns. Also the condition of the existing roads under present situation is poor and requires the immediate attention of concerned authorities for minor/ major repairs for keeping light and heavy transport road worthy.

Market

Role of Markets

Major role for establishment of markets depends upon the availability of raw material as well as the production of agriculture commodities and the approach facilities for transporting those goods to the markets. In addition to that the agriculture lands should be utilized in proper way for production of food and fiber, which can be transported from small markets to big markets and further extra available commodities for export to international markets (Mandies).

The marketing of the Study area mainly depends upon the trade with cities like Karachi, Hyderabad, Sukkur, Nawabshah, Sanghar, Mirpurkhas, Khairpur, Pano Akil, Ghotki, and Mirpur Mathelo and other local markets of the interior Small Towns/ Villages of the left Bank of Lower Indus Region (Fig- Ref Atlas) showing the location of Markets (Mandies).

Monitoring of Markets

Over all at Tehsil (Taluka) Level Government of Sindh has established the Market committees, the function of these committees is to establish and control the rates of agriculture commodities of the

area and also facilitate them by providing the Market places or Market Mandies (Infrastructures) where a common man could be able to bring the agriculture produce for sale and also purchase the agriculture inputs like fertilizer insecticides/ Pesticides, Seed for growing cash crops and vegetables. Over all, market committees on Tehsil (Taluka) level are about 62 in the Study area and big cities are having the mega markets where all types of goods are sold and purchased.

Adequacy

It has been observed that Markets are not located in a proper way and at proper places where a poor farmer could be able to bring his agriculture commodities without facing any problem. Infrastructures (Mandies) have got no capacious space to keep the raw material safely so that it may not be damaged, for example fruits which are counted as perishable items are not preserved properly. However, it is need of time that on large scale for big towns/cities and at small scales on Village basis Markets (Mandies) are required to be developed so that a common man can approach easily and able to bring his agriculture commodities without facing any problem.

Water Diversion

Irrigation Water in Study area is diverted from Indus River through Guddu barrage at Kashmore in the north. Ghotki Feeder Canal off take from Guddu Barrage, Khairpur feeder East Canal, Khairpur feeder west Canal, Rohri Canal and Nara Canal off take from Sukkur barrage and Akram Wah, Fuleli Canal and Pinyari Canal off take from Kotri Barrage. Gross Command Area of 8 Canals is 9.75 MA and Cultivable Command Area 8.58 MA.

The annual Water entitlement of Ghotki Feeder Canal is 3.484 MAF Khairpur West is 1.148 MAF Khairpur East 0.369 MAF, Nara Canal 7.803 MAF, Rohri Canal 8.297 MAF, Fuleli Canal 3.280 MAF, Pinyari Canal 2.593 MAF and Akram Wah 1.786 MAF with total annual entitlement of all 8 Canals is 29.562 MAF.

Total Annual diversions in 8 Canals for years 2004-05, 2005-06, 2006-07, 2007-08, 2008-09 and 2009-10 were 26.7, 29.0, 24.8, 25.199, 22.02 and 23.696 MAF. Diversions are within entitlements. The water diversions in the Canals are presented in Table 4.5.3.

Adequacy

It has been observed that diversions system on Left Bank area is in need of O&M, so that they can carry the water according to their entitlements. The canals which have been silted up should be rehabilitated and most important factor is the adding of the drainage effluent of Town/Cities into irrigation system, which has not only polluted but also have, deposited its bad waste material into the System. Therefore, for running the system in proper way, the concerned authorities should take immediate action for rehabilitation of Canals, branches, distributaries and also to stop the drainage effluent of cities and Industrial area into the irrigation system.

Utilities

Common person, either belonging to agriculture sector or business community or any other discipline, are more or less dependent on utilities for their livelihood. Here specially with reference to agriculture/ agro-Industrial people who are dependent on the important utilities like seed, fertilizer, insecticides, electricity, tillage equipments are the basic needs for agriculture production as well as for livelihood of people. The important basic utilities required from agriculture point of view are discussed as under.

Tillage Equipments

The first and foremost requirement for cultivating the land is the availability of equipments required for tilth & tillage.

Seed for Growing of Different Crops

After tillage the next requirement is to have a good variety of seed for obtaining best agriculture production of crops.

Fertilizer & Insecticides

Fertility level in soils of study area is very low, therefore, different type of fertilizers are required by crops and soils, which are necessary to apply for obtaining good yields. Moreover, during the crop growth period there is attack of insets & pests, hence proper chemicals with proper doses are required to save the crop from disease.

Electricity and Gas

Among all utilities the most important is the electric supply to the consumers, especially for agriculture sector to run the tube wells for irrigation purpose as well as to lower down the underground water to a certain depth, so that water logging and salinity may not affect the soil and crops of the area. Also for running the agro-industries both electricity and Gas energies are required, because many industries and some power plants are also running on gas. Hence, both are important from life line point of view.

Adequacy

Overall in study area it has been observed that there is deficiency in supplying all the above required utilities to a common man which plays the main role in livelihood of people of the area. This is because of the mismanagement of the concerned organizations responsible for supplying the above most important utilities, especially for running the agriculture sector.

4.5.2 Key Findings

4.5.2.1 Irrigation Sector

Barrages

Irrigation water in study area is diverted through Guddu, Sukkur and Kotri Barrages. Over all operational efficiency of barrages need improvement due to various problems in each barrage.

Guddu Barrage

Soon after completion of construction in 1962-63, for ensuring proper distribution of flow passing through barrage structure, T-head spur on the right side in 1965 and T-head spur on the left side of the barrage in 1965 were constructed to improve flow pattern and also J-head spur on right side in 1994 and J-head spur on the left side in 2006 upstream of the barrage were constructed. Inspite of these training works operational problems of the barrage are (i) flood and sediment management problems; (ii) gates and gearing; (iii) a realm of safety of foundations and sub-surface flow conditions; (iv) operational constraints; and (v) lack of monitoring systems and equipment.

The Guddu barrage was designed for maximum discharge of 1,100,000. Since its construction it has passed 9 times the discharges in excess of 900,000 cfs. The Barrage is considered safe to pass 1200,000 cusecs. Bela (shoal) formation on the left side and Bela formation is also noticed at right side. Consolidated sand banks colonized with grass, shrubs and small trees would reduce flood passing capacity of barrage.

To address these issues and problems a detailed feasibility is in progress under WSIP for improvement/rehabilitation of barrage.

Sukkur Barrage

Operational efficiency of barrage was affected due to silt entry problem in Canals off taking on the Right Bank side of the Barrage. Based on the result of the model studies 10 bays of the barrage, 9 adjacent to the right under sluices 6 to 14 and 23 were closed and river training works were carried out for smooth operation of the barrage, however the flood passing capacity of the barrage was reduced from 1.5 million cusecs to 0.9 million cusecs. Several floods exceeding 0.9 million cusecs and including a maximum 1.2 million cusecs passed in 1976 seriously threatening safety of the barrage. During floods 2010 discharge 1.129 million cusecs passed through barrage threatening safety of the barrage.

Major problems in the barrage were experienced in the years 1947, 1985 and year 2004. In 2004 a large scour hole developed downstream of the first pile line in the first three spans of the right under sluices resulting in collapse and damage of the first pile line and the concrete slab in its vicinity. Cavities formed underneath the slab of the under sluices in front of the head regulator of Dadu Canal. Urgent emergency repairs were carried out by the Army Engineers to save this prominent and important structure from catastrophic failure.

Feasibility study was carried out in 2006 for rehabilitation works to the barrage. The feasibility study recommended improvement works. Comprehensive study in required for design of safety, overall performance improvements and modernization of operating and monitoring of barrage.

Kotri Barrage

Rehabilitation of Kotri Barrage constructed in 1955 has been completed recently and there seem to be no major issues with barrage. There is provision in WSIP for inspection as well as assessment of the Kotri Barrage and studies for designing any remedial measures/works that may be necessary.

Cross Regulator Operation

The cross- regulator are not properly operated to maintain upstream water levels, instead the operators are maintaining a variable target water level downstream of the cross-regulators for proxy flow rate control. This causes significant fluctuation in water level upstream, causing flow rate variability into the turnouts.

Condition survey of all head-Regulators and Cross-Regulators on main and branch Canals in the Study area is required for smooth operation, efficient and reliable water distribution in 8 Canal Systems.

Drainage Sector

Non-Operational Tube wells

There are 5,338 tube wells in Study are out of which 1,931 tube wells are non-operational and 3,407 are operational tube wells. Non-operational tube wells have been abandoned or closed due to various reasons. Nearly 36.17 percent tube wells are ineffective which indicate poor management of operating agencies. The major constraint is the insufficient funds for operation and maintenance of the drainage systems. Due to non-operation of the tube wells the withdrawal capacity has been reduced particularly in fresh ground water areas which have direct impact on agricultural production. Rectification of this situation is utmost essential for optimal development of land and water resource in the study area.

The Status indicate that 800 tube wells are closed due to theft/ burning of transformers, 377 due to fault in 11 KVA line, 261 due to bore failure, 260 due to motor defect, 172 due to pump defect and 46 due to control panel defect.

LBOD – Stage-1

LBOD drainage system comprising of sub-drains, branch drains, main drains, spinal drain Badin area drains need rehabilitation to restore original capacities.

LBOD outfall system also need major interventions for safe disposal of storm water to Shakoor Dhand through Dhoro Puran outfall drain (DPOD) and Arabian sea through Kadhan Pateje outfall drain (KPOD).

The problems faced in operation of LBOD during high rainfall events of 2003 and 2006 rains were studied in detail and feasibility report prepared by NESPK is under review.

Water Logging Trend in the Study Area

Pre monsoon & post monsoon seasons for the period of 30 years (1979-2009), water table trend remained at highest level (0-150 cm) in both seasons. In general, the high water table conditions have clearly been observed in the post-monsoon (October) as compared to the pre-monsoon (April) period. The percent wise area covered on bi-annual survey basis indicate that major part within different Canal Commands remained under 0-150cm water table depth during post monsoon season. This is because of the rainfall, flooding condition & simultaneously canals are running in full swing for supplying irrigation water during the Kharif season, and water table rises at the peak before the start of the Rabi season. After that decreasing trend of water table starts, area covered by water logging is more during the post monsoon period.

Further it is pertinent to note that during the recent past drought conditions prevailed throughout region i.e. from 1999 till the end of 2009 because of this the water table depths were remarkably lowered down to a larger extent, leaving a small area within 0-150 cm depth zone in pre monsoon season, where as a decreasing trend has also been observed during post monsoon period.

4.5.2.2 Flood Protection Bunds

- All protective measures should be carried out in accordance with the provision of the Bund Manual as adopted by the Irrigation and Power Department. The floods of the year 2010 necessitated fresh and exhaustive studies to adopt necessary measures in order to avoid similar damages in future.
- There are 49 vulnerable points in the main Bunds stretching from Guddu to Arabian Sea on the left Bund side of River Indus which need immediate attention for strengthening by raising top level of Bunds, providing stone pitching and apron for protection against wave wash. Top level of Bunds should be raised up to 6 ft above recorded HFL during floods 2010.
- The reaches adjacent to the cities should be given special consideration and the preventive measures such as raising top levels, providing stone pitching and apron should be provided on priority basis.

4.5.2.3 Infrastructures in Study Area

Key issues and problems identified are based on the findings. During the assessment and analysis it has been observed that in each sector of task still we are lagging behind and there is either need of improvement for promoting education of Schools, rehabilitation of health system and opening of new health centers in remote areas. This improvement could be done by providing means of

communication, granting the budget for construction of new roads and repair of existing roads which are in very bad condition. Not only this but for facilitating the Agriculture Sector, new markets (Mandies) are to be established where a small farmer may be able to get good return from Agriculture Commodities. Furthermore, if we look to the basic utilities required by the individuals of each Sector, i-e a business man, Agriculturist or affiliated to any private or public sector are facing lot of difficulties. It has been observed that there is lack of co-ordination between allied departments, there is lack of good governance, lack of management and there is lack of monitoring and accountability and insufficient budget releases to institutions.

4.5.3 Issues and Problems

A: Irrigation Sector Issues

Technical

- Low operational efficiency of Cross-regulators on main and branch Canals.
- Safety of Barrages in view of super Floods passing capacity and operational efficiency in view of the sedimentation on up-stream side of the barrage, centralization of flow and other problems.
- Low water availability at tails.
- Operation of the system with more discharge than design capacities.
- In-equitable distribution of water.
- Low water use efficiency.
- Excessive use of water in upper command of channels as compared to lower command (tail areas).
- Direct outlets withdrawing water more than entitlement thereby increasing Water shortage problems in the system.
- Waste full on-farm water use.
- Illegal withdrawal of irrigation water by influential people.
- Low delivery efficiency.
- Tampering of modules

Management

- Institutional weakness, exclusive control of public sector in irrigation management.
- Lack of corporate skills and lack of accountability system.
- Indiscipline in administrative set up of agencies responsible for operation of the system.
- Non-compliance of rules/ duties by operators of system as per O&M manual.
- Less involvement of the farmers in the management and Operation of the water systems.
- Less Budget release for operation maintains of the system.

Fiscal

- Less recovery of water charges due to poorly managed recovery system.
- Non-release of funds for development schemes

B: Drainage Sector Issues

Technical

- Out of 5338 tube wells in Study area 1931 (36.17%) are non-operational.
- Deferred Operation and Maintenance of Tubewells and other infrastructure.
- Theft of transformers and 11 KVA line conductors.
- Frequent brake down of electric power supply affecting operational efficiency of tube wells.
- Intrusion of Saline ground water into fresh ground water aquifers due to over exploitation of fresh water or less pumpage from adjoining saline ground water areas.
- Intrusion of Saline drainage effluent from SCARP VI project into Ghotki area.
- Poor O&M of Surface Drains.
- Weed problem in surface Drains.
- Out fall of canal escapes into LBOD system.
- Issues/ problems in LBOD Outfall System.
- Water logging and salinity problem in study area including the areas where drainage has not been yet provided. (Planned project areas under LBOD Stage II).
- Water logging problems in the vicinity of Chotiari Reservoir.

Management

- Institutional weakness, lack of corporate skills and lack of accountability system.
- In-discipline in administrative setup of agencies responsible for Operation and Maintenance of Drainage Systems.
- Less involvement of beneficiaries/ Stakeholders in planning, implementation and Operation and Maintenance of Drainage Systems.
- Lack of Coordination among various government agencies.

Fiscal

- Insufficient budgetary provision by Government for Operation, Maintenance and replacement of closed components of the projects.

  Gap between O&M funds requirement and cost recovery

C: Infrastructure Issues

Schools

- Lack of accesses to education facilities
- High cost of education literature & Books
- High cost of education fees by private Schools.
- Unsatisfactory quality of education.
- Inadequate infrastructure & poor condition of old school buildings.

- Lack of accountability of school management.
- Poor people are unable to bear the overall education cost for children.

Health Sector

- Lack of the implementation of health policies in applying at different institutions/ Health Centers of Study area.
- Rural areas are still not fully covered by basic health centers.
- At rural health centers staff is not available specially the Lady Doctors/ Lady Health visitors (LHVS), which has created the problem for gender.
- Mostly Government Hospitals/ Health centers are found in dirty and poor conditions.
- There is no good governance in management.

Roads

- Still there is no proper access of communication in remote areas of Left Bank.
- The roads available are in very poor condition.
- Canal & drainage paths for monitoring the system are in bad conditions.
- There is lack of management by concerned department.

Market

- Market facilities for Agriculture commodities have not been fully provided at Town / Taluka level for sale of their products.
- Where ever, there are markets, they are not fully established for example for transport banking, for purchasing and selling of agriculture commodities, for producing raw products from storm Water etc.
- Markets are not located at safe and proper places near the approaches of main roads.

Water Diversion

- Canal system off taking from three main barrages i.e. Guddu, Sukkur and Kotri have passed their lives above half century and are now in need of rehabilitation for proper functioning
- O&M of Water Diversion from barrages has not been attended properly.
- There is no good governance from management point of view.

Utilities

- From Agriculture point of view, the cost of Agriculture inputs like fertilizer, chemicals (for pest & diseases) & cost of tillage operation have increased to an alarming extent.
- Cost of electricity/ diesel has also increased and land owners are in trouble to run their tube wells for Irrigation purpose.
- Poor people or small Land owners are not in position to purchase costly varieties of seed for different crops.
- They also feel lot of difficulty to purchase seed & other utilities from long distances as the small villages have got either no or negligible facilities available within the villages

4.6 OVERVIEW OF CURRENT AGRICULTURE, LIVELIHOOD, AND ECONOMIC ASPECT OF DRAINAGE & FLOODS

4.6.1 Background to the Economics Thematic Area Study

Regional Master Plan issues and problems concerned with the economics of drainage and water disasters have been examined through a study of socioeconomic conditions, description of physical features and resource base, overview of agriculture sector, a framework for improvement of livelihoods in the delta and coastal area, and socio-economic considerations in flood management. This was accomplished using the Phase-I tasks given in Table 4.6.1.

Table 4.6.1: Topic Outline for Summary of the Thematic Area 6

Topic of Concerns for Phase-I Task Studies	
Subjects Covered	**Phase-I Tasks Included**
Overview of Current Agriculture, Livelihood, and Economic Aspect of Drainage & Floods	
✓ Overview of Agriculture Sector and description of socioeconomic conditions ✓ Framework for improvement of livelihoods and its implementation in the delta and coastal area, and ✓ Socioeconomic goals of flood management	• T-12: Determination of human resources, farm size, etc. and socio-economic surveys for the project area • T-19: Landless and poverty nexus and methods for improving livelihood opportunities in the delta and coastal area • T-20: Implementation arrangements for improving livelihood activities in the delta and coastal areas. • T-23: Socio-economic goals of flood protection

The preparation of the master plan is scheduled in four phases.[7] This section, as per terms of reference for the Phase I of the Study, presents an overview of the current situation of agriculture production system in the left bank of Indus River in the province of Sindh, livelihood issues in the delta and coastal zone, and desired economic goals in combating water related hazards, particularly storm water and river floods.

4.6.2 Methodology Adopted To Address the Thematic Area

The approach and methodology adopted to describe the current agriculture and socioeconomic and livelihood condition prevailing in the Study area is based on the compilation and analysis of available published and unpublished secondary data; and supplementing findings from the focus group discussions, using a variant of rural appraisal approach, in the randomly selected 60 communities in the Study area. This would assist in estimating the trends in various variables and the influencing factors. The main objective of the agronomic and socioeconomic study in the Phase-I, is to document and describe the prevailing agronomic and socioeconomic and livelihood situation in the study area. Most of the secondary data is available with a lag of two to three years. The data related to agriculture sector is according to the administrative/revenue boundaries and it is generally difficult to sift out the relevant parameters according to the hydraulic boundaries (canal commands) and or drainage basins.

[7] Phase-I: Preparation of Inventory, assessment of existing conditions, identification of issues, and methodology and plan for consultations and stakeholder participation. Phase II: Development and identification of issues, formulation of a regional master plan, preferred solutions, and their ranking. Phase III: Preparation of the detailed feasibility studies, for the selected options/solution. Phase IV: Preparation of detailed design and preparation of bidding documents, and implementation manuals and standard operating procedures for nonstructural and improvement management measures.

The left bank of Indus, for the purpose of this report is delineated into three subregions. These include i) Guddu subregion in the north irrigated by Guddu barrage; ii) Sukkur subregion (middle) mainly irrigated by Sukkur barrage, and iii) the Kotri subregion irrigated by Kotri barrage, including delta and coastal areas, which is generally outside the canal command. The Ghotki subregion includes districts of Ghotki and Sukkur. The Sukkur subregion include districts of Khairpur, Naushero Feroze, Shaheed Benazirabad (formerly known as Nawabshah), Sanghar, Matiari, Tando Allahyar, Hyderabad, Mirpurkhas, Umerkot, and parts of Tharparkar and Tando Mohammed Khan districts. The Kotri subregion comprises parts of Tando Muhammad Khan and Badin district, and eastern part of the Thatta district. The Delta and coastal subregion include southern parts of the above two districts.

As most of the published data is based on revenue/administrative boundaries, to validate the aggregate data and to observe the ground reality, group discussion were held in sixty villages, spread over the left bank. Separate analysis is presented for areas where drainage projects are in place, hereon referred as Zone A, and areas where the drainage projects are in the planning stage or need to be considered, hereon referred as Zone B. (See Figure 1.1). The distribution of the villages, by subregions and zones, where discussion groups were held is presented in Vol-II Thematic Area 4.6 Table 4.6.1.

In Zone A, the average number of participants in the focus group is 18 persons, while in Zone B, on an overall average about eleven people attended the discussion. In Zone A about 70 percent of the participants are either land owners or sharecroppers, while in Zone B, they constituted 67 percent. The remaining represented private and public sector employees, self-employed and others. Vol-II Thematic Area 4.6 Table 4.6.2 gives composition of the persons by vocation who attended the discussion group.

Irrigation minors/canals were randomly selected in each of the sub regions. Three watercourses, one each in the three reaches, head, middle, and tail were randomly selected In addition to this; three villages were randomly selected in the delta/coastal zone. Out of the 60 selected villages, 36 are in Zone A, while 24 are in Zone B, including three villages in the coastal zone.

Following a rapid rural appraisal approach, village profiles were prepared for each of the selected village settlement based on focus group discussion held at each village attended by beneficiaries in the village served by drainage projects, and intended beneficiaries in the villages that are expected to be served by planned projects. The discussion centered around a structured checklist, and some open ended question to solicit their perceptions about the performance of the completed projects. The findings are indicative and do not merit extrapolating at a higher order, nonetheless, are adequate to describe the current prevailing situation, represent stakeholders perceptions for issues and problems, and to compare and validate the available secondary data.

4.6.3 Key Findings of Thematic Issues

4.6.3.1 The setting and context

The Southern/lower part of the Indus Basin Irrigation System is the main source of water resources for the Sindh province. In addition to this, underground fresh water, torrential flows, and water bodies supplement water availability. The water resources support irrigated agriculture, livestock, inland fisheries, forest plantation, municipal use, and industrial subsectors.

The Indus River in Sindh is managed with an elaborate system of irrigation, and drainage network to dispose of off underground effluent, flood, and storm water. The irrigation system consists of three barrages, Guddu, Sukkur, and Kotri, diverting water in to 14 main canal systems, of which six are on the left bank and eight are on the right bank. The canal systems deliver water to

millions of farms through distributaries, minors, and watercourses. In addition to this, the system provides drinking water supplies to the various urban settlements and industrial establishments. The river supplies, downstream of Kotri, fall into the Arabian Sea, supporting riverine forests, mangroves, and estuaries.

More than three fourth of Sindh is underlain with saline groundwater, and is generally not fit for irrigation. The fresh groundwater, generally confined to the corridor along the Indus River, is of better quality, and is suitable for irrigation and domestic use. To supplement the canal water supplies, the private tubewells pump out the fresh groundwater. To combat the increasing water table, causing water logging and salinity, declining farm productivity, and damage to physical infrastructure, the deep turbines and tile drains/interceptors are employed to pump out and drain out saline groundwater (the effluent). This effluent is disposed off into canals and or drainage network. The same is transported to natural depressions in the delta and Arabian Sea. The drainage network provides relief to the storm water. The floods in the Indus River is managed through a string of flood embankments and spurs to contain the floodwaters within the river channel, and from over-spilling and damaging the standing crops, livestock, physical infrastructure, and urban settlements.

The irrigation, drainage, and flood subsector infrastructure is in disrepair due to deferred maintenance, poor governance and operational management, and equity issues. The gap between O&M expenditure and receipts (user charges – abiana and drainage cess) has been widening since mid seventies. Despite occasional increase in the O&M yardstick and the user charge, the two does not commensurate. In addition, the system needs investment to revamp and rehabilitate the irrigation system and extension of the drainage system to other areas. Similarly, the flood protection works also suffer from similar issues and need attention. Furthermore, investment is needed to harvest and store storm and the floodwater surpluses, where feasible.

In the left bank, about one fifth of the canal command area suffers from water logging and salinity, and hampered farm productivity. The system, therefore, needs to drain out the surplus saline water effluent out of the basin. The Left Bank Outfall Drain (LBOD) collects drainage effluent from the major part of left bank command areas of Sukkur, and Kotri barrages, and drains into the sea. The tidal link and Cholri weir at the tail end of the LBOD botched due to various acts of nature and technical reasons. The failure led to seawater intrusion and devastated the farmland, freshwater bodies, inland fisheries in the delta, and mangroves in the coastal zone. This had an adverse impact on the livelihood of people residing in the lower reaches of Kotri command, delta, and coastal zones, compromising their food security in the deltaic region and coastal areas. This also severely blighted the local ecology and environment. The communities in the affected area strongly feel they were not consulted during the planning, designing, and implementation stages.

The situation requires preparation of a master plan to identify investments in improving the existing drainage infrastructure and extending the same to the remaining areas of the canal commands, and safe disposal of drainage effluent, flood and storm waters through the delta and coastal zone into the sea, ensuring environmental sustainability. The planning process is to ensure a participatory approach, involving consultation with the stakeholders.

The Government of Sindh (GoS), with the assistance from the World Bank, is implementing a Water Sector Improvement Project, Phase I (WSIP-I)[8]. One of the subcomponents of the Project is to support preparation, for the GoS, a regional master plan for addressing the flooding issues and

[8] The WSIP-I approved in September 2007, and made effective in December 2007, terminates in April 2013. The Project is being executed by the Planning and Development Department, GoS.

providing proper drainage to the area on the left bank of the Indus River through appropriate structural and non-structural measures. This should include remedial measures for any outstanding deficiencies in the LBOD, measures for retention and/or safe disposal of drainage, storm and floodwater, improvement of wetlands in the delta area and in the coastal zone recognizing their environmental importance and considerable economic potential for the local communities.

The preparation of the regional master plan was entrusted to Louis Berger Group (LBG). As per terms of reference (TORs) and scope of work (SOW) of the study, the study area include areas located in the left bank of Indus River, delta (and associated wetlands) and adjacent coastal zone. The preparation of the study is to be conducted in consultation with the stakeholders at each stage of the study, namely, identification of issues and solutions/options, and preparation of prefeasibility and detailed feasibility, and ranking and sequencing of structural and nonstructural interventions.

4.6.3.2 General description of the project area

Sindh is the southernmost province of Pakistan, bordering India towards eastern side, the Punjab province in the north, Balochistan province in the west, and a coastline along the Arabian Sea in the south. Sindh links to the rest of the country by a road and railroad network. Karachi city, the provincial capital, serves as the main port city for the country, with two main seaports, Karachi Port and Port Qasim. In addition to the international airport in Karachi, the province has eight domestic airports located in various cities.[9] The Study area is also linked to upcountry with inter district and interprovincial road network, and a railroad.

The Indus River bisects the province into left and right bank. The right bank consists of irrigated plain and dry land along the foothills of the Khirthar mountain of Sulaiman range. The left bank consists of irrigated plains, and flanked in the eastern belt by arid Nara and Thar Desert, delta, Halar range (Karonjhar), and the coastal zone.

4.6.3.3 Demography

According to the Population Census 1998,[10] the population of the left bank of Indus in Sindh, in the census year was 14.7 million, which is estimated as 20.4 million by the year 2010, and is expected to reach 21 million by 2015. This accounts for about 48 percent of total population in Sindh. Out of this population, about 76 percent population, directly or indirectly depend on agriculture. About 72 percent of this population lives in the Sukkur barrage subregion, while 15 percent reside in the Kotri barrage subregion, followed by about 13 percent in the Guddu subregion. Vol-II Thematic Area 4.6 Table 4.6.3 presents the past, current, and projected population estimates in the three subregion of the Study area.

Based on the information provided in the discussion groups, the average number of HHs in the selected villages in the study area is about 261. The average number of HHs in Zone A is 245, and 285 in Zone B. The total number of HHs in the selected villages are 15,670, of which 8,835 in Zone A, and 6,835 in Zone B. Vol-II Thematic Area 4.6 Tables 4.6.4 presents distribution by subregions in the two zones.

The average village population for the selected villages is estimated at 1,711 for Zone A, and 1686 in Zone B. The average family size of HHs in Zone A is 6.9, and 5.9 in Zone B. Vol-II Thematic Area 4.6 Table 4.6.5 presents breakdown of average number of population of selected villages in

[9] Hyderabad, Mirpurkhas, Dadu, Shaheed Benazirabad, Moenjodaro, Jacobabad, and Sukkur,

[10] Development Statistics of Sindh. Bureau of Statistics. Planning and Development Department. Government of Sindh

the three subregions in the two zones. The population data for females seem to be under reported, and needs to be dealt with care, particularly, as the data indicates female population has been under reported.

Access to education and health Services

The information on distances between village and the education and health related institutions from the selected villages shows that the primary schools are generally within walking distance from the villages, except in Ghotki primary school children have to walk about 2 Kms. While middle and high schools are at distance of 4.7 km and 8.2 km. Similarly, college's students on an average have to travel over 15 km. The Basic Health Units are generally with 7.5 km to and hospitals are on an average at a distance of between 16 and 17 km. For accessing agricultural extension and veterinary services, the farmers have to travel on an average 16 km. Vol-II Thematic Area 4.6 Table 4.6.6 summarizes the information on accessibility of the abovementioned institutions from the villages in the three subregions in the two zones.

Literacy

The literacy rate observed in the selected villages shows that in Zone A about 53% male population above 15 years of age is literate, compared with 48% in Zone B. Vol-II Table 4.6.7 shows the present education level for different subregions in the two zones by gender. The table shows that the literacy rate in women is abysmally low. In Zone-A it is estimated that only about 18% female are literate, while in Zone B the situation is relatively better 31% female population has education. The data also shows that amongst the male adults, about 25% have continued their education beyond primary schools, while in Zone B, about 21% got education beyond primary school level.

Incidence of Diseases

The perception of the discussion group participants about prevalence of diseases and it intensity suggests that Malaria is the main cause of illness in both the zones, followed by diarrhea. The other causes of illness of low intensity include flue, typhoid, tuberculoses, and hepatitis. In women prenatal is not considered a major issue. Vol-II Table 4.6.8 presents the incidence and intensity of various diseases in different subregions of the two zones.

Access to utilities

The information from the discussion groups show that in Zone A about 85% of the villages have power supply; while in B 100% of the households have power supply. The situation regarding access to clean water is dismal. In Zone only about 52% have access to clean water (hand pump, dugwells, tubewells, and piped water), while about 37% depend on canal supplies, and about 11% get their water from ponds. In Zone B about 27% have access to clean water, while about 43% draw their water from ponds, and 30% draw their water from canals. In Zone A only 34% of the houses have latrines, and only about 14% have access to sewerage facility. However, in Zone B relatively significant number of houses (about 64%) have house latrine, and 12% houses are connected to sewerage system. Vol-II Table 4.6.9 presents the extent of accessibility in the different subregions/zones.

Employment and off farm Income

In Zone-A 4,669 persons reported income from sources other than crops and or livestock. In Zone A about 71% of those employed earn their income from wage labor, while 6.5% are employed

within the area of residence, and 9.3% are employed in other towns and cities. Also about 5.8% are self employed and others draw their income from pension, rent, and remittances, etc.

Similarly, in Zone B about 2,153 persons have off farm income. About 74% of those employed earn their income from wage labor, while 8.9% are employed within the area of residence, and 6.9% are employed in other towns and cities. Also about 6.1% are self employed and the remaining draw their income from pension, rent, and remittances, etc. Vol-II Table 4.6.10 presents the average income by source of income and location.

Average monthly HH income and expenditure

The main source of income in the villages where discussion groups were held includes crop income, income from sale of dairy products, and off farm income, etc. The latter two items were recorded on a per month basis and monthly estimated crop income was computed by spreading this for twelve months. In Zone A the estimated average total HH monthly estimated income is PKR 27,086, while for B, it is PKR 23,948, say PKR 24,000. In Zone A the share of crop income in total HH income is about 60%, while in Zone B 66% income is sourced from crop income. Vol-II Table 4.6.11 gives a breakdown of income for average HHs located in the three subregions of the two Zones.

The information on average monthly HH expenditure presented in Vol-II Table 4.6.12 for the three subregions in the two zones shows that in Zone A, the average monthly HH expenditure is about PKR 31.5 thousands. Of this about 43% is spent on food, followed by 13% each on health and transportation, while 10% is spent on education related costs, and surprisingly about 8% on communication. The rest (13%) is spent on clothing, utilities, and social obligations. In Zone B, the average monthly HH expenditure is about PKR 28.3 thousands. Out of this about 45% is spent on food, followed by 14% and 11% on health and education respectively, while about 9% is spent on communications, and about 8% on transportation. The rest (13%) is spent on clothing, utilities, and social obligations. It may be cautioned here that the reported expenditure is higher than the reported income. In such surveys it is a universal problem where respondents overstate the expenditure and vice versa understate the income.

Perceived poverty profile

To assess the level of poverty in the selected villages, the focal group participants were asked to classify the HHs in the village, as perceived by them, into four groups. The Zone A, they opined that about 74% of the HHs are poor, while about 22% HHs are perceived as well off or rich. The remaining about 4% HHs are considered as very poor and or destitute. In Zone B, the perceived poverty is pervasive. The proportion of very poor and or destitute (6%) in Zone B is reported to be higher than in Zone A. The HH considered poor are about 70%, while about 20% HHs are considered well off and or rich. Figure 6.1 and Figure 6.2 and the associated tables depict the distribution of the HHs, classified according the perceived poverty, in the three subregions in the two zones.

Source of farm credit

Credit is considered as one of the binding factors in financing farm inputs and other farm related investment. There are two main sources of rural finance: i) formal institutions, such as Commercial banks, Zarai Tariqiati Bank Ltd (ZTBL) formerly known as Agricultural Development Bank of Pakistan, Rural Support Programs, NGOs etc.; and ii) the informal sources include arhtis – the commission agents (who combine the function of input suppliers, cash for consumption needs, and sale of inputs and handle the farm produce in the market on behalf of their clients), moneylenders,

and friends and relatives, etc. The lending of the formal institutions is limited to seasonal, medium term, and long term investment and do not cater for consumption needs. They also require collateral and proper documentation and guarantees. The informal sources generally provide loans for both inputs and consumption needs.

Various studies show that despite special allocation by the State Bank of Pakistan through commercial banks, agriculture development bank, the preference is still the informal sector, mainly, commission agents, money lenders, friends and relatives. It is estimated that despite the informal sources charge exorbitant explicit and implicit interest rate/service charge, the informal sources account for 70 to 80 percent of the credit market.

In Zone A, about 58% borrowers preferred informal sources for obtaining loans. Moneylenders provided loans to about 37% of the borrowers, followed by arhtis and accounted for 14% of the borrowers...Amongst the formal sources, ZTBL provided loans to about 28%, while 14% borrowers accessed loan from commercial banks. The remaining borrowers about 7% borrowed money from relatives and friends

Similarly, in Zone B about 54% borrowers accessed credit from informal sources. Mainly moneylenders were the preferred source who provided loans to about 43% of the borrowers, followed by 11% by *arhtis*. Amongst the formal sources, ZTBL provided loans to about 30%, while only 6% borrowers accessed loan from commercial banks. The remaining borrowers about 9% borrowed money from relatives and friends. Vol-II Table 4.6.13 provides information about sources of credit by type of agency in the different subregions and zones.

4.6.3.4 Description of physical features and resources base

Physiography

The left bank of Indus from North to South is about 550 km long, with varying breadth of between 50 km and 100 km (East to West). The topography is generally flat with deep alluvial and deltaic deposits sloping towards Arabian Sea. Soils are mostly calcareous silt-loam. Soils in Badin and Thatta districts are generally saline. Eastern part is predominantly desert; with inter dunal valleys and alluvial flats. There are isolated limestone rock formations, found near Sukkur and Hyderabad.

In the southeastern corner, Karonjhar/Ravalli range is situated. Along the coast, rocks are oceanic in nature. The coastal areas have about 17 major creeks/lagoons. Historically Indus delta region has been continuously growing reclaiming lands during the historic times, but more recently shrinking due to sea encroachment. The delta is spread over 41.4 thousand square kilometers and consists of clayey and swampy terrain.

Climate

Sindh is part of the subtropical Asian region and is predominantly arid. The mean maximum temperature in summers is around 45^{o} Celsius. During April and August, the mercury touches as high as 46^{o}C to just above about 52°C. During December and January, the minimum average temperature is about 8°C. In the winters, frost is common in the middle and upper Sindh. The climate of lower Sindh (*Lar)* is milder and humid than middle Sindh (*Wicholo*), while the upper Sindh (*Siro*), witnesses extremes.

The climate is arid, with an average annual precipitation is between 100 mm to 250 mm. Some years are very wet, with up to 500 mm, while the province also experience prolonged drought. The main rainy season is during the July and August, during which monsoon comes into from southeast and deflects to the northwest. December and January receives occasional rains. The coastal belt

has mild climate and gets relatively severe towards the north.

Agroclimatic zones

The left bank can be delineated in to three agroclimatic areas. The wheat-cotton-sugarcane zone encompasses Guddu and Sukkur barrage commands, and mainly grows dry crops, wheat, cotton, sugarcane, oilseeds, millets, guar gum, etc.[11] The main fruits grown in this zone include dates, mangoes, banana, guava, etc. The Kotri barrage command, mostly with non-perennial canal supplies, is marked out as wheat-paddy-sugarcane zone. This zone is best suited for sugarcane, paddy, oilseeds, and pulses. As the canal supplies are not available during winter (*Rabi*), wheat is grown with residual moisture. Banana is the main fruit grown in this zone. Towards the south, vegetables, coconut, guava, and oil palms are grown. The third zone is the non barrage areas, mainly Nara and Thar deserts. This area grows rain-fed crops such as millets, pulses, cluster been, oilseeds, and some wheat.

Land resource base and utilization

The left bank accounts for about 73% of to the total reported area in Sindh. The total reported area for the left bank is about 10.3 million hectares (ha), out of which, about 5.8 million ha is arable. Of the available arable land, 4.3 million ha is under cultivation, while 0.6 million ha is under forest, and the remaining 0.9 million ha is culturable waste. The remaining 4.5 million ha is not available for cultivation, and mainly comprise of settlements, waterways, physical, social and productive infrastructure, mountains and rock outcrops, lakes, desert, etc. The share of cultivated area in the Sukkur subregion in the total cultivated area in the left bank is 72.3 percent, followed by 20 percent in Kotri subregion, and 7.7 percent in Guddu subregion. Similarly, the share of cropped area in Sukkur subregion in total cropped area in the left bank is 68.4%, followed 18.5% in the Kotri subregion, and 13.1% in the Guddu subregion. Out of 618 thousand ha forest cover, 58.3% is in the Kotri Subregion, followed by 33% in the Sukkur subregion, and about 8.7% in the Guddu subregion. The share of Sukkur subregion in total culturable wasteland in the left bank is 63.8%, followed by 27.2% in Kotri subregion, and 9.0 percent in the Ghotki Subregion. The subregion wise description of the land use is presented in Vol-II Table 4.6.14

The total arable area of the surveyed villages in Zone A is estimated as 11.7 thousand ha, of which 7.6 thousand ha (65.8%) is cultivated. The remaining area is either culturable waste (due to water logging and salinity and water shortages) or under nonagricultural uses. In Zone B the area available for cultivation is 5.2 thousand ha (72.2%) out of a total of 7.2 thousand ha. In Zone A the average area per observed villages is 322.5 ha out of which about 218.3 ha is available for cultivation, while in Zone B average area of the villages is 300.4 ha, and about 217.0 ha is available for cultivation. The data presented in the abovementioned table shows that, in Zone A the share of net area available for cultivation in the total arable area is higher in Ghotki and Sukkur subregions (84.4% and 78.5% respectively) compared with Kotri subregion where only 29.9% is cultivable; the rest being culturable waste. The percentage share of area available for cultivation ranges between 74.8% and 74% in the three subregions in Zone B. Vol-II Table 4.6.15 presents information on land base in the two Zones.

Farm structure and tenure

According to the last agricultural census of 2000[12], the farm structure in the left bank, despite dominance of small farms (in numbers), is in favor of large farms (in terms of total land area).

[11] Paddy is also grown in parts of Tando Mohammed Khan area.
[12] Agriculture Census 2000: Province of Sindh. Statistics Division, Government of Pakistan

Most farms are fragmented and are in joint ownership of extended family. This skewed structure is a constraint to access and distribution of factors of production, particularly to smaller farms. This also is a factor responsible for income disparity in the rural areas. Following is a description of farm structure vis-à-vis farm ownership, and tenurial pattern.

Farm ownership pattern

There are about 600 thousand farm owners in the Study area, managing about 3.4 million ha. The average farm size is about 5.7 ha. Three fourth of the total farm owners are subsistence farmers. They own about one fourth of the total farm area. The number of farmer owners, in very small farm size category[13], is about 21.4 percent (131 thousand), but they own only 2.4% of the farm area, with an average farm size of 0.6 ha. Similarly, 52.1% (312 thousand) small farmers own about 22.9% of the farm area, with an average farm size of 2.5 ha. The 77.4 thousand (12.9%) owners are medium size farmers, owning about 15.9% of the farm, with an average farm size of 7.0 ha. This farm size is optimal farm size for sustenance of an average family. About 69.2 thousand farmers (11.5%) are in the large farm size category and they own about 34% of the farm area, with an average farm size of 16.7 ha. The very large farmers are about 1.5% (9.1 thousand) and they own one fourth of the farm area, with an average farm size of 92.8 ha. Vol-II Table 4.6.16 presents the farm ownership distribution for the three subregions and the districts in the respective subregions.

Based on the past trends in the ownership pattern, as evident from previous census, the number of farmers and the area owned in the higher farm size group is shrinking, consequently increasing share of smaller farms over the years. The main reasons are: i) land mutation; ii) land transfers; and iii) out migration by selling land and investment in urban areas.

Vol-II Table 4.6.17 presents the subregion wise information on number of farms in different farm size categories, and the area owned by them in the two Zones. These estimates are relevant to the selected villages and may not represent the overall picture of the area. This distribution pattern should not be considered a substitute of the agriculture census type of survey, hence should be read with care.

The pattern of farm size distribution, reported in the discussion groups, indicates a skewed ownership pattern in the Study area. Large size farms dominate the area. In Zone A, the total number of farms reported by the respondents in the surveyed villages is 1,898 farmers owning about 11,809 ha. The very small farmers owning less than 2 ha account for 53.6% while they own about 11.1% of the farm area. The small farmers (owning 2 to 5 ha) are about 24.2% and they own about 13.9% of the farm area. Similarly 15.9% are medium size farmers (5 ha to 10 ha) and they own 16.1% of the area, while large size (10 ha and above) farmers account for 6.4% and own 58.8% of the farm area.

Similarly in Zone B the total number of farms 892 farmers owning about 7,209 ha. The very small farmers account for 39.2% while they own about 5.8% of the farm area. The small farmers are about 27.6% and they own about 10.6% of the farm area. Similarly 21.6% are medium size farmers and they own 18.1% of the area, while the large size farmers account for 11.5% and own 65.5% of the farm area.

The above mentioned table also shows that the overall average farm size in the Study area is about 6.1 ha, and 8.0 ha respectively for Zone A and Zone B. In Zone A, the average farm size of large

[13] Very small farm size group = less than 1 ha; Small farm size =1ha to <5 ha; Medium size farm = 5 to 10 ha; Large size farm = 10 to 40 ha; and Very large size farm = above 40 ha.

farms is 56.5 ha, followed by 6.2 ha for medium size farms, 3.5 ha for small size farms and 1.3 ha for very small farms. In Zone B, the average farm size of large farms is 45.8 ha, followed by 6.7 ha for medium size farms, 3.1 ha for small size farms and 1.2 ha for very small farms.

Operational holdings and tenurial arrangement

Vol-II Table 4.6.18 shows that there are 727.5 thousand operational farms cultivating about 2.8 million ha. About 441.4 thousand farms (60.7%) are operated by owners farmers (self/direct cultivation), managing 81.7% of the operated farm farms. The tenants or sharecroppers account for 35.2% and operate 21.2% of the area. The remaining farms are owner-cum-tenants14 accounting for about 4.1% of the total operators, cultivating 9.2% of the area. The average farm area operated is 3.9 ha. The average area operated by tenants is about 2.3 ha, while owner cultivators manage about 5.2 ha, and the owner-cum-tenants operate on an average about 8.6 ha.

In Zone A the about 37% of the farms are cultivated by owner cultivators, 18% are cultivated by owner-cum-tenants, while the remaining 45% farms are operated by tenants. In Zone B owner cultivators are 17.5%, owner-cum-tenants are 10.4%, while 72.1% sharecroppers' farms is cultivated by sharecroppers. Vol-II Table 4.6.19 details the subregion wise information on tenurial pattern reported in the two Zones. There are about 976 and 387 landlords in Zone A and Zone B respectively who engage sharecroppers.

4.6.3.5 Water resources and canal water availability

The irrigated agriculture is mainly concentrated in the alluvial plains along either side of the Indus; while the rain fed cultivation is in the Thar and Nara desert, along the eastern provincial boundary, and arid Khirthar range along the western boundary. The main source of irrigation is the Indus River, diverted into irrigated areas through a network of three barrages, namely, Guddu, Sukkur, and Kotri. The irrigation supplies to the left bank of Indus is through eight main canals. Between 62% and 65% of the total water diverted by the three barrages feed the command area of the left bank. In the total cropped area, the share of irrigated area is over 90 percent, and within irrigated areas canal irrigated area is about 95 percent, while about 5 percent is irrigated from shallow wells, tubewells, lift irrigation, ponds, etc.

The Guddu subregion gets in canal supplies from Ghotki Feeder off taking from Guddu Barrage. The main canals in the Sukkur subregion include Khairpur Feeder East, Khairpur Feeder West, Nara, and Rohri canals, off taking from the Sukkur Barrage. The Kotri subregion include three canals: Akram Wah (Lined Channel), Fuleli canal (New Fuleli), and Pinyari Feeder (Old Fuleli), off taking from Kotri Barrage.

Surface water

Vol-II Table 4.6.20 presents Gross Command Area (GCA), Culturable Command Area (CCA), and the canal withdrawals during 2004/05 to 2009/10. The Ghotki canal off takes from the Guddu barrage and serves parts of Ghotki and Sukkur districts. The GCA of this canal is 411.7 thousand ha, while the CCA is 347 thousand ha. During 2009/10 about 2.11 bum was diverted to the commanded area.

The four canals that off take from Sukkur barrage includes: Khairpur Feeder (West), Khairpur Feeder (East), Nara canal, and Rohri canal. They provide irrigation supplies to parts of Khairpur, Naushero Feroze, Shaheed Benazirabad, Hyderabad, Matiari, Tando Allahyar, Tando Mohammed

[14] Owner-cum-tenant includes those owner cultivators who self cultivate their own land and acquire land from others as cash tenants or as share croppers.

Khan, Sanghar, Mirpurkhas, and Umerkot, districts. The GCA and CCA of the abovementioned four canals is 2.49 million ha and 2,292 thousand ha, and about 12.9 bcm was diverted in to the canal systems in 2009/10.

The three canals in the Kotri subregion are Lined Channel/Akram Wah, Fuleli canal, and Pinyari canal irrigate Badin and eastern parts of Thatta districts. The GCA and CCA of these canals together are 942.1 thousand ha and 888 thousand ha respectively, and about 5.14 bcm was diverted to the canals.

A review of past canal diversions suggests that the water availability at canal heads declined over time. This is largely due to shortfall in the river flows. It also reflects per CCA acre availability. As the cropped area has not declined commensurate with water availability, it suggests under-watering of crops, relative to the previous years.

Groundwater

Generally, the left bank is underlain with saline groundwater unsuitable for agriculture and domestic and potable use. The fresh groundwater is mostly restricted to the narrow corridor along the Indus river, and occasional lenses and perched water. In the freshwater zone, freshwater is mostly pumped by the private tubwells to supplement the canal supplies. In the saline groundwater zones the public sector tubewells drain out groundwater to dispose that into canals or in to the drainage network.

As shown in Vol-II Table 4.6.21, in the three year period (2004/05 through 2006/07), 13,2 thousand tubewells were installed in the left bank of Indus. Out of these, 12.9 thousand tubewells (98%) are fresh groundwater tubewells, while the balance 382 were installed by the public sector in the saline groundwater zone. The table also shows that during the three-year period most of the fresh groundwater tubewells (12.4 thousand) were in the Sukkur subregion, followed by 392 tubewells in the Kotri subregion. The balance 99 tubewells were installed in Guddu subregion. The saline tubewells were installed in Tharparkar and Mirpurkhas districts.

The sudden surge in the increase in private sector tubewells may be explained as a coping strategy to supplement shortages in the river/canal flows. In the absence of data on quality of underground water and pumpage, it is difficult to predict the soil fertility and overall environmental consequences. As most of these tubewells are shallow wells tapping perched water, they would soon be run out, unless canal supplies are back to earlier flows, or recharged with heavy rains and or canal seepage.

In the left bank, the total area sown in 2006/07 was 2.15 million ha. Out of this 0.36 million ha (16.9%) was un-irrigated, while 1.48 million ha (68.5%) were canal irrigated, and balance 0.32 million ha was well/tubewell irrigated. Similarly out of total irrigated area the canal irrigated shared 82.4% and 17.6% is well/tubewell irrigated. Vol-II Table 4.6.22 presents the area sown by type of irrigation in the three subregions and respective districts. Table also shows that in Ghotki and Matiari districts, well/tubewell is the predominant source of irrigation. In the two districts, the share of well/tubewell irrigated area is 90 percent and 77 percent respectively, followed by Tharparkar (38%), Tando Allahyar (32%), Sukkur (20%), and Khairpur (12%). In the remaining districts, the share of well/tubewell irrigated area is less than 10 percent.

In Zone A, out of 36 villages where focus group discussion were held, sixteen villages have SCARP tubewells, while equal number of villages supplement irrigation supplies from private tubewells. Similarly, 22 villages reported access to drainage network. In Zone B, out of 24 villages, only seven villages reported location of private tubewells. Vol-II Table 4.6.23 gives the

subregion wise access to these facilities.

Lakes (Dhunds) and wetlands

Chotiari lake/reservoir is an off-stream reservoir on the Nara Canal Systems. Originally it was a natural depression lake later upgraded to a reservoir with 55 km long earth embankment, with a maximum height of 30 feet, and with a storage capacity of 0.6 bcm. The main source is its watershed and floodwater from the Indus River, downstream of Sukkur barrage. It was upgraded in to a reservoir to supply irrigation water to the hinterland and to supplement Nara canal system. It was funded under LBOD Stage I Project investment.

The other freshwater lakes include Soonharo and Khipro lakes in Sanghar. Mahboob Lake in Sujawal, Hadeiro[15] and Jafri lakes in Thatta district. Lakes in Badin district include Tando Bago, Khango (Khowaj), Phoosna Bakar, Mehro, Pateji, Sanhro, Cholri, and part of the Shakoor lake. A detailed inventory and description of wetlands and lakes is given in the relevant chapter of the report.

These lakes, fed from harvested storm water and flood supplies, were traditionally used for inland fishing. The lakes, in the southern subregion, are generally been rendered saline due to sea encroachment and failure of the LBOD to effectively transport the drainage effluent. Moreover, the industries, particularly sugar mills, are disposing hazardous effluent into theses lakes.

4.6.3.6 Brief overview of agriculture sector in the study area

Agriculture sector is an important engine of growth in the study area. It directly and indirectly provides livelihood to about three fourth of the Sindh population residing in the left bank. The left bank receives almost 60% to 65% of the canal withdrawals, while its share in the total cropped area is about three fourth. Apart from wheat, the main staple, most of the main cash crops and high value crops, such as cotton, sugarcane, vegetables, condiments, and fruits (mango and banana) are grown.

Cropping pattern

Sindh has two main cropping seasons, namely kharif – summer season (mid-April through mid-October), and Rabi – winter season (mid-October through mid-April). The main Rabi crops are wheat, rape and mustard, vegetables, and fodder. The main crops grown in kharif are cotton, sugarcane, paddy,[16] millets, and cluster-bean, kharif vegetables, pulses, nontraditional oilseeds,[17] etc. In addition to this, the left bank produces different fruits such as mango, banana, dates, papaya, guava, etc. The data on area under various crops for the last three years, shown in Vol-II Table 4.6.24 through Vol-II Table 4.6.26 show that the total cropped area under crops decreased from about 3 million ha in 2007/08 to about 2.8 million ha in 2009/10. This decline is attributed to decline in the canal water availability. This has also changed the share of individual crops in the total area.

The abovementioned tables show discernable increase in wheat area and its share in the cropped area. The area under wheat reported as 764 thousand ha in 2007/08, accounting for 26% in the cropped area, has increased to about 821 thousand ha in 2009/10, sharing about 30% in the cropped area. It appears that wheat has replaced Rabi oilseeds whose area has reduced drastically. Similarly, area under cotton has increased from about 579 thousand ha in 2007/08 to about 600

[15] Hudero Lake is located 85 km from Karachi in the Thatta district Sindh Pakistan. It is a marshy area of salt water where various types of water birds seek refuge.

[16] Mostly in non-perennial areas of Guddu and Kotri barrages

[17] Mainly sunflower and safflower,

thousand ha in 2009/10 accounting for about one fifth of the cropped area. The area under paddy has also increased from about 181 thousand ha in 2007/08 to about 261 thousand ha in 2008/09, and declined to about 238 thousand ha in 2009/10. The share of paddy in total cropped area oscillated between 6% and about 9% in the same period. The share of Sugarcane area in the total cropped area has declined from about 10.4% to 8.3% in the reported years. The area under sugarcane declined from about 304 thousand ha in 2007/08 to about 230 thousand ha in 2009/10. The area under fruit increased from about 142 thousand ha to about 145.5 thousand ha in the same period, while area under vegetables has also increased from 54.6 thousand ha to about 64.7 thousand ha in the same period indicating a shift to high value crops. The details of area under each crop and respective shares by subregion and by respective districts are given in the abovementioned tables for the period 2007/08 to 2009/10.

The existing cropping pattern and intensities of canal commands in the left bank was also estimated from the records of Sindh Irrigation Department, Sindh Irrigation Development Authority (SIDA), and Agricultural Department and published data by the Bureau of Statistics of Sindh and Pakistan. Where the availability of water is limited, the farmer prefers mixed cropping pattern with low delta crops such as pulses, oil seeds, orchard and fodder. In the upper reaches of the canal commands, the annual cropping intensity is higher than the lower reaches of the canal, because availability of water at tail ends is low. In Sukkur Barrage and Kotri Barrages, the upper reaches have higher cropping intensities compared to lower reaches.

The above cropping pattern is for the overall left bank and includes cropped area in the nonbarrage areas. In the following section cropping pattern and cropping intensities has been revisited using the command wise information on cropped area under various crops.

The cropping pattern and intensities has been estimated for the cropping year 2009/10 for all the eight commands of the left bank, and are presented in Vol-II Table 4.6.27 through Table 4.6.34. Data presented in the tables shows that In Kharif season, rice, cotton and sugarcane are dominant crops on command of left bank canals of Indus. However, in perennial canals commands cotton has edge over rice. In Rabi season wheat is the dominant crop, followed by fodder and Rabi oilseeds.

Based on information gathered from the discussion groups, in Zone A the share of wheat is about 37.1% in the total cropped area, followed by cotton (21.2%), paddy (14.2%), sugarcane 11.3%, Fruits 4.9%, and Rabi oilseeds 4.6%. Similarly in Zone B, the share of wheat is about 43.6% in the total cropped area, followed by cotton (30.3%), paddy (14.2%), sugarcane 10.2%, and Rabi oilseeds 5.1%. In both the zones vegetables, which is a high value crop share about 1.8% and 1.2% in Zone A and Zone B respectively. Share of fruits in Zone B (1.6%) is relatively lower compared with 4.9% in Zone A. The subregion wise crop shares in the two zones is presented in Vol-II Table 4.6.35.

Various reports[18] indicate that about 32 thousand ha in Badin district and about 460 thousands in Thatta district was lost to sea intrusion. Analysis of cropped area trends in the Thatta and Badin area based on crop acreage data for 1991/92 through 2009/10 for all the crops, save sunflower, shows that the total cropped area declined after the cyclone and sea intrusion. Nonetheless, the cropped area in two districts has increased significantly in the post cyclone period, if the area under sunflower is also taken into account in the total cropped area. As the two districts are served

[18] Socioeconomic Study and Proposal for Livelihood Improvements: Badin and Thatta Districts, Sindh, Pakistan. Agriculture and Rural Development Sector Unit. South Asia Region. The World Bank. April 25th, 2005

by the eastern drain system i.e. LBOD and the western drain system for the Kotri barrage command area, it is difficult to sift out or isolate the positive or negative impact of LBOD per se. For further analysis would require disaggregated data at the taluka level. Unfortunately, despite concerted efforts this data could not be obtained from the Agriculture Extension Department or the Sindh Bureau of Statistics.

In Badin district the total cropped area (excluding sunflower) in 1991/92 was reported as about 230 thousands ha which declined to about 199 thousand ha by the year 1997/98, during which the LBOD was being constructed. After the collapse of the tidal link and associated structures, the cropped area continued to decline till 2004/05 (about 49 thousand ha), but increased thereafter to about 207 thousand ha, which is about 10% lower than the base year. Similarly in Thatta district, the total cropped area (excluding sunflower) in 1991/92 was reported as about 101 thousands ha which increased to about 120 thousand ha by the year 1997/98. After the collapse of the tidal link and associated structures, the cropped area initially declined, but recovered and has increased to about 145 thousand ha by the year 2009/10; an increase of 43% over the base year. For details, please see Vol-II Table 4.6.36 and 4.6.37. The trend in acreage changes is also depicted in Vol-II Figures 4.6.3 and 4.6.4.

The abovementioned tables also show that with the acreage under sunflower included, the total cropped area has increased significantly over the last 19 years. In the Badin district the area registered an increase of more than 40% over the base year, while in the Thatta district the area has almost doubled in the same period. It may be mentioned here that the decline in the cropped area in the two districts may have been offset by the western drainage system.

The data on crop shares (excluding sunflower) shows that in Badin district, the share of Cotton area has increased from 2% in 1991/92 to 9% by the year 2009/10. In the Thatta district the share of paddy has declined from 58% to 50%, while wheat has increased from 6% to 11% in the same period. With the area under sunflower included, the share of sunflower has increased from 1%, in both the districts, to about 37% and 27% in Badin and Thatta districts. The year wise detail is presented in Vol-II Table 4.6.38. The phenomenal increase in area under sunflower is that the recently introduced hybrid varieties have lower delta and two crops can be grown in the Rabi season.

Cropping intensity

Based on computations from the land utilization data,[19] the overall cropping intensity in the Study area is estimated as 65%. It is highest in the Guddu subregion (110%), followed by Kotri subregion (63%), and 60% in the Sukkur region. One reason that explains high farming intensity in Guddu subregion is rapid growth in private tubewells. Moreover, major portion of the culturable waste and area uncommandable lies in the Sukkur subregion.

The cropping intensity mentioned above should not be seen same as command area specific cropping intensities. The estimated cropping intensity reflects cropping intensity of the Study area as a whole, which include barrage and non-barrage areas.

Based on further analysis of data[20] mentioned earlier, in 2009/10, the annual cropping intensity of Ghotki Feeder of Guddu sub-region is 35%. The annual cropping intensities of Khairpur West Canal, Khairpur East Canal Nara Canal, and Rohri Canal falling in the Sukkur subregion is in the order of 89.7%, 82.7%, 40.4% and 63.7% respectively. Likewise annual cropping intensity of

[19] Volume-II Table 4.6.14
[20] Volume-II Table 4.6.27 through 4.6.34

Akram Wah in Kotri subregion is 30.1%, while cropping intensities of only Kharif season for Pinyari Canal and Fuleli Canal, both no perennial canals, is in the order of 19.3%, and 18.5% respectively. It is evident from the figure of cropping intensities that in Nara Canal command the annual cropping is very low which is the clear indicator that there is either acute shortage of water or the available water potential is not used intelligently. Similarly, there are alarming figures of cropping intensities in the command of canals falling in Kotri subregion, which explicitly manifests that there is a huge shortage of water in this sub-region. This whole scenario needs a special attention to address the problem in a productive manner in order the alleviate the poverty prevailing in problematic sub-regions.

A recent survey conducted by WAPDA in 2006/07 shows that the cropping intensities has decreased from 127.7% in 1982/83 to 114.9% in 2006/07 in the LBOD system.[21] The results are encouraging about increase in cropped area, reduction in current fallow, and production.

The zone wise analysis of cropping intensity for the surveyed villages, as reported by participants in the focal discussion groups[22] is 93.6% in Zone A, compared with 108.3% in Zone B. In Zone A the cropping intensity ranges between 48.8% in Ghotki subregion to 97.8% in the Sukkur subregion, and 105.8% in the Kotri subregion, while in Zone B it ranges from 64.4% in Ghotki subregion to 107.9% in Kotri subregion, to 115.2% in the Sukkur subregion.

Production

In the left bank of Indus the production of wheat during 2007/08 through 2009/10 oscilated around three million mt. The Sukkur subregion accounts for about two thirds of the total production, followed by about 20 % produced in Guddu subregion, while Kotri subregion contributes 6% to the total left bank production.

The total production of cotton (seed cotton) in the left bank during the same period was about 2.5 million mt in the first two years, which increased to about 4 mt in 2009/10. This phenomenal increase is due to wide adoption of Bt varieties. About two third of the cotton is produced in Sukkur subregion, followed by Guddu subregion which contributes about one fifth in total cotton production, while about 5% is produced in the Kotri subregion. Recently it has been reported that the performance of Bt cotton in Kotri subregion has demonstrated exceptionally high yields and cotton may be an important crop in the coming years.

In the left bank paddy is also an important crop, and its production increased from half a million mt in 2007/08 to about 700 thousand mt, of which about 70% to 80% is produced in the Kotri subregion, while the balance is produced in the Guddu subregion and Sukkur subregions.

The total production of sugarcane in the three subregions was about 18.5 million mt, in 2007/08, which significantly declined to about 13 mt in the last two years. The total production of vegetables, a high value enterprise, in the left bank was 686 thousand mt in 2007/08, which increased to about 800 thousand mt in 2008/09, while it shows a drastic decline in 2009/10 reducing to about 200 thousand mt. The Sukkur subregion which contributed about two third of the total vegetable production in 2007/08, its share declined to about 45% by 2009/10. The share of Kotri subregion in total vegetable production in 2007/08 was about 15%, which has increased to about 50% by the year 2009/10. Sukkur subregion produces about 85% of the fruits, followed by about 10% in the Kotri subregion. For details on production of main crops by subregion and

[21] Final progress Report: Continuation of Monitoring of LBOD System. August 2006 to July 2008. SCARP Monitoring Organization (SMO) WAPDA, Hyderabad. June 2009

[22] Vol-II Table 4.6.35

districts, please refer to Vol-II Table 4.6.39 to 4.6.41.

Crop yields

The average yield of wheat during the last three years i.e. 2007/08 through 2009/10 is stagnant at about 3.6 mt/ha, which is higher than the wheat average for Sindh, and higher than national average. The yield of seed cotton has shown significant increase in the last three years. The yield of cotton in 2007/08 was 4.2 mt/ha, which increased to 4.6 mt/ha in 2008/09, and in 2009/10 it recorded a phenomenal increase of 6.8 mt/ha. The yield of sugarcane has been erratic. In 2007/08 the estimated average yield was observed as 61 mt/ha, which declined to about 50.5 mt/ha in 2008/09, and increased to about 58 mt/ha in 2009/10. For region wise details for the last three years per ha yield of various crops in the three subregions/districts is presented in Vol-II Table 4.6.42 through 4.6.44.

As reported by farmers in the discussion group, in Zone A, the average yield of wheat is 3.1 mt/ha compared with 3.5 mt/ha in Zone B. The reported yield of cotton is 2.2 mt/ha and 2.7 mt/ha in Zone and Zone B respectively. Amongst the subregion the yield of cotton is between 3.2 mt/ha and 3.4 mt/ha and is discernibly higher than other subregions in both the zones where the maximum reported yield is 2.5 mt/ha. This is due to recent proliferation of Bt cotton varieties in the Kotri subregion. Similarly, the sugarcane yield in Zone A is about 80 mt/ha compared with 82.5 mt/ha in Zone B. The sugarcane yields' in the Kotri subregion is relatively higher when compared with other subregions. In the case of paddy, the average yield is about 4.3 mt/ha in Zone A, while it is about 3.0 mt/ha in the Zone B. Similar to sugarcane, the yields of paddy in the Kotri subregion in Zone A is significantly higher (5.4 mt/ha) than other subregions in the two zones. Like other crops the yield of vegetables is also significantly higher in Zone A (20.9 mt/ha) compared with about 10 mt/ha in Zone B. The maximum yield reported is for Kotri subregion of Zone A. This is because of relatively milder in the subregion which favors production of seasonal and offseason vegetables. Vol-II Table 4.6.45 presents the subregion wise yield of the main crops in the two zones.

Farm inputs

There are six major inputs required for better production of crops i.e. water, seed, fertilizer, plant protection materials, farm machinery and farm labor. Most farmers generally retain seed from the previous crops. Nonetheless, with the introduction of private seed companies in Sindh, there is a shift in replacing the traditional seed with higher quality seed. The Sindh Seed Corporation is producing and marketing certified seed of wheat, paddy, and cotton on limited scale which does not fulfill the total seed requirement of the area. Private sector is also producing and marketing seeds. It is a matter of concern that seed from India is smuggled and used without screening for seed borne diseases and viruses.

During the year 2007/08 the fertilizer off take in the left bank was recorded as 607 thousand mt. Vol-II Table 4.6.46 presents off take by type of fertilizer in the districts of located in the left bank. The table also shows that per ha use of fertilizer (N+P+K) in the Sukkur Subregion is about 233 kg per ha, compared to 180 kg/ha in the Guddu subregion, and 124 kg/ha in the Kotri subregion. The per ha use and NPK ratio is discernibly lower than the recommended levels. Particularly use of potash fertilizers is abysmally low.

The sale of agrochemicals, insecticides, pesticides, weedicides, etc. is in private sector. These are sold generally through fertilizer dealers, commission agents, and authorized dealers of the pesticide companies. Sale of fake, adulterated, and out dated agrochemicals is a major issue and is being addressed by the Agriculture Department. The farmers' complaint against the high prices of insecticides and adulteration.

Farmers depend on both family and hired labor, which is an important input used at all stages of crop production from preparatory tillage to harvesting. The hired labor is of two types, permanent and causal. The permanent labor is hired on monthly or annual basis, whereas causal labor is hired for short duration during the peak demand periods of planting and harvesting.

Crop enterprise budgets

Gross Margins or enterprise budgets expressed as difference between gross costs and cash costs, reported in the discussion groups has been estimated for various crops grown in the Study area. Vol-II Table 4.6.47 displays the summary of gross margins for different crops in the two zones.

In Zone A, vegetables realized a net income of about PKR 274 thousand per ha, followed by sugarcane which earned about PKR 261 thousand per ha. The next most remunerative crop is cotton (PKR 124 thousand) followed by wheat which fetched PKR 38 thousands per ha. The returns from rapeseed and mustard seem to be reasonable which is valued at PKR 28 thousand per hay.

In Zone B, sugarcane realized a net income of about PKR 291.3 thousands per ha, followed by vegetables which earned about PKR 233 thousands per ha. The next most remunerative crop is cotton (PKR 138 thousand) followed by paddy, about 48 thousands, and wheat fetches PKR 47 thousands on per ha basis. The gross margins for rapeseed and mustard crop seem to be reasonable which is valued at PKR 42 thousand per ha.

The above estimates are based on the estimated gross margins for individual crops detailed in Vol-II Table 4.6.48 through Vol-II Table 4.6.53. These tables give the estimated average gross production costs, gross value of production, gross margins, and yields for abovementioned crops. Volume –II Thematic Area 4.6 gives the summary of prices used in computations of crop enterprise budgets.

The SMO, WAPDA monitoring report[23], mentioned above, estimates per ha gross value of production, gross costs, and net income of various crops. Using 2006/07 prices it reports that the per ha net income from sugarcane surpasses all crops. It is reported as PKR 145.8 thousand, followed by PKR 53.2 thousand, and PKR 31.7 thousand from Rabi and Kharif vegetables respectively, PKR 48.4 thousand from cotton, and PKR 24.9 thousand from wheat.

4.6.3.7 Brief overview of livestock subsector in the left bank

Nationally, it is estimated that the livestock sector accounts for about 50% in the total agriculture Gross Domestic Product (GDP)[24]. As the demand for the dairy products is significantly higher in the province of Sindh, it is estimated that the share of livestock in total provincial GDP is higher than national estimate. In the left bank there are about 8.5 million large ruminants, followed by 11.5 million small ruminants. Amongst the 936 thousand pack animals in the left bank, 73% are horses, mules, and assess. Camel population is about 218 thousand, and is concentrated in the Tharparkar district of the Sukkur subregion. Vol-II Table 4.6.54 presents the distribution of livestock in the different districts in the study area.

The average population of animals per HH in Zone A is about 2.5, out of which 1.3 are large ruminants/milch animals (buffalo and cow), followed by 0.62 goats. In Zone B, the average number of animals per HH is 4.13, mainly about 1.3 milch animals, and 2.1 goats. Amongst the three subregions, per HH animal population is relatively higher than other subregion Vol-II Table

[23] ibid

[24] Economic Survey of Pakistan 2009/10, Economic Advisers Wing, Ministry of Finance, Government of Pakistan

4.6.55 illustrates the per HH average number of different types of animals in the three subregions of the two Zones.

In the study area the milch animals are reared for home consumption and the surplus is sold as milk or after processing into ghee (butter oil), etc. This supplements the household income of farm and nonfarm HHs both. This income estimated here is limited to value of milk and dairy products, and does not include value of milk consumed by the HHs, and hence should not be taken as cost of production of milk which is conventionally estimated for a liter. In both the zones, the average monthly net income from one buffalo, after adjusting for the cost of purchased feed, maintenance, and medicines is a little over PKR 3,200. Similarly, the average monthly income from one cow is a little over PKR 1,000 per HH in Zone A, while it is about PKR 2,760 in Zone B. Vol-II Table 4.6.56 and 4.6.57 presents the monthly expenditure, value of milk sold, of one buffalo and one cow for different subregions and zones.

4.6.3.8 Brief overview of fisheries subsector in the left bank

During the past years the fish catch increased from 57 thousand mt in 2003/04 to 62.8 thousand mt and declined to 60.3 thousand mt in the year 2006/07. Vol-II Table 4.6.58 shows that the during the past few years the share of fish catch in Kotri subregion declined from 62.4 percent to 55 percent, while the share of the Sukkur subregion increased from 12.7 percent to 24.4 percent in the same period. Similarly the catch increased from 29.7 percent to 31.5 percent in the Sukkur subregion, while in the Ghotki subregion it increased from about 13 to 24 percent. This is mainly due to the salinization of freshwater bodies in the Kotri subregion, particularly in the delta and coastal zone.

In the Study area, the fisheries subsector provides livelihoods to about 32,000 household. Vol-II Table 4.6.59 presents fisher folk population distribution in the Study area. It is reported that in 2006/07, the there were 23 thousand full time fisher folks, while there were about 8.8 thousand part time fisher folks. The table also shows that there are 3,560 boats, out of which 1,810 are sailboats and 1,750 are rowboats.

4.6.3.9 Agriculture support services

Both public and private sectors support agriculture, livestock, and fisheries subsectors through a network of research, extension, and teaching institutions. The research institutes provide improved production packages and improved seeds for dissemination through extension service. Private sector companies that market agricultural inputs also provide extension services through their dealers and some print media. Research being a public good, and have long gestation period, private sector is still shy to invest in the research endeavors.

The agricultural research is the main source of basic and foundation seed. They provide these to Sindh Seed Corporation, a public sector institution, and private seed companies for multiplication and its provision to farmers.

Agricultural Engineering Department is responsible to provide services to farmers for improving watercourses, land leveling, both heavy and precision land leveling, and development of tubewells.

The agriculture markets is reasonably liberalized, save for wheat, paddy, and sugarcane. These are partially liberalized, as the federal government continues to announces the reference price to set the prices. Farmers are free to sell their produce to any of the preferred buyer. In case of wheat, the provincial food department procures wheat to meet their targets. To meet the procurement target, the food department uses administrative leverage to claim the first charge. Once the target is achieved met the farmers are free to sell their produce to any buyer. Farmers sell their rice and

sugarcane to buyer of their choice and at a negotiated price.

The provincial agriculture department, however, regulates the markets through quality control and ensuring fair deal to the growers. The public sector grain, vegetable, and fruit markets are managed by the Market Committees elected by the commission agents, representatives of the growers and ex-officio officers from the department of agriculture. In the later report a description of marketing channels will be detailed for each crop.

4.6.4 Issues and Problems

4.6.4.1 General observations of participants of discussion groups

At the end of the discussion group sessions, farmers were requested to give their awareness and performance of the institutions dealing with the farmer managed irrigation system and drainage. Following represent their opinions.

In Zone A, about 67% of farmers in the Guddu subregion acknowledged that the drainage projects have improved water availability, while about 46% farmers in Sukkur subregion recognized water availability. In Kotri subregion farmers opined that there was no increase in water availability. About two third farmers in Ghotki and Sukkur regions expressed that the increase in water availability increased their cropped area. Similarly, one third farmers in Ghotki subregion and two thirds farmers in Sukkur region informed that this also increased the crop productivity. Only 11% farmers in Kotri subregion conceded increase in yield.

Regarding satisfaction with the overall performance of the drainage project staff, only about two third of the farmers reported their satisfaction, while all the farmers in the Sukkur and Kotri subregions expressed their dissatisfaction. During the discussions they mentioned that most of the tubewells are nonoperational due to vandalizing of the machinery, electrical panels, pole mounted transformers, and hook up connections and high tension lines. The tubewells that survived theft suffer from negligence and poor upkeep. Similarly, the farmers felt that most of the main and sub drains are clogged with weeds and poor maintenance of embankments and rain cuts. Regarding consultation with farmers by WAPDA/IPD at the design and implementation stage, one third of the respondents in Ghotki acknowledged consultation, while farmers located in Sukkur and Kotri subregions informed that they were not consulted.

Most respondents, are not aware of the Sindh Irrigation and Drainage Authority (SIDA), however most of them are generally aware of the Area Water Boards (AWB) and its role and responsibilities. Despite their concerns about O&M and physical condition of the system, particularly minor canals and distributaries, they acknowledged that the distribution system has improved relative to what it was when managed by the IPD. They also felt that there has been some improvement in equitable distribution of irrigation supplies, still the tail enders are not getting their due share.

Similarly, almost all farmers are aware of the Farmer Organization (FO), but only few are aware of their mandate, responsibilities, and functions. However, they acknowledged that as the chairperson of the FO is amongst the tail end farmers, there is a slight improvement in distribution of irrigation water. They also informed that they are generally unaware of the rotation schedule and that should be communicated to them at appropriate time in a transparent manner..

Regarding performance the SCARP tubewells, farmers complained that most of them are stolen and vandalized. They also felt that those still in place are functioning less than their capacity. They also desired that those still managed by WAPDA should be transferred to IPD/SIDA for repair and rehabilitation. They felt that more tubewells should be installed to control the water logging

menace.

Farmers also expressed their dissatisfaction about the physical condition of the drains. Most of them are damaged and need proper maintenance. They further informed that the tertiary drains need particular attention, as most of them have been dismantled by farmers through whose land they are passing. The farmers generally emphasized that a well maintained drainage system would increase their farm productivity.

Farmers also felt that the improvement in irrigation management and drainage system alone is not enough for improving productivity. They felt that timely availability of good quality inputs such as, certified seed, fertilizers, pesticides, weedicides, need to be ensured. Similarly, getting fair prices of output is an issue and marketing system need improvement, as arhtis are not fair in their dealings.

4.6.4.2 Drainage related socioeconomic issues

During the Phase I of the Study frequent stakeholder consultations were held at a wider scale in many rural communities. As identified by the communities, following are the main issues related to socioeconomic wellbeing and livelihoods vis-à-vis impact of drainage network, its operation and maintenance, its disposal, stunted growth/denudation of mangroves, seawater encroachment, etc. The key issues and problems identified from the studies performed to assess the economics of drainage and water disasters were grouped into thematic areas as presented below, while a later section on Key Issues and Problems deals theses issues in detail.

4.6.4.3 Issues and problems - social and livelihood

Breeding ground for diseases: In the delta and coastal area due to the swampy conditions and low quality of life, lack of social infrastructure, and health and hygiene related awareness the incidence of various water borne and contagious diseases is quite high. The major illness in the area are malaria, tuberculosis, diarrhea, cholera, anemia, etc.

Shortage of pastures for livestock and camels: The encroachment of seawater in to the grazing lands in the delta and coastal areas has reduced the carrying capacity of such areas. The situation has further worsened by indiscriminate grazing the limited availability. This has also significantly reduced the income of household who depended solely on livestock income. The IPOE study recommends that sequentially some area should be designated where camel grazing is managed through controlled grazing and rotation.

Loss of fish potential of freshwater bodies: Due to collapse of tidal link, the freshwater bodies in the delta and coastal areas have turned saline. This has destroyed the livelihood of the fisher folks and they have lost their livelihood. Similarly, the once productive farmland has gone out of production due to high salinity caused by sea encroachment, and overtopping of tidal link. Many stakeholders suggested that the natural water bodies, depressions, and natural drains should only be used or disposing off storm and flood water as a way to harvest surplus water and replenish the freshwater bodies.

Lack of alternate livelihood opportunities: The affected areas has been back quarters and lagged behind in livelihood opportunities. The main economic activity was fishing and limited agriculture. The skill level is low and need skill development programs to enable them to earn livelihoods, rather than working as low wage unskilled labor.

Stakeholders have suggested introduce and support community based ecological tourism in the delta areas around fresh water bodies, with an integrated value chain approach connecting various

communities.

4.6.4.4 Issues and problems - farm productivity

Introduction of bio-saline agriculture: The main constraint in realizing better yields in the past project area is poor disposal of drainage effluent causing land degradation. In the planned project areas, the farmers reported marginal yields and low crop intensities. In areas that were devastated by failure of LBOD and tidal link are the worst affected. The communities expressed the desire to introduce and promote salt tolerant alternate crops. As the best productive land is allocated to cash crops, marginal land is allocated to fodder; hence the availability of fodder and feed for livestock is limited. There is a need to introduce salt tolerant fodder crops to sustain the animal population.

4.6.4.5 Issues and problems - operation and maintenance (O&M)

Lack of O&M of the tertiary and secondary drains: The drainage network, particularly main and secondary drains are in dilapidated condition and clogged with silt and weeds. This restricts free flow of the drainage effluent and its occasional breaching.

Abandoned onfarm drains: Farmers have, at most places dismantled the tertiary drains fearing the drains will bring salinity to their land. The right of way of these tertiary drains is not well defined and at most places the farmers complained that they did not receive the cost of land acquired for the purpose.

Theft of SCARP Tubewell Accessories: A significant proportion of drainage wells are not functioning due to all or some of the material is missing and not replaced. It was observed during the field visits that most of the tubewells have been vandalized. It was reported that organized gangs are involved in stealing high tension wires, hook up connections, motors and pumps, electrical fittings, and in some places even the doors. Where these tubewell are functioning, they are source of power theft for nonagricultural uses. As these are not functional, farmers have abandoned the connecting farm ditches. This has reduced the effectiveness of the SCARP tubewells, and reduction of water table is constrained.

4.6.4.5 Issues and problems - environment

Impact of constrained flows d/s of Kotri Barrage The constrained river flows downstream of Kotri has lead to adverse impact on the quality of water, marine life, and river morphology. The discharge of untreated industrial effluent in the river and LBOD system has further accentuated the situation. The report by International panel of Experts Report[25] (IPOE) indicates that the water quality of surface water is generally of high standard; nonetheless, the biological and bacteriological contamination is of wide spread. The report further observes that in the delta area the salinity and bacterial contamination of the groundwater is increasing. The affected people felt that there is an urgent need for wastewater treatment before it is disposed off in to the river/sea.

Denuding of mangroves for fuel wood: The reduction in the mangroves has seriously impaired the aquatic life and inland fishing. This has significantly reduced the household incomes. This also reduced their fuel wood supplies from the mangroves. As a coping strategy the inhabitants started denuding the mangroves not only to meet their fuel wood requirement, but also to fetch money. IPOE study recommends that the mangrove area need to be replanted to provide sustenance to the local population, amongst other benefits. The affected communities desired that mangrove cultivation should be introduced on the lines of social forestry programs to regulate excessive

[25] Final Report of the Inspection Panel on Escapage (IPOE) below Kotri Barrage. Federal Flood Commission (FFC), GoP. Islamabad. 20th of November, 2005

harvesting.

Continued sea encroachment: The communities in the Badin and Thatta districts, particularly in the lower reaches of the barrage command area, delta, and coastal area are wary of the seawater intrusion through the remains of tidal link. They apprehend that the sea intrusion will not only engulf the fertile lands at the fringes, but will also render them permanently saline.

4.6.5 Livelihood Development Framework

4.6.5.1 Livelihood context

In line with the stated objectives of the WSIP and the poverty reduction strategy of Sindh, the overall objective of the development is to reduce poverty in the left bank, particularly deltaic and coastal zone, with focus on landless and vulnerable population. This could be achieved by increased access to factors of production, especially land, improving access to social, economic, and financial services, and supporting and creating enabling environment for income generating and improving opportunities for livelihood activities. This require protecting those who are vulnerable and marginalized by maximizing their growth and competitiveness and minimizing as far as possible the negative effects that would occur on material, environmental and socio-economic assets as a result of natural phenomenon and anthropogenic activities. This necessitates policy support from the government to strengthen the capacity of the community to enhance productivity of the resource base, engage in income generating activities, increase employment opportunities, and peoples' income. Thus the purpose of this study is to assess and review the poverty and livelihood opportunities in an environment that constraints the realization of livelihood potential, due to landlessness, and poor access to social services.

The lesson learnt from the previous irrigation and drainage projects suggests that inclusion of livelihood development activities should be an integral part of any investment plan/projects. The purpose is to ward off any likely negative impact and externalities on the quality of life and livelihood of any community or localities within the planned investment areas, particularly in the delta and coastal zone areas.

In the left bank of Indus River, there is a strong correlation between prevailing poverty and livelihood opportunities. The factors that influence livelihood opportunities are multidimensional and interlinked. The main reasons include lack of access to factors of production, including landlessness, access to social services and service institutions, particularly financial, poor infrastructure, and poor knowledge base and skills. Although the livelihood opportunities are relatively limited, as elsewhere in the country or province, the situation in delta and coastal area is precarious. Providing livelihood development support to the entire Study area would need colossal investment and thinly spread, and beyond the context of the drainage related investment. Nonetheless, parts of Badin and Thatta districts, including delta and coastal zones, have been historically back quarters harboring relatively higher poverty incidence need special attention and focus. Particularly, these areas serve as disposal route for drainage effluent, storm water and flood water, and are prone to cyclones and seawater intrusion, are highly vulnerable to occasional threats. Moreover, due to general perception that in addition to the natural water related disasters, the disposal of drainage system interspersed these areas, and collapse of the tidal link had detrimental effect on the limited livelihood opportunities, the communities felt need for support for sustained livelihood.

Prior to the natural and manmade havoc, the main source of livelihoods, were farming, fisheries, livestock husbandry, and trading activities. Despite skewed land ownership, crop agriculture was the main stay of economy. After the loss of fertile land and the grazing lands, and diminished

productivity of the crop and livestock sub-sectors, there was a shift to fisheries as a coping strategy. Nonetheless, due to salinization of the freshwater bodies and stress on the marine fishery potential, the dependence on this activity was also strained. Concurrently the damage and poor allocation to social services reduced the quality of life, particularly access to education, health, and drinking water and sanitation. This all retarded the economic growth and the livelihood activities. The deterioration of the physical infrastructure further accentuated the quality of life in the area, and population increasingly became food insecure.

This subsection analyses various factors that influence livelihood opportunities and recommends a framework of interventions to alleviate pervasive poverty through improving access to existing services, and improving livelihood opportunities.

The basic analytical frame of the assessment study included development of problem tree, as perceived by communities, based on: focus group discussions, multidisciplinary in-house consultation, and employing a Problem Tree. These assessments were made during the field visits conducted by Consultants in the eight districts of the left bank. During the field studies separate group discussion were held for male and female participants in the target rural communities. Attempt was made to solicit their perceptions regarding the abovementioned issues and identified needs. Based on findings from the field and observations made, problem tree was constructed by the Consultant with a multidisciplinary approach involving all the relevant specialists. Based on problem tree analysis, the main factors that have limited the livelihood opportunities and the consequent poverty are described as follows.

Skewed land ownership

One of the main constraints in the delta and coastal areas is the highly skewed land ownership pattern. Agricultural land is concentrated into hands of few, most of whom are absentee farmers. The large landowners also have better access to factors of production such as agricultural inputs, particularly irrigation supplies, and output markets. Most of the people in the rural areas do not own land. They either work as tenants and or as casual labor on others land, or earn daily wages from nonfarm activities. Most of the participants in the discussion stated that with the increasing mechanization on large farms is leading also to displacement of sharecroppers creating landlessness.

Landlessness

Notwithstanding the efforts by the past and present governments to mitigate the situation through land reforms and distribution of government land to landless still the grave situation persists. The situation continues because of the growing population and worsening land man ratio. Most of landless are in poverty trap due to limited access to land and elk a living by either working as sharecroppers or as wage labor in farm and nonfarm activities. In the absence of effective tenancy Act, these landless people are insecure and under constant threat of ejection. Also with increasing population, per person allocation of land to tenants is also shrinking. Landlessness, for housing, also discourages them from improving the living conditions. Those living on landlords land and or unauthorized settlements are under constant threat of ejection, hence are shy of engaging into an income generating activities.

Inheritance traditions, decreasing land entitlements

The area owned by farmers, particularly small farmers is continuously getting smaller due to inheritance and mutation. Because of the outmoded land record system, and petty tyranny of the revenue staff, particularly *tapedar* (revenue clerk/accountant) at village level, the land stays in

joint ownership in revenue records. Even if a shareholder wants to dispose off the land, it is difficult to do so under social pressure. As the land parcels become smaller and not enough to sustain a family, the individual shareholders have to access land in the neighborhood on sharecropping basis, or work as wage labor. This phenomenon is increasing the number of *defacto* landlessness.

Ineffective land reforms and insecure land entitlements

The past land reforms were partially effective. Most of the people complain that land reforms were ineffective in terms of implementation. The land was generally transferred to family members, living or yet to born, and in fictitious names, and the land effectively remained in most cases in fewer hands. The resumed land and other state land was also controlled and occupied by influential landlords. Many attempts to distribute land to the landless have been thwarted by fictitious allotments. As the land records system is still hand written and changes are not transparent, the true ownership is clouded in mystery. They proved ineffective in ensuring the security of tenure for the tenants.

The Tenancy Act requires that *tapedar* should enter the name of tenant in the land records when he enters such arrangement. The law also provides that if a tenant has been cultivated a piece of land for a period of three years he cannot be ejected and acquires permanent tenancy rights. As the entitlements are not secure, the landlord can eject the tenant at any time. Despite there is a Tenancy Act, the rights of the tenants are not protected due to its enforcement and compliance.

Shortage of irrigation supplies

In the lower parts of the Study area, the shortages in irrigation supplies have also reduced cropped area significantly in the lower reaches. This has at places forced the small cultivators to abandon their lands to either work as landless labor or migrate.

Seawater intrusion

In the southern districts, collapse of tidal link and consequent seawater intrusion has further decreased availability of productive cultivable land. The decreasing cultivation and farm intensities has further reducing the available land for cultivation and depressed productivity, even as tenants. The direct and indirect causes of land degradation coupled with increasing population, has increased the landlessness.

According to a report prepared by the World Bank (World Bank, 2005), the coastal villages used to rely on multiple sources of income based on their domestic resources. While fishing formed a large part of their livelihood agricultural and livestock activities were an important component as every family had access to some areas on a subsistence basis. The decline of the fresh water flows in the Indus Delta compelled the villagers to reduce their agriculture and livestock activities and concentrate in the fisheries sector as the main means of subsistence.

Cutting wood enabled families to meet their needs of fuel, as well as to supplement the income of the poorest households. The diminished availability of water accessibility combined with the salinization of the fields substantially reduced the sources of income the villagers had. Fishing became the most important source of income for many families, but it is unreliable as the number of fish species, which were in abundance in the past, has now declined and with much lower returns that it was possible for a decade or so ago. Having only one source of income made the villagers highly vulnerable, as they rely in the diversification of income sources. As a result migration took place. The World Bank indicates that the principal reason for out-migration is lack of drinking water and health facilities.

Poor access to social services

The access to education institutions, health facilities, and drinking water facilities are thinly spread. There is a need to increase their number which is in reasonable travel distance is required. The existing institutions also need upgradation.

Poor physical infrastructure

Lack of farm-to-market roads, adequate transportation facilities is one of the main constraints. The situation is further accentuated during floods. Animal carts, tractors and local transport are the only means of transport to get into markets. It was reported that the farmers have to incur high cartage charges to procure inputs and dispose of their produce in the local markets due to unavailability of transport. The expansion in farm to market roads would also encourage shift to higher value crops, particularly vegetables.

Absence of rural financial markets

The majority of farmers depend on informal sources for production loans. The development of nonfarm enterprises is constrained due to access to or absence of financial markets.

Low level of skills

It was also observed that most of the farmers are illiterate and uneducated. They generally lack skills for gainful employment within or outside the villages. Due to absence of skills, most of the landless work as unskilled labor, which is low paid and frequency of engagement is low. With acquiring of skills would enable the unemployed gainful employment and higher wages.

4.6.5.2 Impact on livelihood opportunities

The current economic situation of households is appalling and upsetting due to rising food insecurity. Poor families and vulnerable households face high commodity prices, food prices, health treatment prices and market prices. There is no proper functioning market system at grass roots to cash agricultural output. This also has effects on low utilization of agriculture inputs. Poverty is directly related to non-employment opportunities. There are few livelihood opportunities. Farming and livestock income is the main income generating sources. The uncontrolled market prices have created dreadful effects on daily household consumption.

Lack of economic growth coupled with the population growth, have raised the poverty level among poor masses. It was found that tenants under sharecropping arrangements had fewer incentives for investment in the protection of soil quality. A greater incidence of poverty was found in the tenant categories. In the light of findings, it was suggested to direct greater efforts towards the conservation of natural resources such as diversified crop rotations and incorporation of legumes in the cropping pattern. Mainly, it is necessary to overcome water shortage by which production can be raised. Due to water shortage, thousand acres of land is uncultivable and cultivators unable to cultivate cash crops. This issue has resulted in landlessness and insufficient livelihood opportunities. Basically, the highest number of rural and urban poor earns livelihoods from small-scale agriculture income and different modes of informal income generating activities based on short term and seasonal cycles. This has resulted in severe food insecurity and even raised the levels of malnutrition among both, adults and children.

The main effects on the community and households of the abovementioned factors include: low quality of life, food insecurity, poor health and malnutrition, work and school absenteeism, involuntary migration, broken families and related social problems including increasing lawlessness and crime rate, weakening of social protection system. Based on the data analysis, the

following recommendations given by communities need to be considered to prevent an increase in poverty in an environment of landlessness, to decrease land entitlements, improve access to existing services, and improve livelihood opportunities:

- Delivery of essential services and basic necessities of life should be delivered in order to reduce the burden of poverty in rural areas of lower Sindh.
- There is a need to improve health and nutrition, preventive hygiene and provision of safe drinking water especially in rural areas of lower Sindh.
- Efforts should be taken to improve the water supply scheme for drinking and irrigation water up to grass root level.
- Provide food security for poor families facing drought situation at the time of food insecurity due to less livelihood opportunities.
- Strong social protection measures should be taken with strong coordination system from District, taluka, union council and up to the Deh level.
- Ensure social protection for the indigenous population and particularly for those who are at extreme poverty in terms of basic needs of life, stability of jobs and food insecurity.
- School feeding programs should be implemented due to extreme food insecurity among poor families, so that children would at least have one nutritious meal. This will reduce malnutrition ratio and increase school attendance.
- The available state land should be distributed amongst landless, both for cultivation and for housing.
- Ensure rights of landless through effective implementation of Tenancy Act.
- As the Study area mainly depends on agriculture, the development of the agriculture sector should be at top priority. In response to this, sincere steps to improve the agriculture production could have immediate and direct impact on poverty reduction in rural area.
- Local markets should be empowered and well functioning in order to generate growth and expand opportunities of livelihood for poor people.
- Expand government job opportunities not only for skilled labour but also for non skilled.
- Effective policies should be developed to encourage labour market engagement in terms of fair prices, work opportunities, easy transport availability and investment from union council to District level.
- In order to ensure that the majority of the population do not fall into poverty, ensure the minimum social guarantees and minimum wages for the rural community.
- Establish the system of unemployment benefits at least for those, who are educated but unemployed, up to the minimum subsistence level.
- Provide professional trainings to the non-skilled labour force.
- Indigenous resources should be exploited to raise the income generating livelihood opportunities for the poor.
- Interest free rural financing schemes should be introduced by providing huge loans to reduce the poverty.

- In order to expand the livelihood opportunities, factories and mills should be established where local people could have opportunity to earn.
- Markets should be linked with villages through roads and transportation facility, so that people could have easy access to the markets.
- Expand and improve physical infrastructure.
- It should be ensured that farmers receive fair price for their farm production.
- It was recommended by the respondents that Government should start implementing effective poverty alleviation programs by involving local participation.
- There is a need to encourage and facilitate rural women for generating home based income activities.
- Handicrafts training centers should be established especially for women in order to create livelihood opportunities at Deh or at least at Union Council level.
- Empower local communities in order to increase their control over indigenous resource allocation process and accountability
- Indigenous participation should be ensured in the planning and decision making phase for the development programs that are supposed to be implemented at grass roots.
- Ensure a fair distribution of benefits, public funds and indigenous resources at grass roots level.
- Implement transparent with effective monitoring mechanisms with the establishment of real prices for food, medication, health and utility services.

Oil and Gas Resources in Sindh and Local employment

The natural resources production and exploration is administered by multinational companies with agreement of the Federal Government. Majority of the oil and gas fields are situated in arid regions of Sindh. These companies work on long term basis (25 to 30 years agreements), along with legal and other compliances. They have corporate social responsibilities known as social license to operate. Under this clause, companies are liable to employ 50% local inhabitants at all level as per their job requirement through company policy procedures and execute community development programs on sustainable basis in the communities where operated. Companies have to invest 2% pre-tax budget in the operated area. The local government representatives and DCO's are authorized to use that amount in local development at their discretion of the area.

A number of companies reflect a readiness to actively contribute towards the welfare of poor communities around them by providing education, health services, and technology access. However, it has been mentioned during consultations, that these efforts do not reflect the communities' needs. The potential for leveraging the enormous potential of corporate sector to alleviate poverty appears to be an area for government policy directions.

4.6.5.3 Ongoing livelihood development investments in the delta and coastal area

The socioeconomic study and proposals for livelihood improvement: Badin and Thatta Districts, Sindh, Pakistan (World Bank, 2005), undertaken following continued disasters such as cyclone of 1999, drought in 2000, earthquake in 2001, drought and floods 2003. The main havoc, *inter-alia*, was due to failure of the LBOD related drainage infrastructure, resulting backflow of drainage effluents in the main drains, salinity of the productive farm land, salinization of the freshwater

bodies, and sea encroachment, destruction of physical infrastructure, etc. The report concludes that more than 85 percent of the population perceives themselves as poor. The report proposed following initiatives: i) better access to basic services and facilitating infrastructure; ii) higher income generation through improved production and marketing of saline agriculture crops, fisheries, and livestock; iii) secure access to, and better management of the coastal area natural resources; iv) viable community organizations that can operate in partnership with the public and private sector and NGOs; and v) improved access to high quality education, information, training and netter nutrition and health.

The report recommended two components, i) community investment fund (CIF) to be implemented through rural support programs and other partner NGOs; and ii) mangrove rehabilitation and ecosystem management to be implemented through IUCN, WWF, provincial forest department and other related agencies. The subcomponents proposed under the CIF component to include: a) mobilization of Community Organizations (COs) where such organizations do not exist and, strengthen existing ones in order to promote demand-based development initiative and for getting active community participation and ownership; training and orientation of the key office bearers and members of COs; b) advisory services in saline agriculture, i.e., dissemination of plant and crop varieties that Pakistani researchers and researchers from other countries have identified as suitable for saline water agriculture; c) social services: construction of primary and secondary schools with adequate equipment and furniture, books and teaching materials, etc., rural health centers and mobile clinics, reconstruction of residential houses that were destroyed by flood and cyclone; d) water supply and sanitation: functioning water supply schemes and promotion of hygiene and sanitation; e) community based fishery management: includes assistance in training, management of fishing facilities, introduction of concept of community-based coastal resources management, preparation and implementation of fishery management plan, development of local fishing regulations and licensing and enforcement mechanism; f) support for coastal aquaculture: assist the COs involved in fishery to explore the potential for high value marine products such as shrimp, mussels, etc.; g) construction of wharfs/jetties, provision of fishing boat and improvements in landing fish: rehabilitate and construct wharfs and small jetties, on selected landing centers; provide essential infrastructure such as water supply, offices and small storage facilities; to improve fish landing, each landing centre equipped with a chilled store; ice maker with store and fish store; h) support for improvements in marketing and processing: streamlining the marketing chain to create value for COs involved in fish production and marketing; provision of marketing facilities; assist in establishing fish processing plants or facilities; and i) rural road and rural electrification: upgrade existing road networks and construct new roads; increase access to electricity to improve living conditions, improve the delivery of basic social services such as health, education and water supply and, spur economic development in the area.

The Sindh Coastal Areas Development (SCAD) Program was initiated by Pakistan Poverty Alleviation Fund (PPAF) in 2006 with financial support of the World Bank as a vehicle to improve livelihoods of coastal communities of Sindh in general and the communities affected by the Left Bank Outfall Drainage (LBOD) in particular. Although an independent PPAF initiative, SCAD is regarded as a targeted and urgent response to the Inspection Panel's investigation report which strongly emphasized the need to address multifarious environment and water management problems in the Sindh coastal areas, in particular, the *LBOD Backwash Region* (LBR) in the districts of Badin and Thatta.

The SCAD program area encompasses 52 union councils and 12 sub-districts (tehsils) of four coastal districts (Karachi, Badin, Thatta and Tharparker) of Sindh, covering approximately 3,350 settlements and a population of over 1.12 million. The aim of the program is to:

- improve access to basic services
- increase incomes through improved crop, fisheries, and livestock production
- secure access to, and better management of natural resources of coastal area
- form viable, inclusive and well governed community organizations
- integrate coastal areas of Sindh with the national economy
- promote technological innovations
- reduce physical vulnerability

PPAF has a long term commitment under the SCAD program and plans to invest more than US$ 35 million by year 2014, under its different phases. Currently (March 2011) the program is in its 3rd phase and over USD 23 million have so far been invested under the various components of this program. The program is mainly funded by the World Bank. However, the Program received some bridge financing from other funding agencies including the United States Department of Agriculture (USDA) and International Fund for Agriculture Development (IFAD) during a short term gap between the two consecutive phases of the World Bank. The program continues to prioritize the LBOD Backwash Region with allocation of over 65% of its total financial resources. SCAD Program comprises of the following components:

a. *Social Mobilization and Institutional Development;* covering the formation of community/village/ union council level organizations, and capacity building of the community as well as the implementing partner organizations
b. *Infrastructure Development;* includes developing rural growth centers, constructing protective infrastructure, constructing productive infrastructure, developing transport and mobility, promoting technological innovations, and integrating workfare concepts in infrastructure projects
c. *Health and Education;* involves adopting, upgrading and operating government facilities, and developing new community managed facilities
d. *Workfare;* includes labour intensive nature of infrastructure, lower than normal community contribution, and first right of refusal to participating community
e. *Social Safety Nets: Targeting the Ultra Poor (TUP); covers* selection and training of ultra poor household, asset transfer, subsistence allowance, and special health care allowance to the selected ultra poor household.

PPAF is implementing this program through matured Partner Organizations (POs). Linkages are established with other projects in the area including Sindh Water Sector Improvement Project (WSIP) and Sindh Coastal Community Development Project (SCCDP) as well as institutional linkages with the Sindh Irrigation and Drainage Authority (SIDA) and the Sindh Coastal Development Authority (SCDA).

The Sindh Coastal Areas Network (SCAN) was established in coordination with PPAF. SCAN is working as a participatory platform for SCAD participating POs, as its regular members, to promote exchange of views, experiences and building synergies to better implement the SCAD Program. For close institutional linkages and coordination, SIDA and the World Wide Fund for Nature in Pakistan (WWF-Pakistan) are also co-opted as its associate members.

In 2008, the Sindh Coastal Development Authority launched a $40 million Sindh Coastal Community Development Project. The project duration is six years. The main objectives include: i) to diversify household income generation options and access to service in ways sustainable to the fragile ecosystem; ii) to improve coastal zone management by stabilizing environmental degradation, protecting coastal areas from accelerated coastal erosion; and iii) to strengthen

institutional capabilities for coastal zone planning and development and management of fisheries resource. The main components include: i) improve coastal area management including mangrove planting, fish and raft pond development, and hatchery rehabilitation; ii) community development including: community organization, demand-driven small-scale community-managed initiatives, and demand-driven local government-managed medium scale initiatives; iii) institutional strengthening, including survey of fisheries fresh/brackish water and water quality survey, capacity building support for CDA management and district governments, developing geographic information system (GIS), preparation of coastal development plan, and monitoring arrangements; and iv) establishment of PMU and field offices. The small scale community managed initiatives is being implemented through a contract to National Rural Support Program, while demand-driven local government-managed medium scale initiatives is being implemented by the Badin and Thatta district governments.

4.6.5.4 Indicative structure/design frame of the livelihood development support

The TORs for this Study require the Consultants to "develop implementation arrangements; give structure for developing livelihood activities, to ensure the social aspects of the project are adequately addressed during the assignment the Consultant will also develop detailed implementation arrangements such as monitoring indicators, targets, baseline data collection and analysis, and give the structure for developing an implementation manual for livelihood activities in the coastal and delta areas."

This has been accomplished by constructing an indicative design frame for the purpose. This is based on a review of various documents and Consultant's findings from studies undertaken and observations made in the field, and comments and suggestions gathered from the stakeholder consultative workshop. The table below summarizes the likely design frame for the initiative. This will be further developed in consultation with stakeholders, particularly CDA.

Table 4.6.2: The Indicative Design Frame

Design Summary	Performance Targets/Indicators	Data Sources/Reporting Mechanism	Assumption and Risks
Impact Lives of the delta and coastal communities improved and vulnerable protected from food security risk	The targets will be ascertained based on consultation with Sindh Coastal Community Development Project, and after ascertaining the remaining gap and additional resources required	Periodic performance and impact assessment surveys	**Assumption**: Adequate funding support is made timely available from the GoSindh and development partners Drainage infrastructure is in place **Risk** D/S water discharges are not adequate and mangroves area is may not be rehabilitated
Outcome **Increased Household Income;** **Improvement in social indicators**	Increase in household income; Improvement in social indicators		**Assumption** Communities are cohesive and benefit from new opportunities Adequate funds are allocated for social infrastructure and its operation

Design Summary	Performance Targets/Indicators	Data Sources/Reporting Mechanism	Assumption and Risks
			Risk Inadequate funding for social infrastructure Poor support for sustainable community mobilization Vagaries of nature. Major macro economic shocks
Outputs 1. Baseline and diagnostic cum need assessment studies 2. Introduction of biosaline agriculture to produce appropriate crops, fodder and feed, and tree crops 3. Extension services for improved agriculture and animal husbandry 4. Community mobilization 5. establishing social protection networks and support 6. Construction of community based infrastructure including fish markets, cold chain for fish, transportation of fish catch, spur roads 7. Improved link roads 8. Skill development program in boat building and repair, net making, and other trades 9.. Enterprise development and access to microfinance 10. Capacity building of stakeholders and service providers 11. Early warning system 12. training in preparedness for natural calamities 13. Awareness programs for judicious use of natural resources such as mangroves, grazing lands, forests, preservation of wildlife 14. Impact assessment surveys.	1. Accomplished within 6 months of commencement 2. Number of ha planted and output 3. Number of communities visited and messages conveyed 4. Number of CBOs established and matured 5. Number of beneficiaries 6. Number of infrastructures completed 7. Number, type, and length of roads improved 8. Number of trainees 9. Number of enterprise supported and amount of credit made available 10. Number of training provided and persons trained 11. Early warning system established and its performance 12. Number of training provided and number of trainees 13. Number of orientation session, outreach material, and area preserved 14. Conducted each	Monitoring and impact assessment surveys	**Assumption** Adequate funding is available Communities are mobilized Effective linkages are established between communities and nation building departments and service providers **Risks** Inadequate funding from public sector Communities are not responsive and risk averse

Design Summary	Performance Targets/Indicators	Data Sources/Reporting Mechanism	Assumption and Risks
	year and benefits quantified.		

4.6.5.5 Implementation arrangements

In view of the two ongoing projects, with an investment outlay of $75 million, it would be advisable not to undertake additional initiative to improve livelihood in the delta and coastal area. This would be duplicating the efforts and resources. Both the institutions, PPAF and CDA are implementing their respective projects through parceling out the components to partner Rural Support Programs, NGOs, and district governments. If SIDA undertakes such initiative, given the capacity at SIDA and lack of experience, will also have to act as conduit or clearing house, similar to PPAF and CDA, for its implementation.

During a meeting with CDA it was learnt that they have commissioned a baseline study to map out the current socioeconomic conditions, and are planning to undertake a study to prepare an integrated development plan for the delta and coastal area. Once these studies are in hand, assessment will be made, during the later phase of the Study to identify the gaps and areas of intervention, scope of intervention, financing requirement, and mode of financing, etc. Pending this, the detailed preparation of a livelihood development initiative by SIDA along with its implementation arrangements and implementation manual, is recommended to be put on hold.

4.6.6 Socioeconomic Goals of Flood Management

The flooding events experienced by the Sindh population during the last decade, mainly the 2003 and 2006 events related to the LBOD overtopping and breaching the embankments and the 2010 Indus River super flood, have raised a number of questions as to the approach being followed by the authorities and agencies in charge of disasters and flood protection. The modern approach is to control the physical environment threats with modern technology and organized society, making it possible to control the physical and climatic factors, aiming to minimize people's displacement and suffering and economic losses by reducing the population's vulnerability.

The difficulty of properly reacting to catastrophic floods in a complex and fast-changing socioeconomic environment became obvious during the LBOD floods in 2003 and Indus River super flood in 2010. The floods are socioeconomic events that extend beyond the mere hydrological and hydraulic phenomena, which comprise long lasting consequences on the livelihoods and wellbeing of the local population and the Country as a whole.

The fast-changing socioeconomic environment, such as urbanization, industrial growth and deforestation aggravate the magnitude, frequency and intensity of the flooding phenomena by increasing the vulnerability to floods to an ever growing population.

Flood control structural measures, such as bunds have significant impact on the populations' socioeconomic aspects. Structural interventions have positive and negative effects on people's life. Structural interventions benefit the local population during construction by providing them with jobs and by providing them with protection to flooding, thus a safer place to live, to work and to practice agriculture. However, structural interventions can also motivate the conversion of agricultural land to residential and industrial use, thus making a significant impact on people's life, by helping some increase their profit and displacing others or forcing them to change their activities. Also, land acquisition activities tend to make people unhappy by dividing their land and

making it difficult to move from one place to the other and also because the cumbersome paperwork required to get compensation.

The major floods in the Indus plain have time and again has devastated human lives, farmland, and both public and private properties including housing, physical, productive, communication infrastructure, livestock, and vital installations. The main impact is on the livelihoods of the affectees, particularly poor and vulnerable population living in the rural areas. This also have a slow down effect on overall national productivity, and adverse impact on the socioeconomic growth of the poor and marginal, particularly living in the rural areas. The floods, if not managed effectively, leads to increase in the poverty incidence, and decrease in social indicators, especially related to education, health, malnutrition, sanitary conditions, and availability of clean drinking water.

To mitigate and minimize the adverse impact of flood damages, the flood management programs and strategy, in addition to technical/structural measures, also need to focus on the nonstructural measures to ensure sustained socioeconomic levels, and minimum vulnerability to the livelihood capacity of the flood prone communities. The strategy should also give emphasis on minimizing the adverse impact on women and children who are the most affected.

The main elements of the nonstructural measures to minimize the adverse impact of floods include:

- Support to farmers and livestock herders through provision of essential factors of production to jumpstart the economic activity;
- Rehabilitation and extension of mangrove areas to serve as biological wall to retard sea intrusion and erosion.
- Relocation and redesigning of social infrastructure which acts both as temporary refuge during floods and able to provide uninterrupted services;
- Standard Action Plan for the rehabilitation and restoration of physical, productive, and communication infrastructure that is essential for the restart of the livelihoods;
- Capacity building of the flood prone communities to take part in the restoration and rehabilitation of infrastructure to receive of food for work assistance rather than dole outs;
- Support to nonfarm workers and entrepreneurs through rural credit and technical training.

Historically, the socioeconomic activities have been along the waterways. Floods, a natural phenomenon has both its benefits and costs. They had been seen as a blessing for flood plains, replenishing topsoil, recharging underground aquifer, natural storage into lakes, etc. However, with the population pressure and consequent demand for farm land, close to water sources, has made the human lives, farm land, dwellings, livestock, social, productive, and physical infrastructures vulnerable in the event of extreme flooding. This increases the risk of negative impact on the human lives and livelihood and socioeconomic wellbeing. Integrated flood management can provides insurance against the flood disasters, and play a protective role to maintain socioeconomic conditions.

Depending upon the intensity and frequency of water disasters, the extremes take its toll from what it comes in its path, and leaves behind quantifiable and nonquantifiable economic damages. In addition to the economic losses, environmental aspects are also important, if they have negative externalities.

The economic losses due to vagaries of water disaster encompass loss of lives, adverse impact on social wellbeing, loss of assets, and environmental degradation. Apart from irreversible human losses, the mismanaged water hazards take its toll by slowing down the economy. Any integrated flood management therefore needs to have well defined goals. The goals should include safeguards against:

- loss of life, which otherwise have social consequences including psychological;
- damage to farmland, standing crops, and grains stored in houses;
- damage to livestock which is source of dairy products, particularly for children, meat, draft power for agriculture, and important assets for the poor and small farmers;
- damage to houses, particularly rural houses;
- restrained access to food, education and health facilities;
- interrupted supply of fodder for livestock;
- damage to productive infrastructure, such as irrigation and drainage networks, tubewells, ponds, and lakes, particularly those which provide livelihood to fisherfolks;
- damage to social infrastructure, such as buildings for education, health, domestic water supplies, and sanitary and sewerage disposal system;
- damage to physical infrastructure, such as public utility buildings, storages, particularly grains, bridges, roads, railroads, airports, etc.;
- damage to vital installations, such as communication towers, power houses, power lines, etc.
- damage to industrial and other nonfarm activities.
- damage to water bodies; pastures, and grazing lands.

The above socioeconomic goals of flood management is to ensure that the national/regional pace of growth, livelihood, food security, employment rate, and other socioeconomic indicators, is not adversely affected or stalled, and that the vulnerability to the threat is minimized.

4.7 SOCIAL ISSUES OF DRAINAGE OPERATIONS AND FLOODING

4.7.1 Background to the Thematic Area Study

Regional Master Plan issues and problems concerned with related social issues were identified through study and assessment of social activities and from stakeholder consultations. This was accomplished as required by the four tasks given in Table A.

Table A – Topics Outline for Summary of the Thematic Area 7 Study

Topics of Concern for Phase-I Studies	
Subjects Covered	**Phase-I Tasks Included**
VII - Social Issues relevant to Drainage Operations and Flooding	
• Stakeholder consultations	T-18: Document and review poverty assessments in lower Sindh T-31: Develop methodology and plan for consultations with

Topics of Concern for Phase-I Studies	
Subjects Covered	**Phase-I Tasks Included**
• Stakeholder interventions • Poverty	stakeholders T-32: Design interventions with key stakeholders T-34: Carry out consultations, with local and provincial/national workshops, to finalize the Phase-I study report and to develop a shared understanding of issues that should be addressed in subsequent stages of the study

4.7.2 Approach and Methodology

The main objective of this phase of community consultations is **to assess poverty in the Lower Sindh and identify Project relevant issues/problems and get communities' views and opinions.** In accordance with the stakeholders consultations objectives, the data collection and analysis required a primarily qualitative approach. The literature consulted in determination of the methodological approach indicate qualitative approach as the most appropriate for the set objectives:

Everet and Louis (1981) define qualitative approach as "inquiry from the inside" and quantitative approach as "inquiry from the outside".

"*These approaches differ in the degree of the researcher's immersion in terms of experiential engagement, direct contact with the subjects, and physical involvement in the setting. In the "inside" or qualitative approach, the researcher aims for a holistic picture from historically unique situations, where idiosyncrasies are important for meaning. The researcher uses an inductive mode, letting the data speak. In contrast, traditional "outside" or quantitative researchers aim to isolate the phenomenon, to reduce the level of complexity in the analysis and to test hypotheses derived previously."* (Cited in Sonia Ospina, 2004)

In addressing the tasks and objectives stated in the Terms of Reference, the Consultant formulated the methodology which would realistically cover the Project area and issues relevant to the Project. In order to cover a large geographical area and a number, diversity and complexity of issues, a multi-dimensional methodological approach was adopted for the consultations with communities and poverty assessment. The approach focused on: a) location, b) persisting issues, c) current flooding issues and d) extreme poverty.

1) Location

The Project area is divided in three Area Water Boards. Each Area Water Board is represented in the sample by the number of consultations with stakeholders at district level and number of villages from different districts. The districts located outside the Area Water Board are also represented in the sample.

2) Persisting issues

Population residing in different parts of the province faces different problems. To ensure representation of villages facing different problems, a focus on persisting problems was applied.

3) Current flooding issues

The enormous current flooding affected a countless number of villages and settlements across the Project area. A number of currently affected villages are included in the sample.

4) Extreme poverty

Poverty has remained one of the most serious problems of Pakistan- over one third of the population is living under the poverty line. About forty-four percent of population is below the poverty line on the human poverty index (UNDP, 2002). Although governmental bodies, local and international NGOs, and international organizations operating in Pakistan have made eradication of poverty a top priority and have operated many social development programs, poverty has been on a rise when compared to the level of 26 percent in 1988 (GoP, 2003). A significant proportion of Pakistan's population does not have adequate quantity and quality of food, access to basic services and opportunities and hence are particularly vulnerable to economic, environmental and political shocks. Sixty five percent of Pakistan's population lives in rural areas and majority of them live below the poverty line (World Bank, 2002). Poverty is especially spread in the Lower Sindh region.

4.7.2.1 Sampling Design and Sample Size

A feature of qualitative sampling is that a small number of cases are sampled. The data aim for depth as well as breadth in understanding Project related issues as seen through the eyes of the affected people. The corresponding sample methodology involved non-probability sampling as it did not aim to produce a statistically representative sample or draw statistical inference. The targeted phenomenon/issue needs only to appear once in the sample. Nevertheless, relevant quantitative data on the village level were also collected and analyzed in this study. Literature consulted on sampling methods and sampling size outlines the differences between qualitative and quantitative approach in phenomena researched:

"Purposive sampling, one of the most common sampling strategies, groups participants according to preselected criteria relevant to a particular research question… Sample sizes, which may or may not be fixed prior to data collection, depend on the resources and time available, as well as the study's objectives. Purposive sample sizes are often determined on the basis of theoretical saturation (the point in data collection when new data no longer bring additional insights to the research questions)… Even if it were possible, it is not necessary to collect data from everyone in a community in order to get valid findings. In qualitative research, only a sample (that is, a subset) of a population is selected for any given study… Purposive sampling is therefore most successful when data review and analysis are done in conjunction with data collection." (Family Health International, Qualitative research method)

In order to fairly cover the whole Project area (including the districts outside the Area Water Boards) and to ensure representation of rural and urban/semi-urban population which faces different problems, a purposive sampling within a multi-dimensional approach was considered as one of the most applicable approaches to address the aims of the defined tasks. The combination of methodological tools enabled reasonable insight into communities' perceptions about contemporary problems, causes of the persisting poverty and problems and their concerns and suggestions about the effects of Project related issues on their livelihoods.

A broad range of issues and corresponding villages were identified across the Project area. Identified issues were grouped into a few main categories which served as the selection criteria for villages which could comprise the village sample. Overall, pre-identified issues were grouped into seven major categories: water shortage, water logging, safe disposal of drainage water, salinity, sea

intrusion, LBOD/drainage effects and current flooding. Consequently, seven village sample selection criteria were set.

Each of the seven major issues are represented by one or two villages (depending on severity of issues in a particular area). The largest sample was assigned to the Left Bank Area Water Boards mainly due to the most severe effects from the LBOD and the recent flooding in districts Badin and Thatta. Districts outside the Area Water Boards are represented by one or two villages. In total, 36 out of 61 identified villages were chosen to comprise the sample for the LBOD/Drainage issues/problems study. The selection of a sample village within identified villages was determined according to issues prevailing in each area.

All eight districts in the Lower Sindh are covered by consultations on poverty. Based on the criteria for identification of rural areas, stakeholders, UC offices and local NGOs helped to identify rural Union Councils in each district. One Union Council in each district and one Deh in the sample Union Council were selected randomly. Representatives from each village in a sampled deh participated at consultations. Overall, 40 villages from the area were consulted in the poverty assessment.

4.7.2.2 Data Analysis

In accordance with the applied qualitative methodology and choice of sample size, the data collection and analysis required a primarily qualitative approach which "…*provides sufficient description to allow the reader to understand the basis for an interpretation, and sufficient interpretation to allow the reader to understand the description" (Patton, 2002, p.503-504)".*The data aim for depth as well as breadth in understanding of the Project related issues as seen through the eyes of the affected people.

The primary data collected during the community consultations were analyzed using qualitative content analysis. Qualitative content analysis focuses on unique themes that illustrate the range of the meanings of the phenomenon. It involves a process designed to condense raw data into categories or themes based on valid conclusion and interpretation. This process uses inductive reasoning, by which themes and categories emerge from the data through the researcher's careful examination and constant comparison. The process of qualitative content analysis began during the early stages of data collection. The early involvement in the analysis phase enabled the researcher to move back and forth between concept development and data collection, and helps direct the subsequent data collection toward sources that are more useful for addressing the research issues.

Information gathered through consultations with stakeholders, open consultations with communities, key informants' interviews, focus group discussions, case studies, informal interviews, open-ended questionnaires, filed notes analysis and observation, were complemented by related information derived from government population censuses and relevant studies and reports.

The basic unit of analysis was a community message which expresses the basic idea to be classified under the content analysis. Messages were unitized into individual themes (issues) which served as the unit for analysis.

4.7.2.3 Selection of Data Sources and References for the Thematic Area Study – Primary and Secondary sources

In order to identify the main issues relevant to the Project area population, the Consultant pursued multiple secondary sources of information. The sources include various reports and studies relevant for the Project, census data on population, consultations with resourceful local individuals

and news and websites articles. The secondary sources were of the utmost importance for identification of the core issues as well as for setting the appropriate communication strategy and methodological tools for interaction with communities and stakeholders.

The major related issues within communities have been pre-identified and grouped. The identified issues served as the platform for discussions with communities. To identify the most severe issues, the Consultant pursued practical steps and gathered information from numerous secondary sources. The following actions were undertaken and sources consulted:

- Revision of various reports and studies about the Project area
- Pre-flood visits to Kotri Barrage and surrounding area
- Visits to flooded or flood critical points and barrages (Guddu, Ghotki, Sukkur, Kotri, Bhanot and Khyber)
- Visits to the Tidal Link
- Information from numerous NGOs working in different parts of the Project area
- The Consultant's local staff knowledge and experience and
- SIDA's field staff knowledge and experience

4.7.2.4 Primary Data Collection

The primary data collection included workshop consultations with stakeholders, open community consultations with males and females, focus groups discussions with males and females, case study, open-ended questionnaires, key-informant interviews and observation in selected villages.

Before commencing the consultations at workshops with stakeholders and in villages with the local population, the Consultant conducted one information session. The objective of the sessions was to inform the participants about the scope and objectives of the Project, the objectives of the community consultations, and to discuss issues and concerns relevant to the Project objectives. A Power Point presentation or A1 flip charts were used at workshops. A verbal introduction to the Project and the purpose of consultations were used in the sample villages. The team encouraged the participants not only to list the problems and issues relevant to the Project but to express their perception and to give their suggestions and recommendations about the implementation of the Project.

4.7.3 Communication Strategy used for the Study

The community consultations were planned in close cooperation and shared with SIDA social team and numerous NGOs working in the Project area. The first step was a preparation of the communication strategy. The strategy draft was shared at a few workshops with stakeholders. The particular input at the group discussions was related to access to village women and the best approach and tools to be used at consultations with village communities. Their suggestions and opinions were incorporated and applied during the following consultations with communities.

The foundation of the communication strategy suggested for this Project is primarily the grassroots communication approach. The approach supports and strengthens peoples' ability to formulate their problems, to suggest appropriate solutions and to shape possible resolutions of the identified problems. Furthermore, the set communication strategy reaches other levels of stakeholders by articles and press releases in the local newspapers and electronic media communication such as the website post and email communication. Such a communication environment should make Project

interventions possible, more effective and ensure engagement of the stakeholders and wider audience.

Planning communication activities as a support to the Project is the central point in our approach. It aims to create a common understanding among all participants in the Project initiatives. The communication activities emphasize:

- identification of communities' needs and problems related to the Project
- facilitation of exchanges of points of view among the various stakeholders involved
- taking into account perceptions of the affected communities' in the planning of the Project and
- mobilizing communities and other major stakeholders in the development activities set out in the Project

This kind of communication moves away from informing communities and to persuading them to play a role in the Project activities planned by someone else. Instead, it facilitates exchange of ideas, perceptions, opinions and solutions between different stakeholders.

4.7.3.1 Communication objectives

The central part of the proposed communication strategy is communication with communities at village (distinctive groups) level. The main objectives of this approach are to:

- inform communities about the Project
- encourage active involvement of different community groups and foster partnership and community ownership of the Project
- engage communities in identifying the Project related problems and suggesting solutions
- engage communities in identifying poverty causes and suggesting solutions
- record as many dimensions and potential solutions as seen by the communities
- decide on actions communities want to see implemented
- identify communities' willingness and readiness to participate in all Project phases
- engage communities in setting the communication systems which will serve as the platform for interactive exchange of information between different stakeholders
- enable affected communities to make relevant Project planning decisions and to ensure community monitoring of different Project phases.

In order to achieve the set communication objectives, a variety of communication tools and approaches have been planned and used at various stages of the consultations with local communities and other major stakeholders. The following communication tools were planned: Larger group discussions, focus group discussions, case studies, PowerPoint presentation or/and posters/flipcharts and mass media tools.

Summary of communication methods used are given in the following table:

Table 4.7.1: Communication strategy

Type of communication	Purpose of communication	Target groups	Number of interventions
District workshops	Genuine involvement of the local stakeholders, identification of issues/solutions	District/AWB/regional stakeholders	17
Regional workshops	Share Phase I findings Engage targeted major stakeholders Secure support to the Project Exchange of ideas/suggestions	Targeted NGOs, line departments and other major stakeholders	(1) Hyderabad,
National workshop	Share Phase I findings Engage targeted major stakeholders	Targeted NGOs, line departments and other major stakeholders	(1) Karachi
Project pamphlet	Disseminate Project information	District offices	10,000 in Sindhi, 1,000 in English language
	Engage more stakeholders	NGOs, FOs, CBOs	
	Foster transparency and accountability	Line departments	
	Maintain visibility of executing agencies	Women's associations	
Press release in Jang, Kawish and Dawn	Disseminate Project information Engage larger audience	Large Project area audience	Minimum 3 articles
Newspaper supplement with questionnaire *(Planned for Phase II)*	Identification of solutions	Large Project audience	1
Radio program *(Planned for Phase II)*	Disseminate Project information Engage non-consulted communities Maintain visibility of executing agencies	Large Project area audience	Minimum 3 airings
TV airing *(Planned for Phase II)*	Disseminate Project information Engage the non-consulted communities Maintain visibility of executing agencies	Large Project area audience	2
Hotline	Endorse meaningful communication - feedback Encourage Project ownership Engage larger audience	General public interested in the Project	1
Email	Endorse meaningful communication and exchange of ideas/suggestions, get feedback Project ownership Engage Stakeholders/Community members	General public interested in the Project (with access to internet)	1 account
Website (linked	Disseminate Project information	Major stakeholders	1

Type of communication	Purpose of communication	Target groups	Number of interventions
to the SIDA's website) *(in process)*	Engage stakeholders/Community members		
Face to face meetings	Feedback	Stakeholders / affected communities	As needed
	Exchange of ideas/suggestions		

4.7.4 Stakeholder consultations

The process refers to the full and equal involvement of men and women of all ages, backgrounds and social status in the decision making processes, especially in activities which affect their lives and lives of their communities. Women and other vulnerable groups are often excluded from the decision making process particularly in the public spheres. The meaningful community participation assumes systemic learning processes which will lead to action and change.

It was essential that all major stakeholders were identified and given the opportunity to be involved and informed regarding the Project, the irrigation and drainage issues and potential structural and non-structural solutions for the current issues/problems. Open public consultation sessions, workshops and other systems for receiving comments are indispensable for encouragement and opportunity for any interested parties to access information about the Project and to express their opinions, suggestions and recommendations relevant to the Project.

As already underlined, a meaningful community and stakeholders' engagement goes beyond formal dissemination of the Project information or people's pro-forma voicing their opinions. It should build trust, rapport and understanding between the stakeholders and to ensure that the perspectives and realities of the Project beneficiaries are integrated into longer-term strategies and concrete actions.

The consultations with communities and other major stakeholders were conducted on five levels: grassroots level, district level, Area Water Board level, regional level (to be conducted) and national level (to be conducted).

There are 3,259 villages/settlements in the Project area (UNOCHA 2010 and PCO). The Consultant accessed 148 villages, which represent about 4.5% of the sample universe. Each of fifteen districts in the Project area , and each of the three Area Water Boards were represented in the consultations on the Project issues and problems. The consultations involved the collection of primarily qualitative data from primary sources. The consultations were conducted at five levels: grassroots level, district level, Area Water Board level, and regional and national levels (to be conducted).

Community consultations were conducted topically for specific issues. Consultations were conducted for: 1) LBOD/drainage issues and problems in 36 villages, 2) poverty issues in 40 villages of Lower Sindh, 3) economic and livelihood issues in 60 villages and 4) environmental issues in 12 villages **(Table 4.7.1).** Moreover, the Consultant made almost 200 reconnaissance trips across the Project area. More than 300 different organizations, NGOs, CBOs etc. were represented at consultations and over 5,000 stakeholders were directly consulted in the first phase of the Project. The area directly accessed for consultations represents over 300,000 residents.

The consultations with stakeholders and affected communities include the following: workshops with stakeholders, open community consultations with sample village population, focus group discussions and key informant interviews.

1) Workshops with stakeholders

In order to cover a geographically large Project area, the Consultant organized and conducted stakeholders' workshops in the following districts: Badin, Thatta, Umerkot, Tando Muhammad Khan, Hyderabad, Mirpurkhas, Tando Allahyar, Matiari, Sanghar, Ghotki, Sukkur, Naushero Feroze, Shaheed Benazirabad, and Khaipur. The stakeholders came from a variety of organizations and groups such as farming communities, fishermen, villagers, urban populations, non-government organizations (NGOs), water user groups, groups interested in environmental and social issues, women's groups, civil society organizations, universities, local media and others. Over 300 organizations, NGOs and Civil societies were represented at the stakeholders' workshops.

To achieve transparency, continuity in the stakeholders' participation and to encourage ownership of the Project, the Consultant shared the workshop records, notes and photographs with the participants and asked them to review the records, fill in the gaps in the information and give additional comments and opinions. (Appendix 7.3) These actions were taken for the sake of thoroughness and partly in response to specific observations of those consulted. Selected specific quotes are:

'We request that the suggestions of these discussions should not be thrown into the dust bin. At least please forward these suggestions to the concerned quarters'. (Stakeholders, Sanghar)

A participant from the Mirpurkhas workshop wrote:

'*Trillions thanks for sharing proceeding of Mirpurkhas Workshop. It was very informative, interactive and subject oriented workshop. It were abilities of facilitators who kept participants around the topic. That is why in one day, we discussed lot on water sector improvement. As we all were local participants, so we shared our views and suggestions in local languages…Our findings are reflecting theoretical perspectives. We should find out what happened practically in normal conditions and in flood conditions. We should share with participants historical background and then require their opinion'.*

2) *Open community consultations*

Open community consultations were conducted in 36 sample villages in the fourteen districts of the Project area. Villagers were informed about intended community consultations a minimum of one day prior to consultations. Usually, an NGO working in the area was engaged to inform villagers about the consultations and to help in organizing the meeting. The participants were verbally informed about the Project and the objectives of the consultations with them. Overall, 70 open community consultations for 36 villages in fourteen districts were conducted.

3) Focus Group Discussions

Focus group discussions were planned to be conducted with village women. The objective of these discussions was to ascertain women's perceptions of problems and issues related to the Project benefits. Out of the 36 visited villages, only two focus group discussions on Project related issues with women were conducted. In the rest of the sample villages, open community consultations were conducted with women as great number of women requested to participate. Poverty assessment was based on the focus group discussions with representatives from each village in a sampled deh. In total, the poverty assessment included 8 focus group discussions with men and eight with women.

4) Key Informant Interviews

Additional information on the village population, available basic services in the villages, distance and access to services outside the villages, information on the village poor, landless, education, health etc, was collected from the key informants. The Consultant conducted 36 such interviews; one in each of the sampled villages. In addition, eight key informant interviews were conducted at eight dehs for assessment of poverty. The matrix for village data collection was prepared in advance. Usually, the key person was the village headman, a wadera, a local teacher or any other educated and/or well informed person.

5) Case Studies

To complement findings obtained through the focus group discussions on poverty, the Consultant conducted 16 case studies, 8 with women and 8 with men. The focus group participants chose the poorest members among the participants for the case studies. The case studies thus are narrative and document life in poverty as experienced by the poorest.

Table 4.7.2: Summary of the Consultant's Field Activities

Study	No. of Work shops	No. of Key Informants	No. of Community Consultations	No. of Case Studies	No. of Reconnaissance trips	No. of Villages	No. of Participants	Estimated population
LBOD/ drainage	19	36	72	0	108	36	3,689	79,364
Poverty assessment	0	8	16	16	30	40	296	98,500
Environmental study	0	0	12	0	41	12	846	10,000
Socio-economic study	0	0	0	0	15	60	633	102,060
Total	**19**	**44**	**100**	**16**	**194**	**148**	**5,464**	**289,924**

(*One regional and one national workshops will be conducted before the finalization of the report)*

In addition, 10,000 Project pamphlets in Sindhi and 1,000 in English were distributed. (Appendix 7.3) A hotline number for public questions and comments and an email account for stakeholders' comments/ opinions were established. Individual feedbacks were incorporated into community consultations records and in the final analysis of the stakeholders/community consultations. The stakeholders request continuity in meaningful engagement and consequential actions to follow.

Preliminary findings from the first round of community consultations were shared with stakeholders at the workshops organized by the Consultant in November 2010, March and April 2011. The workshops' outcomes were analyzed and used for fine tuning of consultations strategy, refining of the methodology and tools used at the consultations, focusing on under-represented community issues and problems in the Consultant's approach and sharing the findings on issues identified.

4.7.5 Key Findings of the Thematic Assessment

The following are the main issues brought up at the community consultations.

4.7.5.1 LBOD/ Drainage System

The opinions of the stakeholders and communities about the LBOD are divided. Those who benefited from the LBOD expressed a positive opinion, while those who experienced negative effects, the communities from Badin and Thatta districts in particular, are angry and frustrated. According to the communities experiencing negative effects, the LBOD water became poisonous, it has deprived thousands of families of their source of livelihood, caused displacement of the villagers and affected agricultural production. The intended purpose of LBOD was to drain out saline and storm water and to alleviate water logging and salinity. However, the adversely affected people strongly feel that the LBOD has failed to fulfill its objective. The communities claim that LBOD always brings flood, it was not constructed appropriately, it does not drain rain water properly, and it has caused substantial losses to the people, ecological system, fisheries and agriculture in many areas.

Some stakeholders believe that The World Bank has its own interests in giving loans. *'Keenjhar and Haleeji lakes projects were financed by the IMF and the World Bank and both projects have failed. We know consultations were also conducted before for LBOD but the suggestions of the local community were not given any value'. (Stakeholders, Thatta)* In addition, there were some opinions that that the World Bank should compensate the population for lost lives, livelihoods and degraded environment caused by the LBOD.

Some communities expressed serious reservation against any future drainage/irrigation projects. Their arguments range from the total rejection of any extension of the drainage system because of the bad experience of some villages with LBOD, to contentions that no drains should be built across the land of small growers because they cannot afford to lose any more land. In addition, people apprehend that such a project would bring contaminated and poisonous water from the factories. For these reasons, they prefer to be without vital drains rather than to suffer from poisonous chemical effluent that would flow from the factories and sugar mills.

4.7.5.2 Access to Drinking Water

Drinking water is one of the main problems in most of the consulted villages. In such villages drinking water is brackish and contaminated. The villagers mostly draw water from wells by hand pumps from irrigation canals and ponds. A number of villages do not have enough water for their daily needs. In some villages the village ponds are filled in once a month. In such villages, people strictly ration water usage, fearing that the ponds may run out of water before the new supply arrives. The Consultants witnessed the people drawing muddy water for drinking, cooking, washing and for animals. Villagers cannot afford a basic purification system which costs around PRs 1000 per month. Usually, only *wadera's* homes have some system for water purification.

4.7.5.3 Shortage of Irrigation Water

In most of the sampled villages, the consulted people report that unavailability or shortage of irrigation water is one of the major issues. The greatest impact of water shortage is reported in the villages located at the tails reaches of the irrigation canals. Unavailability or shortage of irrigation water has caused an increase in the salinity of the soil, turned pastures and arable land into barren and unproductive land and devastated the livestock and fishery. In the opinion of the consulted villagers, the shortage of irrigation water is mostly man-made, caused by unfair water distribution;

lack of equity. They stated that because the big landlords in the area have closed the canals to villages the land became dry and impossible to cultivate. According to the villagers, other powerful individuals in the area also divert water to their land and the villagers cannot get it back.

Stakeholders at Ghotki district pointed out that they were in dire need of irrigation water for their rice fields while plenty of water was available in dams. No water was delivered to meet their requirement. Their perception is that, if the requirement for water was fulfilled from dams, the super flood water of 2010 could have been diverted to fill dams and the flood damage could be avoided.

An issue was raised by the stakeholders in a consultative workshop at Sukkur that the drainage water of SCARP-IV together with the effluents from industries is diverted unattended to the Ghotki district. The toxic drainage effluent enters the Bagoo Wah and spreads in the fertile and productive lands damaging the crops and degrading their lands. They demanded the government of Sindh for immediate stoppage of the drainage effluent from Punjab that have degraded their valued land resources.

4.7.5.4 Sea intrusion, water logging and salinity

The issues of sea intrusion, water logging and salinity were brought up at each community consultation, particularly in the coastal area which is reported to be the most adversely affected. The consulted people argue that the LBOD was not constructed properly so the drainage effluent does not flow into the sea. Furthermore, the fresh water from the Indus River was the main source/force for pushing back the sea tides. Due to saline water, fish cannot get enough food and its reproduction is decreasing as a consequence. Arable land has become salinized and unsuitable for cultivating any crops.

4.7.5.5 Agriculture /livelihoods

A great majority of villagers are farmers who depend on farming and livestock husbandry. In some areas people claim that up to 80% of agricultural land has been degraded because of increase in the water table (water logging and salinity). The saline land is not suitable for cultivation. When it rains, the villagers cultivate as much as they can although usually they can only cultivate very small plots of land because they cannot afford to buy seeds and fertilizer.

Livestock has decreased significantly, as there is a shortage of fodder. In most of the villages, people reported having a goat or two, or one or two buffalos/cows - in some ‘better off’ households. Some villagers try to preserve their livestock by giving their animals to farmers in the districts in which fodder is available and then they share the benefit of livestock productivity.

In the delta and coastal area, more than 90% of the villagers make their living from fisheries. The remaining 10% of the population depends on agriculture. Before the LBOD, the main crop was rice. These communities claim that after the construction of the LBOD, they lost their main source of income because sea intrusion and water salinity haves increased. The Mallah community, which depended entirely on the fishery, became jobless and was forced to migrate. Communities stated that before it was a sin to catch a small fish or a crab, but now they are ashamed that they have to eat and sell anything they can catch.

4.7.5.6 Health

Health is one of the burning issues in the sampled villages. Due to brackish, saline, contaminated, poisonous and non-potable water, the villagers suffer mostly from diarrhea, vomiting, stomach pain, high fever, malaria, all types of hepatitis, tuberculosis, liver and skin diseases. They believe

that after the construction of the LBOD and the closure of the old Dhoro Puran, the diseases became common in the villages. There is a bad smell from the Doro Puran Drain which makes local people dizzy. A lot of the surveyed people report headaches and skin diseases.

In addition, access to women's health care is almost nonexistent. In the majority of the consulted villages there is no Lady Health Worker (a local expression) or a midwife who can help women during deliveries. Many villagers reported high mortality of mothers and babies due to the lack of medical help in the villages, or difficult access to qualified medical assistance.

4.7.5.7 Insecurity and Shortage of Food

The consulted people reported that the extreme poverty in their villages is caused by the low productivity of agricultural land, diminished livestock and fisheries, floods, inflation, landlessness, shortage of irrigation water and lack of access to any other economical resources. Those who have some land cannot cultivate it because of water shortage. The landless people are requesting that the government distributes some land to the poor, so that they can work and feed their families. There is chronic insecurity for the landless people. *'We live on government land and when the government needs the land, we have to go. We only need a home – a place to live'. (A woman from Major Bakar village, Hyderabad).*

The participants of the discussion groups reported a widespread shortage of food and significant increase of poverty in all sampled villages. Women reportedly sit all day in wait for husbands to bring some food so that they can prepare meals for their families. Boiled chilies and bread (rotti) is a common meal for many families. They can afford potatoes once or twice a month, while most people get meat only on the occasion of Eid-e-Qurban, when they are offered meat by the well-off people. A poor person in people's opinion is: *'One who eats at night and starves in the morning is poor'. (Village Mureed Khoso, Thatta)*

Food expenditures comprise on an average 90-95 % of the total income of the poor and the hike in prices has severely hurt the people's purchasing power. As a result most of the people suffer from malnutrition. This increased food expenditure means that poor get to spend less money on other facilities like health or education.

Other devastating effects of poverty are loneliness and depression, continuous illness, increased debt for health treatment, debts to overcome droughts and preparing dowry for daughters, which creates a vicious poverty circle.

4.7.5.8 Crop Yield

The crop yields are low, mainly due to depletion in soil quality and erosion, water-logging and salinity, and inadequate input levels. In addition, seeds, fertilizers, pesticides are costly, and quality of seeds is questionable. The fertilizers and pesticides are mixed and very expensive.

4.7.5.9 Unemployment and Low Daily Wages

Employment opportunities in the public sector are very limited. There are few chances for employment for the rural jobless in the private sector mainly due to the poor standard of education

and non-availability of technical training in the rural areas. The sources of livelihood and employment opportunities for rural inhabitants are shrinking and there is no family planning. It is common in rural areas that one family consists of 12 to 18 members, and they depend on only one earner. Consequently, poverty and unemployment is increasing gradually, and more people are sliding in to poverty. Those who are educated are also facing unemployment and this situation has raised the non-importance of education among poor, peasants and small farmers and landless especially. Those who have jobs receive low wages and are unable to meet the basic needs of their families.

4.7.5.10 Lack of Education and Modern Technologies

Lack of education and knowledge is other main reason of poverty. The literacy rate of Pakistani society is less than fifty percent; the female education rate is at miserable state. The farmers don't know about the scientific ways of farming and the result is low production of yield from their fields. However, in some villages, people do not see any benefits of women/girls education or vocational training as those who have some education cannot get the job or due to cultural constrains, family does not allowed a female member to work outside home.

The majority of the surveyed villages have segregated primary schools for boys and girls. Middle and high schools are rarely located n the villages. The surveyed villagers report that education in the available schools is of low quality. Girls have much lower school attendance than boys.

4.7.5.11 Inflation

Inflation is on the rise. Most of the people demand control on food prices. Families that used to have three meals a day, now can afford food twice a day, while those who used to have two meals a day, now have only one meal daily.

4.7.5.12 Women in the Local Context

The shortage of water, increasing water-logging, land salinity, and adversely affected farm productivity, and livestock decrease, have changed women's lives. They used to work in the fields with their husbands and minded livestock. The loss of these major sources of women's work has had a substantial impact on local women. In many villages, they must walk long distances to fetch drinking water. In others, they sit all day at home without work, caring for children and waiting for their husbands to bring some food for the family. Some women go with husbands to cut wood while others, in villages where some land is cultivated, pick cotton or do some other agricultural work. In addition, population growth puts additional constrains on local women. As a cause of poverty, women in one of the sample villages stated: *'Too many babies, but we cannot do anything as God gave them to us'.*

4.7.5.13 Environment

The community consultations, especially consultations with district stakeholders, revealed that the people are very much aware of the condition of their environment. In their opinion, nobody takes care of the environment and the Government's allocation of funds for this purpose is meaningless. Several endangered species have vanished, fish cannot survive in the contaminated water and local

lakes are dead. Migratory birds do not visit lakes anymore and the indigenous birds population has diminished considerably.

The sugar industries in the area drain poisonous waste into the LBOD and pose a serious threat to the environment, livelihoods and health of the villagers. The natural drain of Dhoro Puran is clogged with mud and is connected with the LBOD. During the rainy season (July-August), water overflows LBOD and floods a number of villages with toxic water. Some of the communities allege that some sugar mills have established wine factories within the sugar mill boundaries, and the waste from the wine factory is reportedly released into the natural drainage of Dhoro Puran. The adjacent agricultural land has been destroyed and the eco system is badly affected. The affected communities demand that sugar mills immediately stop discharging poisonous chemical water into the natural Dhoro Puran which was the only and last source of their livelihood.

4.7.5.14 Institutions and Government Departments

It is a general impression of the consulted communities that the Farmers' Organizations (FOs) are dysfunctional. In the opinion of these communities, FOs do not have enough power even to ensure a proper share of water for the communities as local powerful individuals and large farmers control their operation.. Moreover, the FOs' chairmen are selected rather than elected. There are widespread complaints about the malpractice of powerful landlords in the majority of the consulted villages.

The majority of the consulted stakeholders and communities believe that most of the staff of the Irrigation Department sell water to the rich and the powerful. The Department does not maintain the irrigation system regularly and properly and some mismanagement of funds is present. In addition, there were some opinions that that the World Bank (because of its own mistakes) should compensate the affected population for lost lives, livelihood and degraded environment caused by the LBOD.

The consulted stakeholders want to see the WSIP free from government and political interference. In their opinion, this should be achieved by establishing development committees at district level, which should include members from all parts of the society, such as landlords, social workers, journalists etc. The committees would monitor the Project and make sure that bureaucracy and corruption do not dominate the Project. People reported that there are a number of projects initiated by the previous government that have not been completed. Every change in the government brings to a closure started development schemes, so many projects have never been finished.

4.7.5.15 Community Engagement

The majority of the consulted villages and stakeholders report the absence of meaningful consultations with the communities. There is disbelief that anyone will consult locals at all, and a deeply embedded distrust about the outcome of the consultations prevailing in the visited villages. The information from the villages and the stakeholders consistently indicate that people want genuine consultations, appropriate actions and feedback on any action taken.

In areas where some consultations with the stakeholders were conducted in the past, the stakeholders stated that no value was given to their opinions and suggestions. People do not believe that any of their suggestions will be considered at all: *'At least, please forward these suggestions to the concerned quarters'.* Stakeholders, Sanghar

The stakeholders requested transparency and accountability in any project in their area and, in particular, that the projects' cost and expenditure are published in the newspapers, so, that the population is properly informed.

The significance of consulting men and women equally about any of the issues related to their lives is of ultimate importance. In each of the visited villages, women were genuinely surprised that anyone asked for their opinion and recommendations. An absence of social inclusion of women in voicing their opinions and participating in the decision making process in public spheres of their lives is persistent.

4.7.5.16 Flood

The recent catastrophic flood of 2010 has adversely affected a number of the sampled villages. The displaced communities lost their homes, crops, livestock and jobs. The Government provided food but (according to the consulted people) the rations were insufficient. There was no provision of fodder for the saved livestock. Also, the procedure for the issuing of Wattan cards is ineffective.

The villagers who suffered from the recent mega-flood think that the system for early warning is nonexistent or ineffective. They stated that people were forced to leave because of the catastrophic flood but the government could not inform them in time.. The community suggested that the Government prepares a complete plan for the relief and rehabilitation of the affected villages and the replenishment of the livestock in the post flood period.

The stakeholders demand an extensive awareness campaign about the preventive measures during natural calamities. In addition, they suggest the strengthening of the river banks, tree planting along river and canals, construction of rain and flood canals, clearing katcha areas around the river and better management and coordination between the responsible departments and agencies.

4.7.5.17 Other issues

Innate desire to work at home or near home: Local men tend to seek employment in the village or places closed to their villages. Women prefer an in-house or within-village work providing a women-friendly working environment.

Difficult Access to Credit: Increasing cost of living and agricultural inputs reduce the purchasing power of rural people. It is a general perception that in Sindh people are born in debt, live in debt and die in debt. The availability of credit is a key prerequisite for the farmers, for their production as well as their post harvesting requirements. The majority of growers depend on non- institutional sources, such as friends, relatives, land lords, village merchants and money lenders at local level.

Road condition: The condition of local roads in the sampled villages is very poor. Because of bad roads, access to basic services is difficult and expensive.

Sanitation: Proper sanitation is not available in most of the villages. People need help to construct latrines in the villages.

4.8 REVIEW CAPACITIES OF PROVINCIAL AGENCIES INVOLVED IN EXECUTION OF THE IRRIGATION AND DRAINAGE PROJECT AND ITS MANAGEMENT

(*Review of Potentials of NGOs to Partner in Implementing Components of the Master Plan*)

4.8.1 Background to the Institutional Reform, Thematic Area Study

Abstracts and separate reports were drafted, during fall of 2010, for two Tasks of the Regional Master Plan Report, Phase I. Task 1-14 addressed institutional capacities of provincial agencies for management of water and drainage operations of the left bank of the Indus River, Guddu to the Delta and Coastal Zone. Task 1-15 addressed the capacities of NGOs to participate in implementation of the Regional Master Plan.

Topics of Phase I Task Studies for Institutions	
Subjects Covered	**Phase-I Tasks Included**
Institutional Capacity of Provincial Agencies for Water, Drainage, and Flood Management and for Implementation of the Regional Plan	
✓ Human Resources ✓ Technical capacity ✓ Physical Capacity ✓ Financial Capacity ✓ Organizational Relevance	T-14: "Review institutions, technical and physical capacity (i.e. skills expertise, staffing and equipment) of provincial agencies that are involved in the execution of the irrigation and drainage development project and their management". T-15: Evaluate the capacity of local institutions (NGOs working in social, development and environmental sectors of Sindh) as potential future partners to implement some of the components of the Master Plan.

Following an extensive review by the stakeholders and a Panel of Experts (PoE), appointed by SIDA, the separate reports for 34 tasks were grouped into thematic groups for consolidation into one cohesive report. Section 8 has been drafted to address major issues and problems as identified to date and to incorporate comments from various reviewers including the comments of the PoE.

4.8.2 Approach to address the thematic area

Initially identified were the two agencies that will: 1) determine the success or failure of the Reform Program begun in 1995 with enactment of the SIDA Act and 2) that are involved in operation, maintenance, and management (OM&M) of canal and drain systems and management of flood works and floods affecting the left bank area of the Indus River. Further identified were other agencies that perform project implementation and then hand over projects to Provincial Agencies for operation and maintenance.

Two agencies are responsible for operation, maintainance and management (OM&M), IPD and SIDA and its two operating units, AWBs and FOs. Two other agencies, WAPDA and DGAEWM, implement programs and projects and then turn them over to the owners.

A third group NGOs and RSPs are involved in the largely non-structural activities associated with social, economic, and cultural conditions that prevail in irrigated areas and the Delta and Coastal Zone.

Revenue, staffs and operations of IPD, SIDA, AWBS and FOs were determined through interviews with SIDA, FOs and IPD Circles and through discussions at workshops with stakeholders. Specific information was gleaned from review of public and official documents, in particular, the Provincial Budget for 2010-2011.

Considerable information and perspective was gained through review of documents and reports for earlier and on-going programs including LBOD, SCARPS, NDP, SOFWM, and WSIP-1. Public records including the Provincial Budgets for IPD and SIDA, 2009-2010 and 2010-2011, were analyzed to assess personnel and mechanized capacities for maintenance and for flood protection and remediation.

Library resources of SIDA were accessed, information for organizations and NGOs were assessed through the internet and follow up was accomplished by visits, telephone and email contact. Personnel, equipment and transport capacities and legal and financial standing of NGOs were secured for use during implementation to facilitate short listing.

4.8.2.1 Consultation methods used and stakeholder inputs to the thematic assessment

Stake holders were contacted and consulted on institutional matters through workshops, during interviews in the countryside and by interviews of FOs and staffs of the IPD at Division and Circle levels. Individuals and NGO stakeholders generally were highly critical of the ineffectiveness of IPD and the lack of willingness of IPD operational staff to provide support to the FOs even though IPD retains control of Daroghas, Beldars and Abdars who are budgeted by the Province for transfer to SIDA.SIDA is largely unrecognized by people of the villages.

4.8.3 Key Findings of the Thematic Assessment

Revenue and budget capacity of the two primary water, drainage and flood management agencies, IPD and SIDA and associated AWBs and FOs, were assessed. It was determined that: 1) they are not well organized, located, staffed and equipped (mechanized) to carry out even routine operation and maintenance functions, and 2) have few specifically allocated reserves for coping with floods and other disasters. There is no identified budget and organizational capacity of IPD is inadequate for effective conduct of O&M of the Tidal Link and LBOD. This situation will be even more critical to sustainability once rehabilitation works are accomplished under WSIP-1.

Beneficiary Drainage Groups have not been formed and consequently there is no ongoing emphasis on drainage operations and management at the local level.

4.8.3.1 Recognition of the need for institutional reform to achieve self-sustaining water delivery and drainage management

During the 1980s the Government of Pakistan recognized that the rapidly expanding systems for delivery of irrigation water and for drainage of irrigated lands could not be maintained by institutions that were organized to administer simple canal systems that originally delivered a low duty of water. Problems of water logging and salinity and the need for costly drainage works intensified after partition because water supply was greatly increased with the construction of river reservoirs and installation of large numbers of tubewells.

The Ministry of Water and Power and the World Bank stimulated the central government to adopt, in the mid 1990s, an institutional program of reform, based on participatory irrigation management (PIM), that would lead to decentralization through participation and transfer of water management

from bureaucracies to self sustaining utility like entities. The National Drainage Program[26] of 1995 was framed to promote institutional reform within each province with the intent of converting the Provincial Irrigation and Power Departments (IPDs) into Provincial Irrigation and Drainage Authorities (PIDAs) that would manage intra-provincial bulk water transfers at the heads of main canals and manage main drains. Self-governing, self-financing Area Water Boards (AWBs) were to transmit water along main and branch canals to distributaries and minors where the water would be delivered to the Farmer Organizations (FOs) that would deliver water to watercourses and recover costs of operation and maintenance through collection and retention of the Abiana (water user charge).

4.8.3.2 Primary agencies concerned with water, drainage, and flood management in Sindh Province, year 2010-2011

National and provincial responsibilities are inter-related -- National agencies including WAPDA, are responsible for storage, transmission and distribution among provinces water of the Indus River. Also they regulate river flows during periods of high and low river discharges and flooding. Once water arrives at Guddu Barrage, IPD is responsible for: 1) diverting and delivering water into the canal systems for agricultural and Municipal and Industrial (M&I) use; 2) management and operation of tubewells and subsurface and surface drains that collect agricultural drainage effluent and storm water for discharge through branch and spinal drains for outfalls to the sea; and 3) management of the Indus River and its bunds and barrages. During floods the interaction among national and provincial agencies responsible for operations of the river, canals and barrages, and the populace of Sindh Province has been documented in tasks of this Phase I report that addresses floods and disaster management.

Two operating agencies -- Two agencies, IPD and SIDA, are responsible for operation, maintenance and management of the Indus River and its barrages and for the canal water delivery and drainage systems. During this period of Transition SIDA is functioning administratively within the Secretariat of Irrigation, Organization Chart, Figure 8.1, and the MD SIDA reports directly to the Secretary of Irrigation as do five Chief Engineers.

However, the Water Sector Improvement Project (WSIP-I), executed by the Sindh Planning & Development Department, and implemented by SIDA, (Figure 8.3), is designed to bring about reform through transfer of operation and management functions to irrigators by beginning with transitional funding of SIDA and the AWBs. SIDA and the AWBs are to become self-managing, self-financing utility type organizations. By direction of provincial government, some 5,000 personnel of IPD and a budget approximating Rs.1.25 billion are to be transferred to SIDA and to the three AWBs -- Ghotki Feeder, Nara Canal, and Kotri Left Bank. IPD has not, however, transferred personnel and budgets to SIDA.

Personnel to be transferred have two functions, management of the canal divisions (4,200 staff, Table 4.8.2) and those who manage TW and surface drainage systems including LBOD (870 staff, Table 4.8.3). For 2010-2011 there are no construction or maintenance funds in the budgets for canals and drains. However, the drainage divisions are budgeted Rs. 124 million for civil works during 2009-2010. Offices expenses for the three drainage divisions are barely enough to pay for electricity.

[26] "Feasibility Study National Drainage Programme I, Vol. 1- Main Report", NESPAK/Mott MacDonald International Ltd., May 1995, Sponsored by Islamic Republic of Pakistan,/WAPDA, IBRD, and Japan Fund

Table 4.8. 1: Summary – Staffing And Budget of IPD Left Bank 2010-2011

Divisions / Circles	Unit	Officers		Other Staff					Allowances (Rs)	Office Expenses (Rs)	Civil Works (Rs)	Total (Rs)	Total Staff
IPD Secretariat Director Regulations	Sum - Budget (Rs)	1,698,300			3,048,100				5,477,200	104,250,200		**114,473,800**	**43**
	Sum - Staff (No.)	**E**	**TH**	**T**	**C**	**JT**	**SK**	**L**					
		2	5	9	9	4	2	12					
MD SIDA Hyderabad	Sum - Budget (Rs)	2,451,100			4,424,400				10,274,500	4,815,000		**21,965,000**	**47**
	Sum - Staff (No.)	4	3	15	8	0	3	14					
Chief Engr. Sukkur, Left	Sum - Budget (Rs)	4,087,400			8,685,300				9,777,200	2,351,100		**24,901,000**	**110**
	Sum - Staff (No.)	2	13	31	34	7	4	19					
Ghotki Feeder Canal & AWB	Sum - Budget (Rs)	2,461,400			36,894,800				26,718,600	2,760,500		**68,835,300**	**427**
	Sum - Staff (No.)	2	8	17	27	49	49	275					
NARA Canal & AWB Mirpurkhas (Grant-In-Aid)	Sum - Budget (Rs)	9,030,200			173,544,100				160,967,900	176,876,600		**520,418,800**	**2,485**
	Sum - Staff (No.)	3	31	73	97	236	651	1394					
Rohri Canal Nusrat Benazirabad XEN Hala Irrigation Hala Sakro Mirpur Sakro	Sum - Budget (Rs)	8,400,900			108,779,100				108,177,900	19,695,300		**245,053,200**	**1,559**
	Sum - Staff (No.)	4	28	60	93	205	196	973					
Chief Engr. Kotri	Sum - Budget	5,991,700			36,247,200				31,164,600	59,183,700		**132,587,200**	**400**

Table 4.8. 1: Summary – Staffing And Budget of IPD Left Bank 2010-2011

Divisions / Circles	Unit	Officers		Other Staff					Allowances (Rs)	Office Expenses (Rs)	Civil Works (Rs)	Total (Rs)	Total Staff
Hydraulics Lab Hyderabad	(Rs)												
	Sum - Staff (No.)	4	18	49	52	35	76	166					
Upper Pinyari T. M. Khan @ Hyd Feeder Hyderabad Lower Pinyari Sajawal Pinyari Hyderabad	Sum - Budget (Rs)	6,888,000				148,649,600			119,900,000	6,935,300		**282,372,900**	**1,777**
	Sum - Staff (No.)	4	22	48	160	207	360	976					
Left Bank Badin Akram Wah Badin Guni Canal Badin Fuleli Canal Badin	Sum - Budget (Rs)	13,195,600				228,745,800			171,085,500	77,591,000		**490,617,900**	**1,228**
	Sum - Staff (No.)	4	22	50	83	193	222	654					
Thatta Drainage Lower Sindh Drainage Drainage Tando Mohd Khan	Sum - Budget (Rs)	9,530,700				115,504,200			92,764,400	8,903,000		**226,702,300**	**885**
	Sum - Staff (No.)	3	17	60	49	50	121	585					
Total (Rs)		**57,743,600**				**828,275,400**			**705,143,200**	**404,178,000**		**1,995,340,200**	**8,961**
Total Staff (No.)		**32**	**167**	**412**	**612**	**986**	**1,684**	**5,068**					

Source: Budget 2010-2011, Finance Department Govt. of Sindh

Footnotes:

E/ BPS: 18-20 = MD, PD, GM, CE, SE, XEN;
TH / BPS: 16-17 = TECHNICAL HEADS, AE, AXEN, SUPERINTEDENT, HEAD CLERK;

T/BPS: 10-14 = TECHNICIANS, DRAFTSMEN, PHOTOGRAPHER;
C/BPS: 6-9 = CLERKS, PA, ASST;
JT/ BPS: 5 = JUNIOR TECHNICIANS;
SK /BPS: 2-4 = SKILLED CRAFTSMEN;L /BPS: 1 = LABOR;

Table 4.8.2: Summary – Staffing and Budget of IPD Earmarked For SIDA and AWBS 2010 – 2011 (Except Land Reclamation)
Summary Report, Regional Master Plan Phase – I

Div/Circles	Staff / Budget	Officers		Other Staff				Allowances (Rs)	Office Expenses (Rs)	Civil Work (Rs)	Total	Total Staff
MD SID Hyderabad (Grant-in-Aid)	Budget (Rs)	2,451,100		4,424,400								
	Category	E	TH	T	C	JT	SK	L				47
	Staff (No)	4	3	15	8	0	3	14	10, 274, 500	4,815,000	-	21,965,000
NARA Canal & AWB Mirpurkhas (Grant-in-Aid)	Budget (Rs)	9,917,700		174,839,9000								
	Staff (No)	4	33	76	103	237	651	1401	163,047,700	177,545,200		525,350,500	2, 505
Ghotki Feeder Canal & AWB Sukkur	Budget (Rs)	2,461,400		36,894,800								
	Staff (No)	2	8	17	27	49	49	269	26,718,600	2,760,500		68,835,300	421
Left Bank Canal & AWB, Badin	Budget (Rs)	6,202,900		106,9111,3000								
	Staff (No)	4	22	93	157	193	222	654	93,267,000	40,054,200		246,435,400	1, 345
Total (Rs)		**21,033,100**		**323,070,400**					**293,037,800**	**225,174,900**		**862,586,200**	
Total Staff (No)		**14**	**66**	**201**	**295**	**479**	**925**	**2,338**					**4,318**

Source: Budget 2010-2011, Finance Department Govt. of Sindh

Footnotes:

E/ BPS: 18-20 = MD, PD, GM, CE, SE, XEN;
TH / BPS: 16-17 = TECHNICAL HEADS, AE, AXEN, SUPERINTEDENT, HEAD CLERK;
T / BPS: 10-14 = TECHNICIANS, DRAFTSMEN, PHOTOGRAPHER;
C / BPS: 6-9 = CLERKS, PA, ASST;
JT/ BPS: 5 = JUNIOR TECHNICIANS;
SK / BPS: 2-4 = SKILLED CRAFTSMEN;
L / BPS: 1 = LABOR;

Table: 4.8.3: SIDA Allocated Budgets 2010-2011, Drainage Divisions, For Land Reclamation

Unit	Name	Officers (Note 01)		Other Staff (Note 02)				Allowances (Rs)	Office Expenses (Rs)	Civil Works (Rs)	Total (Rs)	Total Staff
		E	TH	T	C	JT	SK	L					
DIV	Drainage Div (LBOD) Benazirabad (SIDA)											
No	Staffing	1	4	12	15	80	59	239				410
Rs	Budget 2010-2011	2,009,900		28,197,900					23,716,800	87,127,900	141,052,500	
DIV	Drainage Div Sanghar (SIDA)											
No	Staffing	1	6	17	24	5	33	15				101
Rs	Budget 2010-2011	1,730,100		7,761,500					6,941,800	185,167,500	201,600,900	
DIV	Drainage DIV. Mirpurkhas (SIDA)											359
No	Staffing	1	5	22	21	13	61	236				
Rs	Budget 2010-2011	1,502,900		25,465,000					16,994,400	24,082,400	68,044,700	
Rs	Sum – Budget (Rs)	5,242,900		61,424,400					47,653,000	296,377,800	410,698,100	
No	Sum – Staff	3	15	51	60	98	153	490				870

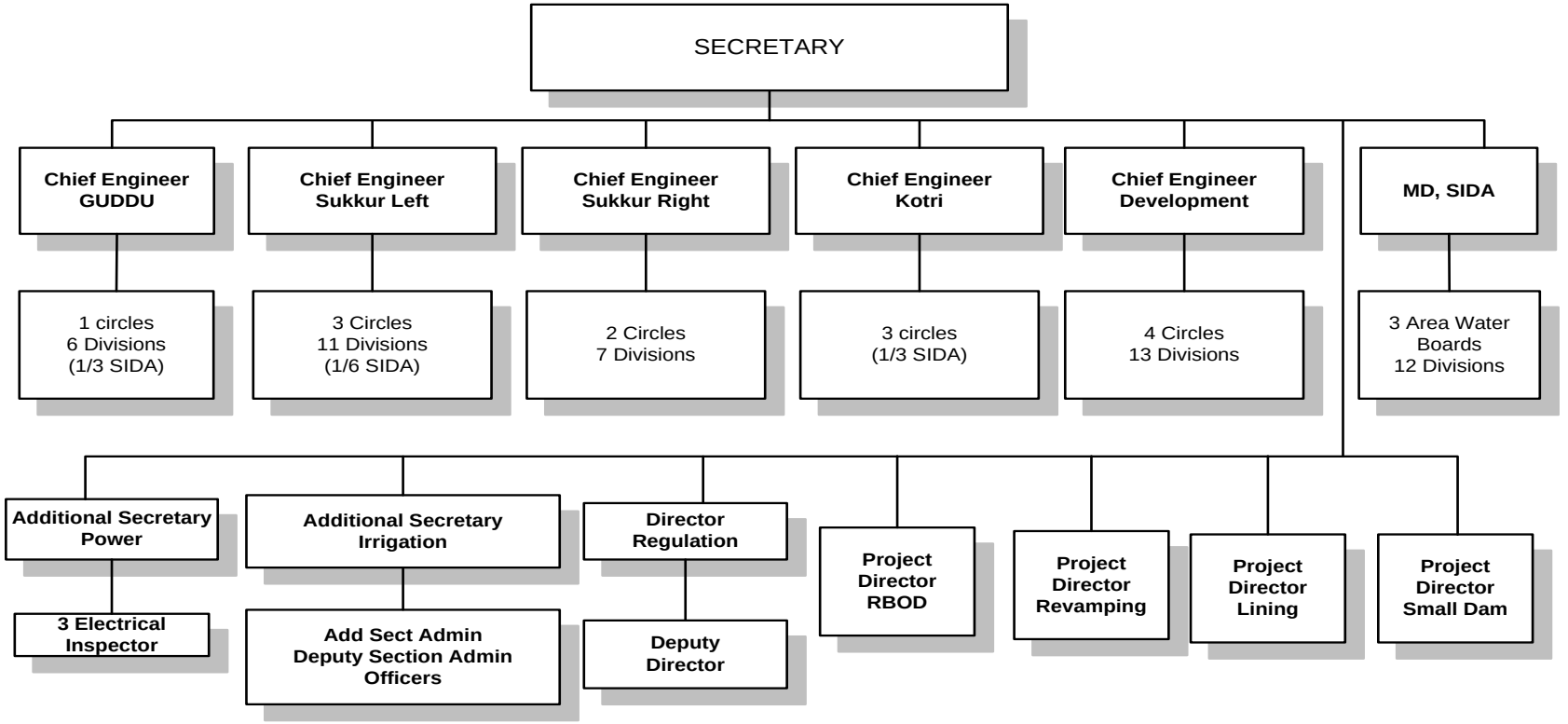
Source: Budget 2010-2011, Finance Department Govt. of Sindh

Note 01:
E = ENGINEER, CE, SE and XEN (BPS: 18-20);
TH = TECHNICAL HEADS, AE, AXEN, SUPERINTEDENT, HEAD CLERK (BPS: 16-17);

Note 02:
T = TECHNICIANS, DRAFTSMEN, PHOTOGRAPHER (BPS: 10-14);
C = CLERKS, PA, ASST (BPS: 6-9);
JT = JUNIOR TECHNICIANS (BPS: 5);
SK = SKILLED CRAFTSMEN (BPS: 2-4);
L = LABOR (BPS: 1);

Figure 8.1
ORGANIZATION CHART
IRRIGATION & POWER DEPARTMENT, SINDH

Summary Report, Regional Master Plan Phase-1



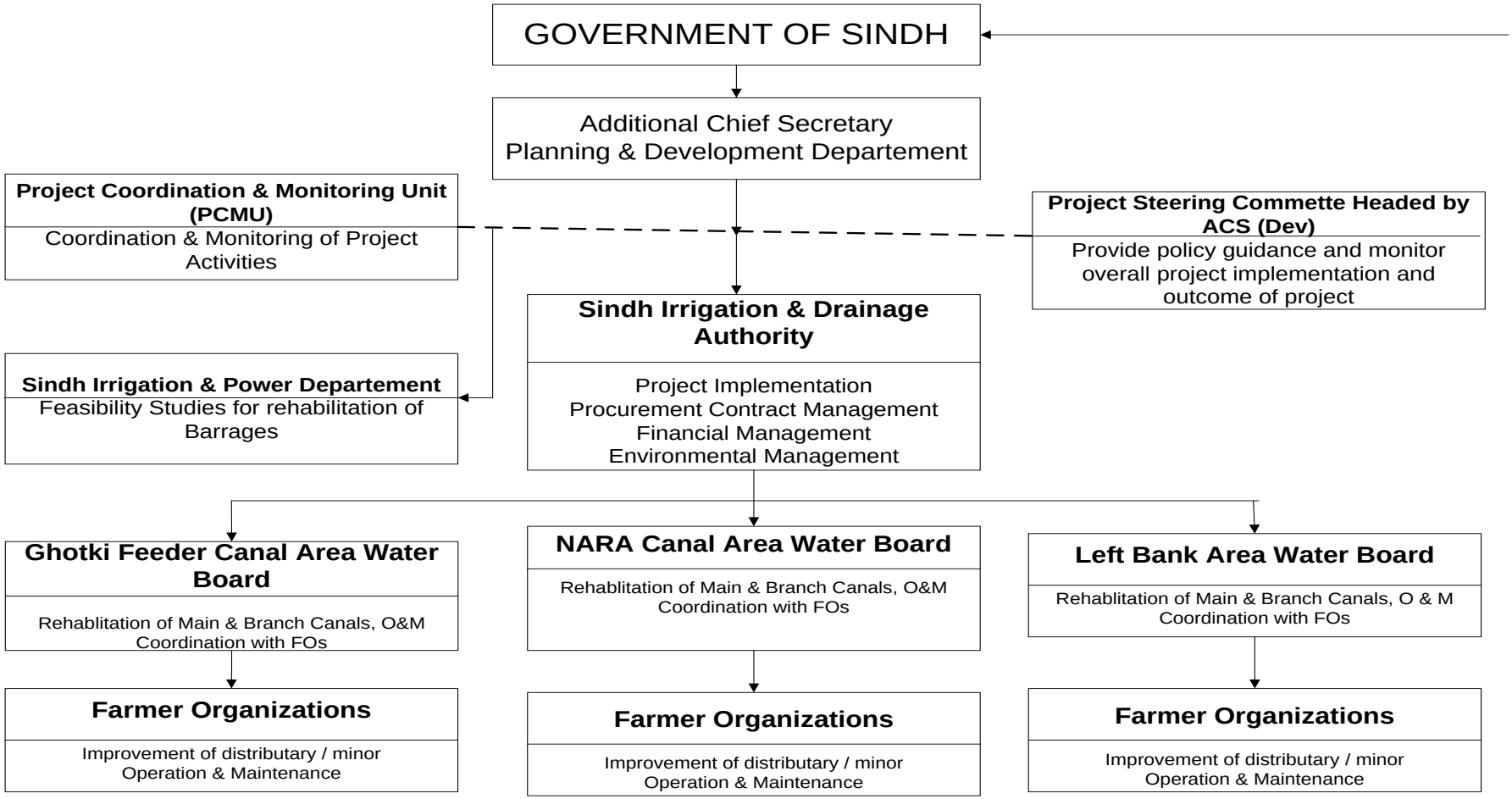
Source: After IPD, Official Website

LBG / INDUS April 2011

Figure 8.1

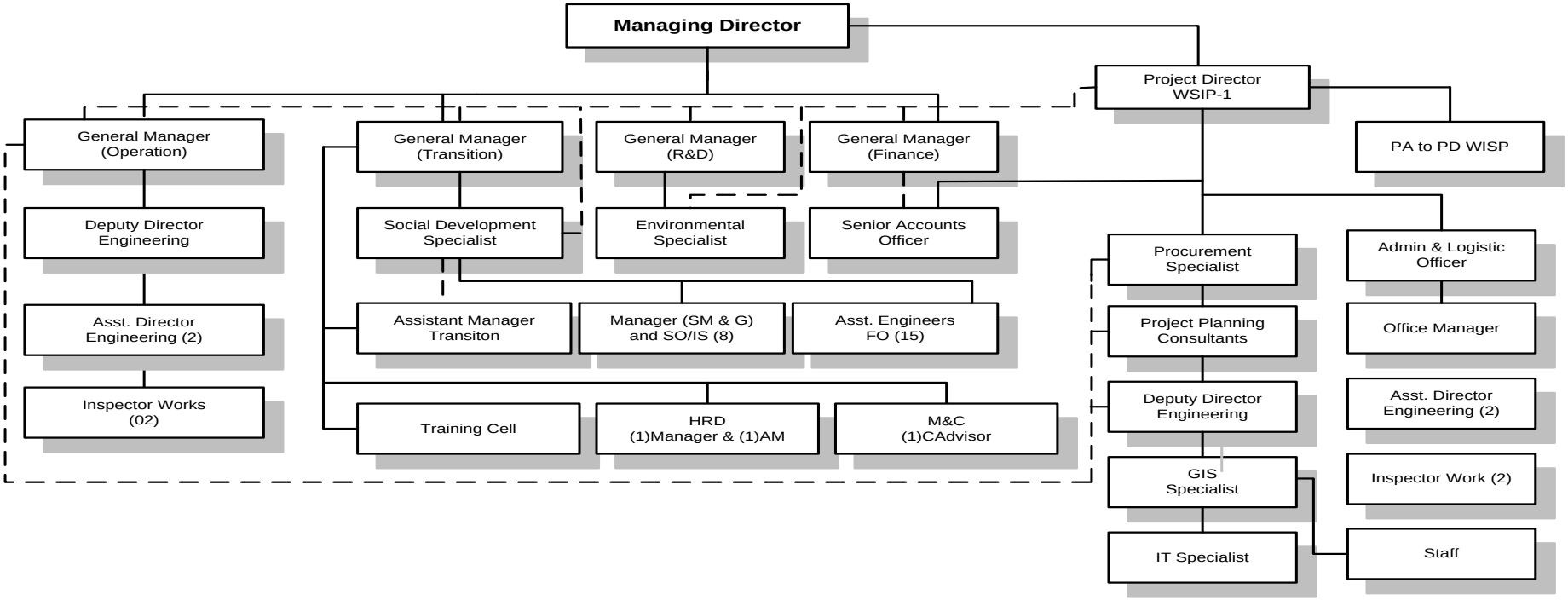
Figure 8.2

Functional Relationships within Sindh Water Sector Improvement Project (WSIP) Phase-I



Source: 12th Meeting, Project Steering Committee, 22 Oct 2010 *LBG / Indus, 8th April 2011*

Figure 8.3
SINDH WATER SECTOR IMPROVEMENT PROJECT
ORGANOGRAM, SIDA Headquarters



4.8.4 Provincial Actions for Reform

Much of the framework for change from the inefficient, bureaucratic operations of IPD to utility/business style operations by SIDA, the AWBs, and the FOs has been legislated and budgeted and now only needs to be further implemented through decisions to transfer personnel and budgets from the control of IPD technical staff to SIDA and the AWBs. The positive steps taken by the Government of Sindh up to spring 2011 include:

- Passage of the SIDA Act of 1997 and the Sindh Water Management Ordinance (SWMO) 2002, which provide the legal basis for implementation of a program of Reform[27].
- Processing of funds of the WSIP, including Grants-in-Aid to SIDA; which is vital if reform is to be successfully financed through a period of Transition.
- Finance Department earmarks in the Irrigation and Reclamation Budgets of the IPD for transfer to SIDA including the Grants-in-Aid to MD SIDA and the Nara AWB.
- Administration of WSIP through the Sindh Planning & Development Department rather than through the Secretariat of Irrigation.
- Enabling SIDA to form more than 350 Farmers Organizations (FOs) who will be responsible to assess and collect Abiana, and deposit the proceeds to bank accounts of the FOs and AWBs for maintenance and operations, whereas. Abiana collected in the areas administered by the IPD still flows directly to the provincial exchequer.

4.8.5 Agencies for Supply of Water and Drainage and Flood Control Management in Sindh

4.8.5.1 Operating agencies, IPD and SIDA

Although there are many agencies involved in approval and financing of projects, the Sindh Irrigation and Power Department (IPD) and the Sindh Irrigation and Drainage Authority (SIDA) are the two primary agencies most directly involved in operation, maintenance and management of the distribution of irrigation water to the *Moghas* at the head of water courses for irrigated agriculture. Additionally, these agencies oversee drainage and flood management as well as delivery of bulk water to industries and municipalities.

4.8.5.2 Non-Operating Agencies with Responsibilities for Program Implementation, DGAEWM, WAPDA and NGOs

Directorate of Agricultural Engineering and Water Management (DGAEWM)

Below the *Moghas* where IPD is not engaged, the Directorate General of Agricultural DGAEWM is administering programs of watercourse upgrade and associated extension service. Currently DGAEWM is managing an IDA credit of $50 million for extension of the Sindh on Farm Water Management Project (SOFWMP)[28]. Of the 42,000 water courses in Sindh some 17,000 watercourses had been improved between 2005 and 2009 under the National Program for

[27] "The Sindh Water Management Ordinance, 2002", Sindh Ordinance No. XL of 2002, The Sindh Government Gazette, Karachi, October 26, 2002

[28] Project information Document (PID), Appraisal Stage, Report No: AB4779, "Additional Financing for Sindh On-Farm water Management", PID, prepared May 7, 2009 Directorate General, Agriculture Engineering and water Management, Department of Agriculture

Improvement of Watercourses (NPIW)[29]. It is expected that 2,500 additional watercourses will be improved as a component of the current credit extension. Additionally, there will be increased emphasis for, "enhancing the long-term financial sustainability of the irrigation system by fostering self-sustaining farmer organizations – Watercourse Associations *(WCAs)* – at the watercourse levels".

Watercourse Associations are active in areas administered by FOs and in areas that remain with IPD. Thus the programs for watercourse improvements are vital both to success of the Reform Program of SIDA and to upgrading of water use efficiency in areas administered by IPD.

Water and Power Development Authority WAPDA

WAPDA, a national organization, has been responsible for large provincial infrastructure developments, including SCARPs and LBOD on the left bank of the Indus River, but it has no operational role in water management and drainage of agricultural areas. Beyond water and drainage operations and management, however, WAPDA is a key organization for the management of floods of the Indus River and other disasters since it has operational authority at dams and has active offices in Sindh and the other provinces.

NGOs for Implementation

Use of the term NGOs herein includes both NGOs and GONGOs (government organized NGOs). They are well suited to partner for the conduct of economic, social and environmental elements of the Regional Master Plan at district, Taluka, village and household levels. Generally, a number of NGOs are promoting and executing programs that have an objective of sustainable community development for achieving equitable economic, social, political, and cultural development. As documented in Vol-II Table 4.8.1, twelve listed NGOs have submitted information and have ongoing programs. They are staffed and equipped to carry out education, training and organization of local persons and communities. The following quote, Annex 15A, p 4, provides insight to the thrust of past and ongoing activities of NGOs, "…. purpose of poverty alleviation – enabling people to break the poverty cycle, which begins with lack of opportunity, extends to the well-known miseries of economic and nutritional poverty and leads new generations to endure *the same"*;

Vol-II Table 4.8.1 lists only NGOs that currently are *actively engaged* in Sindh and who *are responsive* to invitations to prequalify. The list was drawn from among more than 100 NGOs who are registered. During preparation of Task I-15, Phase-I, NGOs were invited through newspaper advertising to submit prequalification documents both for future implementation of planned works and for conduct of current investigations. Additionally, available fact sheets for more than 30 NGOs were downloaded from web sites. While the fact sheets provide statements of vision and professional engagements; LBG/Indus followed up with letters requesting information regarding personnel strengths, equipment, and transport and office facilities.

NGOs listed in Annex 15-A may, during the remainder of the planning and subsequently during implementation of the Regional Plan, be evaluated and invited to submit competitive proposals for works and program completion. This list will be revised and updated during the remainder of Phases II, III, and IV of the project as more information comes available. There are no important issues and problems to be identified in Phase I and carried over to subsequent phases of the Program with respect to NGOs.

[29] Sindh On-Farm Water Management Project (SOFWMP) Project, Monitoring and Evaluation (M&E) Consultants, 2009

4.8.6 IPD and SIDA, Only Two Operating Agencies for Water, Drainage and Flood Management

The Sindh Irrigation and Power Department (IPD) Is the only Authority in Sindh with a full range of capacity for dealing with: 1) management, operation and maintenance of canals and drains, 2) operation of the Indus River for water supply and during floods, 3) conduct and oversight of flood works before, during and after events, and 4) control of water in major drains of the area on both the left and right banks. The Sindh Irrigation and Drainage Authority (SIDA) is intended to be an independent agency for eventual acquisition of all these functions and to operate them on a business basis. The capacities of IPD and SIDA were reviewed and issues and problems associated with reorganization for improved water distribution, drainage services, and river and drain operations were identified successively through review of literature and official documents and vetted with stakeholders through surveys, workshops and interviews. Field trips were made by teams from Louis Berger Group and Indus Consulting Services for data collection and observation of the condition of infrastructure. Also during and after the flood of 2010 the extent of flooding and damage to bunds was observed and subsequently sites of bund reconstruction were visited.

4.8.6.1 The Sindh Irrigation and Power Department (IDP)

Sindh IPD, as depicted on figure 8.1, operates three barrages, Guddu, Sukkur, and Kotri, and Main and Branch canal systems under the supervision of four Chief Engineers (CEs). Additionally, the CE Development has responsibility for 4 Circles and 13 Divisions and his portfolio includes administration of the Reclamation Budget as distinguished from the Circles that are dedicated to operation and management of canals. Three of the 13 Divisions manage tubewells and horizontal drainage systems; their budgets have been assigned to SIDA as tabulated in Table 4.8.3. Although, Rs. 125 million was allocated to these divisions for civil works in the budget year 2009-2010[30], there is no budget for maintenance and upkeep allocated in 2010-2011, likely due to stringency measures being imposed by the International Monetary Fund. This impacts tubewells more than any immediate effects on canal systems that result from program cuts. Some 40% to 60% of tubewells are “dead lined”, some due to theft and vandalization, and others for lack of spare parts.

Staff of the IPD that manage canals on the left bank of the Indus River and in the Secretariat at Karachi total 8,961 Table 4.8.1. Additionally IPD, Left Bank includes three drainage divisions, with staffs numbering 870 that deal with public sector tubewells and horizontal drainage including LBOD, Table 4.8.3. Nearly 60% of the IPD staff for left bank canal and drainage systems are budgeted as SIDA, yet after 10 years they still are controlled by IPD. At Distributaries within the jurisdiction of the AWBs, FOs are struggling to manage delivery of water to watercourses. Local water users, FO office bearers and staffs and NGOs report that IPD personnel often obstruct operations of the FOs by not providing timely assistance during canal breaches and by arbitrary restrictions on water deliveries.

The following observations and findings regarding IPD were identified during the review of the organization and staffing of IPD and as collected during more than 4,000 interviews by the social, environmental and economics teams of LBG/Indus.

[30] Budget, 2010-2011, "Current Expenditure (Part-VII)" Finance Department, Government of Sindh, Vol. III.

Organizational Review of IPD

1. Table 4.8.4 lists units of IPD that that have dedicated budgets for maintenance of machinery and to carry out bund upkeep, desilting and other maintenance operations at barrages and along the bunds. The combined budget totals about Rs.310 million.
2. About Rs. 1.1 billion is provided for the maintenance, repair and desilting of the Main, and Feeder Canals of the Left Bank, Table 4.8.5. These funds are assigned to specific canals in amounts varying from Rs 4.3 million to Rs. 55.9 million, presumably for "force account" or in-house work.
3. There is little to no budget for conduct of routine Preventative Maintenance in the budgets of operating Divisions. Budgets for each Division and unit lack monies for POL, vehicle and tool purchases and repairs, Tables 4.8-1, 2, and 3. Table 4.8.3 identifies that about Rs 296 million is available as Office Expenses. Most of these funds are for payment of electricity charges for tubewells and pumps.
4. Repairs to bunds breached during the flood of 2010 have generally been delayed until special budgets for consultants and construction companies could be authorized and provided.
5. Although IPD is the only organization in Sindh that has personnel and apparent capacity to manage delivery of water, budgets of canal divisions and circles lack resources other than for personnel, allowances and routine office expenses. Thus, as noted in 3 above, maintenance languishes and deferred maintenance grows progressively worse until there is need for replacement and rehabilitation system wide.
6. Assigned resources and personnel are inadequate to maintain the LBOD system.

The following observations and findings regarding IPD were compiled during the above noted review of the organization and staffing of IPD and primarily as collected during more than 4,000 interviews by the social, environmental and economics teams.

1. Stakeholders are divided, some recognize benefits of LBOD, i.e. shorter periods of inundation after storms and as an outlet for discharge of saline groundwater and agricultural drainage; while other stakeholders are negative, especially with respect to the quality (often poisoned by industry and agricultural pesticides and fertilizers) of the drain water which often is the only available water supply.
2. Villagers draw water from wells by hand pumps and from irrigation canals and ponds, when these sources are available.
3. Irrigation water is in short supply.
4. Adequate water is not released downstream of Kotri to "push back the sea".
5. Water logging and salinization of agricultural lands is spreading.
6. Health problems result from poor quality drain water.
7. Women are acutely affected by poor water quality and the resulting decline of livestock which they attend. Numbers of livestock have declined across the region, and particularly in flood prone areas, due to lack of fodder and other pressures.
8. Fish cannot survive the changed environment due to water pollution.

9. Sugar Mills are primarily responsible for the LBOD and other drain channels becoming toxic during periods of low runoff; there were repeated demands that sugar mills be forced to stop discharges of processing water to drains.
10. Communities consulted generally held the view that Farmer Organizations (FOs) are dysfunctional. Observations were:
    - FOs do not have enough power to ensure a proper share of water for their communities,
    - Powerful local individuals and "waderas" control the work of the FOs to the detriment of the rest of local people.
    - A majority of the stakeholders and communities consulted believe that IPD staff is corrupt and they sell water first to the rich and powerful.
    - There is malpractice by powerful landlords in the majority of the villages where consultations were held.
    - The IPD does NOT maintain the irrigation system regularly and properly, funds that are available are mismanaged.
    - Development Committees should be formed among local communities for monitoring of projects to help assure that bureaucracy and corruption do not dominate.
11. Villagers surveyed with respect to recent catastrophic floods hold views that are relevant to institutional reform:
    - Government response was too little, too late.
    - Displaced communities lost homes, crops livestock and jobs.
    - A system for early warning is non-existent or ineffective.
    - Government provided rations were insufficient.
    - No fodder was provided for surviving livestock.
    - Procedure for issuance of Watan Cards was ineffective and often a source of harassment in that flood victims repeatedly traveled to issuing offices and were day-after-day told to return tomorrow.
    - Communities ask that Government prepare a complete plan for relief and rehabilitation of flood affected villages including replenishment of livestock.
    - Stakeholders want strengthening of river banks and bunds through tree planting, construction of rain and flood channels, clearing of "katcha" areas and ***better management and coordination among responsible government departments and agencies.***

4.8.6.2 The Sindh Irrigation and Drainage Authority (SIDA)

The Sindh Irrigation and Drainage Authority (SIDA), Figure 8.3, was initially established under the SIDA Act of 1997 and the program of reform was further defined in the Sindh Water Management Ordinance (SWMO) 2002, as amended in 2005. SIDA is authorized and planned to be a semi-governmental utility. It also is an umbrella organization for formation and nurturing of Area Water Boards (AWBs). AWBs are designed to be independent utilities for administration and

management of Main and Branch Canals that deliver and ultimately will sell water to Farmer Organizations (FOs). FOs are small utilities that have been designed, chartered and formed for operation, maintenance and management of distributaries and minor canals that deliver water to watercourses and collect water charges (Abiana) from farmers.

SIDA is receiving considerable financial support, during an as yet undefined Transition Period, through: 1) Grants-in-Aid 2) pass through financing of components of the Sindh Water Sector Improvement Program, WSIP-1, and 3) allocations of the Provincial Budget. Both SIDA and the AWBs currently receive budgetary support through Provincial allocations to IPD[31], as tabulated in Table 4.8.2 entitled "Staffing and Budget of IPD Earmarked for SIDA 2010-2011" and Table 4.8.3 sub-titled, "Drainage Divisions for Land Reclamation". The two tables show that SIDA and the AWBs have allocated budgets that total about Rs.1.3 billion for staffs of 4,181 for canal divisions and additional staff of 870 in three divisions of the Reclamation group of the CE Development.

Staff budgeted for headquarters in Hyderabad, total 47 including the Managing Director (MD), Project Director (PD), and four General Managers (GMs). Directors of AWBs have been appointed under WSIP. Upper level managers are directly supported by 41 specialists at Headquarters and indirectly by the Directors of the AWBs who are former SE (Nara) and XENs (Ghotki and LB Kotri). IPD personnel who operate canal systems in the name of the AWBs remain under the administrative control of IPD and range from Directors (SE and XENs) to support staff (Daroghas and Beldars) and *Abiana* collectors (*Abdars*). It is significant that the AWBs are tightly under the control of the Directors at the top and that FOs have no control over Abdars who are key for the collection of water charges and Daroghas and Beldars for the maintenance of the Distributaries and Minor canals. Also FOs have little to no input to gate operations at the points of diversion from the Branch Canals to Distributaries.

The distribution of the budget among Officers, Other Staff, Allowances, Office Expenses and Civil Works (WSIP-1 funds) is summarized in Table 4.8.2. There is no budget allocation for Civil Works in 2010-2011; there was a small allocation in 2009-2010 totaling about Rs. 58 million. This amount illustrates the severe lack of funds in the budget for other than personnel, allowances, and office expenses. Monies are not allocated or are miniscule in these line items of the Provincial Budget for POL, transport, preventative maintenance or for rehabilitation of facilities considering the backlog of deferred maintenance.

The Nara Canal AWB (NCAWB) was formed in 1999 and the Ghotki Feeder Canal AWB (GFAWB) and Kotri left Bank Canals AWB (LBCAWB) were inaugurated in 2001. No additional AWBs have been formed subsequently due to the slow pace of reform implementation. However by 2010, 354 of 383 potential FOs had been registered.

It is significant that operating budgets for SIDA and AWBs are earmarked in the "Government of Sindh Finance Department Budget of 2010-2011". The budgets of the Managing Director and for the Nara AWB and the XEN Nara Canal are detailed on pp 631 to 643 of the Provincial Budget as Grants-in-Aid. Whereas budgets for the Ghotki Feeder Canal Circle and for the Left Bank Circle, Badin and for three left bank divisions, Fuleli, Akram Wah, and Guni, are specified as normal IPD budgets, not as grants-in-aid. MD SIDA also has a budget for Operation and Maintenance which provides for minor works in the jurisdictions of each of the three AWBs. Former Superintending Engineers or XENs of IPD have been re-designated as Directors of the AWBs and they manage, through XENs and AXENs, the traditional divisions of IPD that now operate with budgets

[31] Budget, 2010-2011, "Current Expenditure (Part-VII)" Finance Department, Government of Sindh, Vol. III.

earmarked by the Finance Department as agencies of SIDA. The management by traditional IPD staffs and procedures still prevail down to the jurisdictions of the FOs. Thus there are tensions that result from stakeholder complaints about the lack of cooperation or even obstruction by IPD staff at distributaries and minors.

SIDA and AWB operations benefit from funding through the Water Sector Improvement Programme, WSIP-I. Administration of that program under P&D and as guided by the Steering Committee is as shown in Figure 8.2.

The audited income of SIDA in 2009[32] was grants that totaled Rs 14.7 million. This was the same as was allocated in the Provincial Budget of 2009-2010.The audit report shows that Rs. 4.8 Million was expended for projects and Rs. 9.9 Million was non-operational expenditure used to pay salaries, office and travel expenses. This total dependence on grants needs to be reexamined after a decade long period of Transition. Of even more dire concern is the situation with the AWBs who, in theory, have budgets totaling more than one billion rupees but are totally controlled by IPD personnel appointed to direct the AWBs and to administer all the circles and divisions of the three systems.

Issues and Problems Related to Reform

Issues and problems associated with the reform program were identified within the context of implementation of the Water Sector Improvement Project Phase-I. The government of Sindh has identified an overarching objective to improve the efficiency and effectiveness of distribution of irrigation water particularly with respect to measures of reliability, equity and user satisfaction. This is expected to be achieved by deepening and broadening the institutional reforms that have been underway in Sindh since the 1990s and enhancing long-term sustainability of irrigated agriculture through participatory irrigation management and developing and modifying institutions for improved operation and maintenance (O&M) of the system that, after a period of transition, are to be financed from cost recovery.

Globally the issues relate to how can IPD and SIDA be energized to provide water more efficiently to irrigation, municipalities and industry in a cost effective manner that does not depend on the national and provincial treasuries to provide financing and operating funds. Findings indicate that IPD still is organized essentially as it was 50 years ago and has lapsed into paralysis due to poor administration and governance and political interference. and is not concerned with or does not value the public good. SIDA was formed more than a decade ago and has yet to secure enduring momentum that will permit it to achieve reform goals. Both agencies require rethinking and prompt action to reverse the institutional deterioration. The decay has enormous potential for irretrievably damaging the National economy.

Below is identification summary of major issues and problems that will guide the work of Phase II to achieve institutional reform.

4.8.7 Major Issues and Problems Identified for Guidance of Phase II

A large number of findings, issues and problems were voiced by the stakeholders. They were consolidated with respect to the institutional and organizational study and are presented by topic as questions that will guide the work of Phase II:

[32] "The Sindh Irrigation and Drainage Authority, Financial Statements for the Year Ended June 30, 2009", A. F. Ferguson & Co., Chartered Accountants, Karachi, transmitted to SIDA January 31, 2010.

- *Problem: Abiana* is the primary revenue collected by the FOs. It is not adequate to operate and maintain distributaries and minors. By law sixty percent of the *Abiana* collected by FOs is passed to AWBs. Sixty percent also is inadequate for O&M of the Main and Branch Canals.

  Abiana is crop and acreage based and does not encourage efficient water use. This is a major impediment to reform and achievement of water use efficiencies and consequent potential increase of National income. Of equal importance to shortfalls of revenue collection is that the *Abiana* system of crop acreage assessment and adjustments for yields lends itself to broad interpretation and reduced payments. There is an urgent need to rationalise the collection of a water fee.

  Although SIDA is making a maximum effort to collect *Abiana* through expansion of the *Abdar* staff and is conducting intensive programs of training, the collection of *Abiana* likely will continue to fall far short of OM&M needs.

  Issue: Revenue being derived from Abiana is inadequate for OM&M for canal systems of FOs and AWBs.

  Question: Can collection of water revenue be simplified and administered to fully cover costs of operation, maintenance and rehabilitation of the irrigation and drainage systems assigned to SIDA, AWBs, and FOs?

- *Problem*: IPD is not carrying out routine maintenance and has only a limited program of reconstruction and rehabilitation that is constrained by inadequate budgetary allocations. A well organized program of Preventative (routine) Maintenance requires that a complete inventory be made of each structure and its hardware, of each canal and drain reach, by sections of road and for cross drainage structures, buildings and other infrastructure. Frequency of each level of inspection for each structure is determined and work tasks are issued daily to mobile teams whose vehicles are equipped with tools and stores for on-the spot maintenance. Major problems are written up and repairs are made by "Force Account" involving in-house staff or by subcontracting.

  Review of the budgets of Table 4.8.1 illustrates the severe lack of funds in the budget for other than personnel, allowances, and office expenses. Monies are not allocated or are miniscule in these line items of the Provincial Budget for POL, transport, preventative maintenance or for rehabilitation of facilities considering the backlog of deferred maintenance.

Table 4.8. 4: Budget Allocated for Upkeep of Equipment, Machinery & M & R of Embankment & Headworks Budget 2010-2011

Ser No.	NAME	CIVIL WORKS (Rs)
1.	Repair & Maintenance of Machinery & Equipment	643,600
2.	Bund Works	189,295,000
3.	Embankments & Drainage Works	28,465,600
4.	Machinery & Equipment, Sukkur Barrage	7,693,800
5.	M & R (Head Works)	83,517,100
6.	Sum - Budget (Rs)	309,615,100

Table 4.8. 5: Budget Allocated for Maintenance & Rehabilitation of Main and Feeder Canals and Lift Irrigation & Silt Clearance

NAME	CIVIL WORKS (Rs)	NAME	CIVIL WORKS (Rs)	NAME	CIVIL WORKS (Rs)
Main Canals (Left Bank)		**Feeder Canals (Left Bank)**		Silt Clearance	475,000,000
Nusrat Canal	40,280,000	Akram Wah (Feeder)	21,520,000	Lift Irrigation Schemes	47,555,800
Nasir Canal	17,050,000	K.B. Feeder	13,640,000	Drainage Schemes	86,315,700
Guni Branch	8,105,700	Khairpur Feeder East	38,970,700		
Pinyari Branch	27,891,000	Khairpur Feeder West	30,545,000		
West Division Khairpur	30,404,800	Ghotki Feeder	55,947,600		
Rohri Division Moro	35,465,500	Fuleli Feeder	21,317,800		
Dadu Division Nawabshah	40,112,400	Pinyari Feeder	40,577,500		
Hala Division Hala	25,957,000				
Nasir Division Hyderabad	19,160,500				
Barrage Div. Sukkur	4,292,400				
Sub Total	**248,719,300**		**222,518,600**		**608,871,500**
Total					**1,080,109,400**

Source: Budget 2010-2011, Finance Department Govt. of Sindh

Table 4.8. 6: Number of Staff BPS: 1 to 14
Summary Report, Regional Master Plan Phase-I

Group	BPS (Range)	No. of Posts
Draftsmen	13,10	58
Stenographer, Sub Engineer	12,11	288
Assistant	6	271
Clerks	14,9,7	499
Abdar, Storekeeper, Telephone Operator, Tracer	7,5	729
Craftsmen, Gauge Reader	2,3	161
Darogha, Sub Darogha	4,2	668
Driver	4	212
Daftari, Typist	2	37
Beldar, Attendant	1	3200
Gate man, Fero Printer	1	664
Cook, Sweeper	1	361
Mehtar, Helper	1	238
Khalasi, Naib Qasid, PW MAT, Mali	1	1102
Masson Mistry, Mechanic Grade-1, Telephone Attendant	1	78

Source: Budget 2010-2011, Finance Department Govt. of Sindh

Table 4.8. 7: Income and Expenditure Account For the Year Ended June 30, 2009 Rupees in *'000'*

Income	2008	2009
Grants received from the Government of Sindh-non project	7,931	9,914
Deferred grant released	6,054	4,819
(Excess amount received) /amount short received from Donor Agencies on account of reimbursement of expenditures	16,111	(45)
Total:	**30,096**	**14,688**
Expenditure		
Project Expenditure	21,314	4,819
Non Project Expenditure:		
Salaries & Allowances	5,817	6,905
Telephone and Postage	547	598
Travelling and Conveyance	605	520
Electricity	1,207	998
Fuel Expenses	481	635
Printing and Stationary	53	54
Repair and maintenance	3	47
Others	69	102
Sub Total	8,782	9,869
Total:	**30,096**	**14,688**

PROPERTY, PLANT AND EQUIPMENT

	Office Equipment	Furniture Fixtures	Electric Installations	Total
As at June 30, 2009				
Cost	3,353	580	1,773	5,706
Accumulated Depreciation	2,547	148	263	2,958
Net Book Value	806	432	1,510	2,748
Depreciation Rate (%)	15%	10%	10%	

Source: Budget 2010-2011, Finance Department Govt. of Sindh

Issue: IPD is not organized, equipped, and staffed to carry out a routine program of maintenance

Question: How can IPD and the transferred Divisions be reorganized, equipped and re-budgeted to implement and maintain a Preventative Maintenance Program (PMP)?

- *Problem*: Neither SIDA nor IPD has organization, staff, or budget to manage rehabilitation, operation and management of LBOD. It is urgent that an effective entity with financial muscle

be empowered, organized and dedicated to manage a rehabilitated LBOD/DPOD/KPOD/Tidal Link/Dhand system. This can be accomplished with consolidation and restructuring of divisions of IPD that are programmed to be passed to SIDA.

Issue: IPD and SIDA have no operational program or staff for maintaining the LBOD

Question: Can current units of IPD and SIDA be regrouped and reorganized to monitor and manage a rehabilitated LBOD?

- *Problem*: IPD is a bureaucratic organization that has lost much of its capacity to perform because of inertia and reluctance to self examine and innovate. Perhaps the most serious of the problems of the Department is that the Divisions are not staffed, Table 4.8.6, or equipped to carry out routine every day maintenance, and compounds and offices are sited as they were decades earlier when needs were different.

  Also, the flood of 2010 revealed serious shortcomings in bund and barrage maintenance and no enduring effort has been made to take charge of the OM&M of LBOD even though it long has been a point of difficulty between WAPDA and IPD.

  Issue: IPD needs reorganization to routinely and equitably distribute water, to manage the Indus River and Main Canals and to maintain flood protection infrastructure before, during and after floods.

  Question: How can the Circles, Divisions, laboratories, M&R and other special units of IPD be regrouped and staff altered to upgrade efficiency and effectiveness in providing water equitably among water users and for addressing the issue of flood and river management?

- *Problem*: The transformation of SIDA, AWBS and FOs into utilities began well but has been halted/stalled due to the reluctance and active opposition to formation of utilities by IPD. The legal authority, budgetary allocations, and formation of FOs and AWBs provide the basis for early release of the administrative restraints that bind SIDA and that are preventing its development into a series of utilities. It is important at this juncture that consideration of roles appropriate to a self financing Utility and a government bureaucracy like IPD be sorted through. A utility cannot become self financing if it has to manage floods, bunds, and barrages on the Indus River. This is more appropriate to IPD which leads to a second point that needs resolution before SIDA and AWBs can become successful utilities. What are the appropriate roles for each of the two organizations, should IPD retain control and carry out maintenance of larger components of the river and canal systems while SIDA has operational input and buys and sells water, at some agreed point in the canal systems.

  Issue: Serious constraints to transfer of the AWB systems to SIDA are hampering reorganization

  Question: What are the steps appropriate to securing the administrative decisions that will secure transfer of budgets and personnel from IPD to SIDA for those units of IPD already identified in the Provincial Budget?

- *Problem*: Tubewells currently are mismanaged and not functioning as needed to supply supplemental irrigation water and to provide the drainage necessary to reduce water logging. The problem is complicated because tubewells are sited in fresh water zones, in zones where skimming is taking place and in areas where saline groundwater is discharged directly to drains.

Issue: Many public tubewells are not operational and consequently water logging and salinity are spreading.

Question: Can water pricing be rationalized so that self financing entities can be formed to provide supplemental irrigation water on demand and thus relieve government of a major share of the tubewell burden.

- *Problem*: There is no Financial Muscle for accomplishment of drainage and flood management in the irrigated areas and along the LBOD. Sustainable entities likely can be made functional only after IPD and SIDA functions are rationalized and fully implemented such that users pay a fair share for drain and river works and operations. It is only with financial muscle that organizations can become sustainable. Otherwise government bureaucrats who set budgets have little sympathy for budgetary needs and resulting budgets are modified to suit political rather than business goals. The management of floods is the business of the Nation and the Province, therefore direct identified users of agriculture and industry should be required to pay only a part of total costs.

  Issue: Budgeting for drainage systems and operations is negligible while the need is large in flat, waterlogged Sindh

  Question: Can existing units of IPD be grouped and consolidated with user groups (Drainage Beneficiary Groups, etc) to realize organizational and operational sustainability along with rationalization of user inputs to budgetary needs?

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