SINDH IRRIGATION AND DRAINAGE AUTHORITY

SINDH WATER SECTOR IMPROVEMENT PROJECT-I (WSIP-I)

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

Final Report - Phase - II

MAIN REPORT

Proposed Regional Plan

Volume – I

The Louis Berger Group Inc.

In Association with

Indus Associated Consultants (Pvt.) Ltd.

May 2012

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Chronology of Phase II Report

Date of submission of Preliminary Draft	March 26, 2012
Comments received from Panel of Experts/ SIDA	May 10, 2012
Submission of the Final Report	May 31, 2012

Letter of Transmittal

31st May, 2012

Dear Mr. Junejo,

We are pleased to submit the Final Report for Phase II of the Study 'Master / Regional Plan for the Left Bank of Indus, Delta, and Coastal Area'. The final report incorporates comments received from various stakeholders and observations and recommendations of the Panel of Experts meeting held in May 2012.

This report has been prepared with a stakeholder consultative approach involving a wide array of stakeholders, and represents their aspirations and expectation that the identified issues and problems will be studied and pre feasibilities are undertaken to resolve the issues, particularly related to timely and safely draining out drainage effluent, storm and flood waters. Accordingly this report presents a set of 16 pre feasibilities, and three position papers.

We would like to place on record our appreciation for the guidance and support extended by Engineer Ehsan Leghari (MD SIDA), Mrs. Farzana Abbasi (GM Transition) and Engineer Mr. Habeeb Ursani (Director AWB Badin), and yourself in the preparation of this report.

We would also like to place on record the support provided by Mr. Fateh M. Mari, PhD, Project Coordinator, PCMU, and Engineer Ylli Dedja, PhD, FAO Project Management Consultant (PMC/A), and Mr. Mohammed Ehsan, The World Bank Consultant. We would also like to express our gratitude to the Honorable Ministers, Mr. Murad Ali Shah, Minister of Finance, Mr. Jam Saifullah Dharejo, Minister of Irrigation, Mr. Nadir Ali Khan Magsi, Minister of Food, and Syed Raghib Abbas Shah (Member Water, WAPDA). Special thanks are due to the Panel of Experts (PoE) for their instructive comments. We take this opportunity to acknowledge the encouragement and guidance received from the Chairman PoE, Dr. Asad Kazi.

We would also like to mention here the appreciation and concurrence of the President of Pakistan on the perspective plan, who desired that the people of Sindh do not undergo this level of misery, in the event of similar unprecedented rainfall.

Sincerely yours,

Assuring our best services and cooperation,

Carlos A. Gandarillas,
Team Leader

PRESIDENT REVIEWS SITUATION IN FLOOD-HIT AREAS

DAWN dated Monday, October 31, 2011

KARACHI: Presiding over a meeting at the Bilawal House on irrigation, dewatering and drainage of flood-affected areas on Sunday, President Asif Ali Zardari directed the government to prepare water storage and drainage plans at the divisional level in the province.

He also called for devising a plan to divert rainwater to desert areas of the province during floods and store it for irrigation.

Sindh Chief Minister Syed Qaim Ali Shah, Water and Power Minister Syed Naveed Qamar, Petroleum Minister Dr Asim Hussain, provincial ministers Murad Ali Shah, Sharjeel Memon and Saifullah Dharejo, Secretary General to President Salman Farooqui and provincial secretaries attended the meeting.

In their briefings at the meeting, WAPDA and the provincial irrigation department claimed that 80 per cent of the floodwaters had been drained out from the inundated areas and work was going on round the clock to clear the remaining areas.

Foreign consultant Louis Berger gave a presentation on a drainage plan for dealing with similar calamities in future and submitted a plan for enhancing capacity of the Left Bank Outfall Drain (LBOD).

He asked the WAPDA and provincial authorities to give top priority to the work of clearing the flood-affected areas because of the upcoming Rabi crop and fast approaching winter. The president was briefed on the implementation of his earlier directives and steps taken for dewatering various localities.

The president stressed the need for a permanent drainage plan in the country which, he said, would reduce flood damage as incessant rains might recur due to climate change. He directed that after the completion of the dewatering work, a mechanism should be devised to provide wheat seed to affected areas to enable farmers to sow wheat crop because any delay would not only adversely affect farmers, but would also reduce national crop output.

http://www.dawn.com/2011/10/31/president-reviews-situation-in-flood-hit-areas.html

Acronyms

AWB	Area Water Board
B/C	Benefit Cost
BOD	Biochemical Oxygen Demand
C	Celsius
CDM	Clean Development Mechanism
cfs	Cubic feet per second
CO	Community Organization
COD	Chemical Oxygen Demand
DCO	District Coordination Officer
DDMA	District Disaster Management Agency
DPOD	Dhoro Puran Outfall Drain
DRIP	Drainage Reclamation Institute of Pakistan
EC	Electrical Conductivity
ENMD	East Nawabshah Main Drain
ETo	Evapotranspiration
FGOD	Fuleli Guni Outfall Drain
FGW	Fresh Ground Water
FO	Farmers Organization
GCA	Gross Command Area
GFCAWB	Ghotki Feeder Canal Area Water Board
GIS	Geographic Information System
GoP	Government of Pakistan
GoS	Government of Sindh
ha	Hectare
IAC	Indus Associated Consultants Pvt.
IBIS	Indus Basin Irrigation System of Pakistan
IBRD	International Bank for Reconstruction and Development
INGO	International Non Government Organization
IRR	Internal Rate of Return
IUCN	International Union for Conservation of Nature
Km	Kilometer
KPOD	Kadhan Pateji Outfall Drain
LBCAWB	Left Bank Canal Area Water Board
LBG	The Louis Berger Group Inc.
LBOD	Left Bank Outfall Drain
MAF	Million Acre Feet
M cft	Million Cubic feet
MD	Managing Director
MDP	Metrological Department of Pakistan
M&E	Monitoring & Evaluation
MF	Micro Filtration
MH Dhoro	Meharabpur Hussainabad Dhoro
mm	Millimeter
MMD	Mirpurkhas Main Drain
MPL	Maximum Permissible Limit
NCAWB	Nara Canal Area Water Board
NDP	National Drainage Program

NF	Nano Filtration
NEQs	National Environmental Quality Standards
NGOs	Non Governmental Organization
NPV	Net Present Value
NTU	Nephlometric Turbidity Units
NTW Dhoro	Nangreja Talpur Wada Dhoro
O&M	Operation & Maintenance
PBD	Patoyun Branch Drain
PCRWR	Pakistan Council of Research in Water Resources
PDMA	Provincial Disaster Management Authority
PEPA	Pakistan Environmental Protection Agency
PMU	Project Management Unit
POL	Petrol, Oil and Lubricants
PSQCA	Pakistan Standards Quality Control Authority
RD	Reduced Distance
REDD	Reducing Emission from Deforestation and Forest Degradation
RF	Rapid Filtration
RO	Reverse Osmosis
Rs.	Pak Rupees
SBD	Sinjhoro Branch Drain
SCARPs	Salinity Control and Reclamation Projects
SDPI	Sustainable Development Policy Institute
SFD	Sindh Forest Department
SGS	SIDA Gender Strategy
SGW	Saline Ground Water
CDA	Coastal Development Authority
SIDA	Sindh Irrigation and Drainage Authority
SMD	Sanghar Main Drain
SMO	Salinity Monitoring Organization
SSF	Slow Sand Filtration
TDS	Total Dissolved Salts/ Solids
TMA	Taluka Municipal Administration
TSS	Total Suspended Solids
UASB	Up flow Anaerobic Sludge Blanket
UN	United Nations
UNFCC	United Nations Framework Convention on Climate Change
UV	Ultra Violet
WAPDA	Water and Power Development Authority
WASA	Water and Sanitation Authority
WCA	Water course Associations
WHO	World Health Organization
WNMD	West Nawabshah Main Drain
WSIP	Water Sector Improvement Project Phase
WSSD	World Summit on Sustainable Development
WUA	Water Users Associations
WWF	World Wildlife Fund for Nature
WWG	Women Water Group

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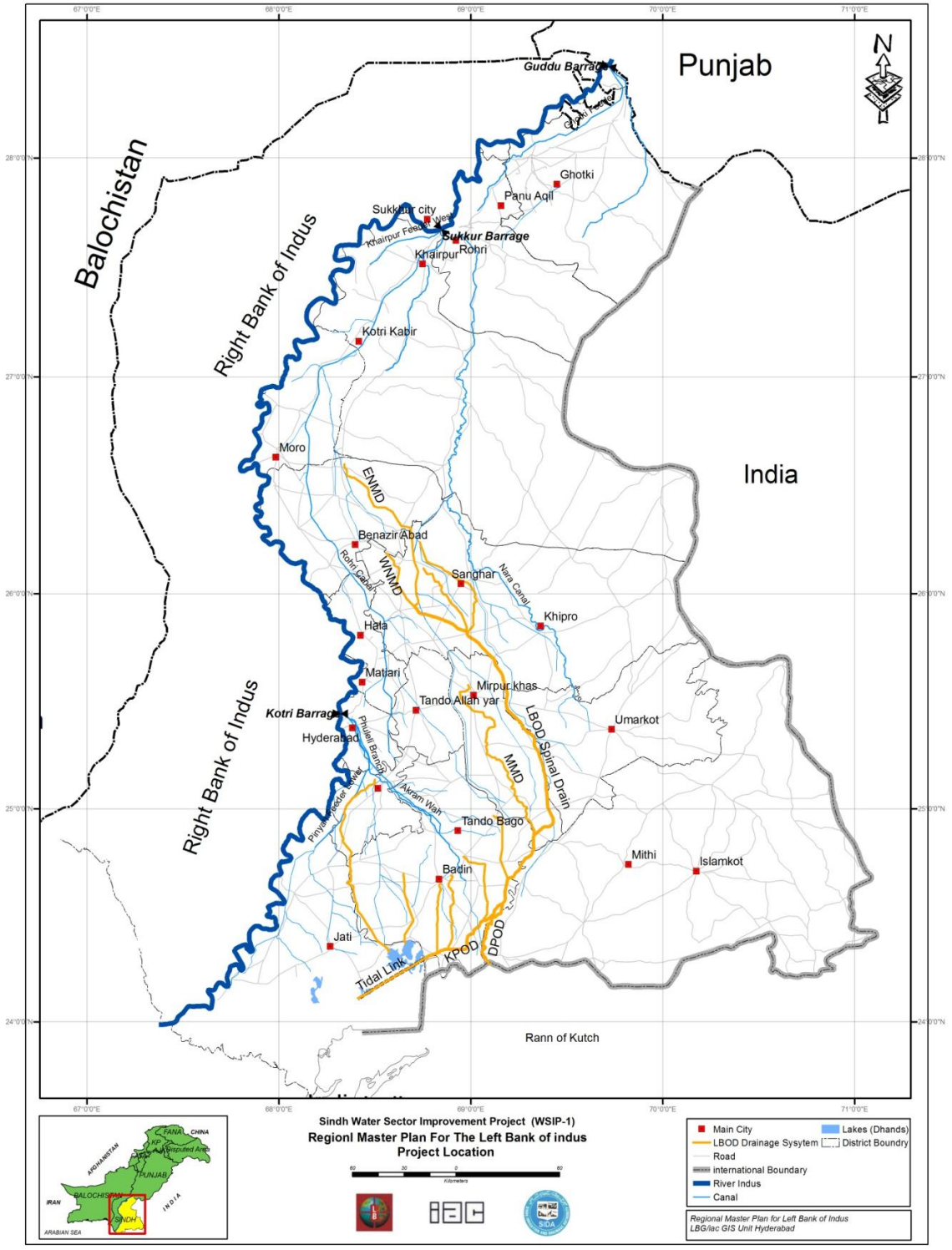


1 INTRODUCTION

1.1 The Report

This is the draft report for the Phase II of the study '*preparation of the regional plan for the left bank of Indus, delta, and the coastal areas*', hereon referred as Regional Plan Study (RPS), submitted for the approval of the Sindh Irrigation and Drainage Authority (SIDA), Government of Sindh. The final report will be submitted to SIDA after incorporating comments and suggestions received from SIDA and their designated review process. This report mainly presents the pre feasibilities of the structural and nonstructural interventions selected by the stakeholders through a consultative process that included identifying the problems/issues, deliberating the solutions, and selection of agreed interventions based on technical feasible options, socially acceptability, financial/economic viability, and desirable impacts. In the following phases of the study, detailed feasibilities and tender documents for the ranked, identified, and approved interventions will be prepared.

1.2 The RPS Background

The RPS is one of the subcomponent of the Sindh Water Sector Improvement Project Phase-I(WSIP-I). The WSIP-I has four components, namely, i) community development and capacity building; ii) improvement of irrigation and drainage system; iii) management plan for irrigation and drainage infrastructure; iv) project monitoring, evaluation, and supervision of environmental management plan; and v).project coordination, monitoring, technical assistance and training. One of the subcomponent of component iii) is '*preparation of regional plan to deal with floods and drainage issues on left bank of Indus river and designing measures for improvement of the Indus delta and the coastal zone*.'

The six year duration project, with a funding support from the World Bank was launched in December 2007, terminating in April 2013. The main objectives of the WSIP-I includes: i) strengthening and fast tracking the institutional reforms that are already underway in Sindh; ii) improving the irrigation system in a systematic way covering key hydraulic infrastructure, main and branch canals, and distributaries and minors; and iii); 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 main objective and scope of the RPS is to prepare for the Government of Sindh (GoS) a regional plan for addressing the flood issues and proving proper drainage to the area on the left bank of Indus River through appropriate structural and nonstructural 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, and 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 RPS is designed to be completed in four phases. The scope of each of the four phases of the study includes:

Phase I Study: Preparation of 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. The report of this phase was submitted in December 2010, and approved in June 2011. This Phase-I study is also required 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.

Phase II Study 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.

Phase III Study 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 Study 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.

All the above study phases are to be undertaken with an extensive participatory consultations with a wide array of stakeholders and communities in the study area, including delta and coastal areas, activists, NGOs, various public sector agencies, and decision makers.in identifying issues and solution options, prioritizing interventions, and participation in planning, designing, and implementation stages. The overall regional plan process is depicted in the following diagram.

1.3 Phase- II Study Objectives and Scope

The main objective of the Phase II study is to i) identify structural and non-structural solutions/options and interventions; ii) prepare pre feasibilities of the interventions selected through stakeholder consultative process, detailing rationale, output, impact, along with technical and economic viability, sustainability, and socially acceptability. Based on the selection criteria developed the pre feasibilities will be ranked and prioritized by the stakeholders for the preparation of detailed feasibilities and tender documents in the following study phases.

1.4 Report Preparation Process

Following the submission of Phase 1 study report, as a proactive strategy, the Consultants embarked on the preparation of pre feasibilities for solutions for intervention aspired by the stakeholders. This was based on review of available studies, field studies, surveys, procurement of satellite imagery, and ongoing process of consultation with the stakeholders. The near finished pre feasibilities, that were technically feasible and economically viable were presented to the stakeholders, along with the selection criteria, at the district and Area Water Board (AWB) levels. Based on feedback from the stakeholder workshops, 19 pre-feasibilities were presented at the national stakeholder workshop, held on 14 January 2012 in Karachi. The participants agreed with the Consultants selection and advised to submit the pre-feasibilities for approval and final selection of interventions for detailed feasibilities.

During the course of preparation of pre-feasibilities, the unprecedented rains and havoc thereof, provided an opportunity to monitor the performance of the drainage system to cope with the strain and weaknesses in the system, and its damage to the human lives, agriculture, livestock, private properties, irrigation, drainage, and physical infrastructures, miseries of the flood displaced persons including their constrained access to social services, and livelihoods. This required reallocating Consultants focus and resources to closely evaluate the systems' capacity and alternatives options and interventions to ensure safe disposal of storm water in the event of future similar extremes.

During the preparation of the report sufficient Consultants resources were reallocated to provide support and assistance to SIDA and the Core 5 Engineers, and providing information and analysis to the irrigation department and senior politicians, including the President and at the provincial Cabinet level. This also included preparation of a plan of emergency works to restore the capacity of the drainage system, and measures to ensure safe disposal through natural waterways in the event of similar rains.

1.5 Stakeholder Consultation Process for Phase -II Study

During this Phase of the study, 12 workshops were organized at the district level, 3 at the Area Water Board (AWB) level, and one regional/national level, The Consultants supported by fifteen local partner NGOs and a consortium of six organizations/NGOs, strived hard to bring relevant stakeholders into the workshops, attended by about a little over one thousand participants, of which 121 were women. In addition to this six TV programs were held for wider dissemination and feedback.

In these workshops, the stakeholders were facilitated to express their aspirations and apprehensions vis-à-vis the possible solutions and interventions proposed by the Consultants. Based on the stakeholder consensus and agreement 16 interventions were selected for preparing the pre-feasibilities. The conceptual outline of the selected pre-feasibilities was presented in a regional/national workshop, held on 14 January 2012 in Karachi, for the final selection and approval of the stakeholders. Attachment 1 presents a summary exposition of the consultative process, during both the phases of the study.

1.6 Report Organization

1.6.1 Description of Volumes

The report has been organized in four volumes.

i. Volume I is the Main report (this volume).
ii. Volume II embodies the detailed pre feasibilities.
iii. Volume III presents the hydrology and hydraulic simulation studies.
iv. Volume IV presents the consultation process, and workshop proceedings.
v. Volume V is the Atlas.
vi. Volume VI presents the Preliminary Drawings

1.6.2 Outline of the Main Report

The section I introduces the report in terms of background to the RPS, its purpose, report preparation process, and coverage of the report. The section II provides a brief recap of the Study Phase 1 report. Section III summaries the findings of the hydrology and hydraulic simulation models, while section IV presents a rapid assessment of the 2011 floods, lessons learnt including a change in the mindset of the stakeholders, and guidelines and directives of the decision makers. Section V presents project/intervention briefs on basis for the ranking and selection of pre feasibilities, comments from the participants of the provincial stakeholder workshop. Section VI presents recommendations for screening and the selection of interventions.

2 RECAP OF THE PHASE- I STUDY

2.1 Brief Overview of Phase I Study

The Phase study commenced in April 2010, and a draft was submitted in December 2010. The phase I study report, after a series of reviews and incorporation of comments was finalized and approved in the June 2011. This Phase of the study was dedicated to the 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.

The main activities during the preparation of the study Phase 1 were i) review of available relevant reports and interaction with staff of relevant agencies, ii) field visits to assess the performance of existing infrastructure, wetlands, and coastal areas and improvements and revival needs; iii) preparation of technical, descriptive and analytical reports on area description, inventory of existing irrigation and drainage infrastructure and issues related to its operation and maintenance, impact of seawater intrusion, institutional issues, disaster management etc.; iv) scoping sessions and intensive consultation with the stakeholders at the village, district, regional, and provincial levels.

About 5,000 persons were consulted/participated in the workshops. The objective was to solicit the perceptions about issues related to safe disposal of drainage, flood and storm water, and impact of these infrastructures on poverty and livelihoods.

The Phase 1 report was organized in eight thematic areas detailing of the work and findings that addressed the requirements of the scope of work mentioned in the contract. The thematic areas included: i) overview and development of planning for drainage and flooding; ii) water resources and water usage for drainage and flooding; iii) impacts of drainage and flood on environment and wetlands; iv) flooding, disaster management and mitigation; v) structures for irrigation drainage and flood protection; vi) overview of current agriculture, livelihood, and economic aspect of drainage & floods; vii) social issues of drainage operation and flooding; and viii) review of capacities of provincial agencies involved in execution of the irrigation and drainage projects and its management.

2.2 Summary of Issues and Problems Identified by Stakeholders

During the course of the Phase 1 study, extensive consultations were held with the stakeholders, including knowledgeable people and opinion makers, NGOs and activists to solicit their perception and opinions vis-à-vis the issues and problems related to the performance of the irrigation and drainage subsectors, and their adverse impact on agriculture, general welfare and livelihoods, and environment, need for extending the drainage infrastructure in the areas outside the LBOD system, need and options for the safe and timely disposal of storm water, and apprehensions regarding increasing the capacity of existing drainage system in the lower reaches of LBOD system. In addition to this they expressed their concern on the sea encroachment damaging the productivity of farm land, fisheries potential, and quality of life. The findings were presented in a series of workshop in the study area and in the national workshop, and were the basis for formulating various options to ensure safe disposal of drainage and storm water effluent.

3 OVERVIEW OF 2011 FLOODS

3.1 Rapid Assessment

The monsoon of 2011 was manifested by remarkably high rainfall event in Sindh, particularly in the left bank of Indus. The cumulative rainfall varied between 423 mm to as high as 1,143 mm. The Tharparkar district recorded the highest rainfall, followed by 866 mm in the Mirpurkhas, 628 mm in Shaheed Benazirabad, 615 mm in Badin district, 544 mm at Chhor in Umerkot district, and 423 at Padidan in the Naushehro Feroze district. In Tharparkar district, where the infiltration rate is quite high, the runoff was minimal, compared with the other areas in the left bank. The average intensity during the 8 August to 18 September was about 800 mm. The area inundated in seven severely affected districts of Sindh is shown in Figure-1

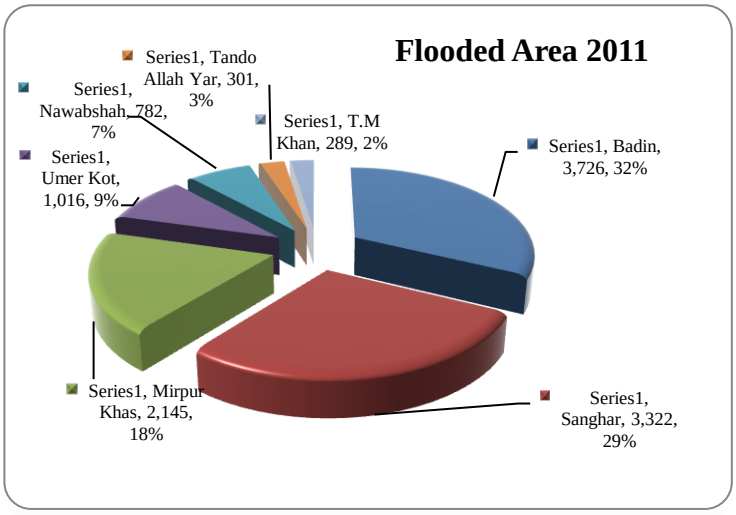


Figure 1: Flooded Area 2011 in LBOD Area

As the gradient of the coastal areas is near zero, the disposal of the runoff was inhibitive causing inundation and stagnation of the storm water. In addition to this infrastructure such as rail and road networks, canal and drains, and encroachments in the natural water ways also inhibited the free flow. The delay in the evacuation of the storm water runoff was further compounded by the breaches in the irrigation and drainage network. The situation further exasperated with the gushing influx of storm water into the drainage system beyond its design discharge capacity of 4,600 cusecs.

Two to six feet of stagnated water marooned the settlements and restricted access to social infrastructure submerged the standing crops including fodder, and a significant number of livestock, particularly milch animals were lost. It also damaged the productive, physical, and communication infrastructure. It is estimated that about 500 people succumbed to the floods.

According to the Provincial Disaster Management Authority (PDMA) estimates about 38.5 thousand villages were affected, mostly in Badin district followed by Shaheed Benazirabad, Sanghar, and Umerkot districts, causing misery to about 9.3 million flood affectees. PDMA also estimates that about 1.6 million houses were fully or partially damaged. A large number of flood displaced persons had to take refuge on the sparse higher grounds. Of these about 769 thousand people were provided refuge in the relief camps.

PDMA estimates that due to the storm water floods, about one third of the paddy area, half of the area under chilies, and 80 percent of the cotton area, and about 90 percent of the tomato and onion acreage were wiped out. In terms of production, it is estimated that about two million bales of cotton, 250 thousand mt of paddy, 330 thousand mt of onion, 77 thousand mt of chilies, and some 70 thousand mt of tomato were lost to the catastrophe. In addition to this about 117 thousand animals were lost, excluding a significant number of poultry in the houses and the poultry farms.

3.2 Key Field Observations on the floods

3.2.1 Depth of the Storm Water

During the field visits, observations were made to sound the depth of flooding in the affected areas. It was observed on 15 August that, in the vicinity of breached canals, water was about four feet deep across the countryside inundating villages, submerging crops, and was flowing over the roads eroding its shoulders. The sheet flow of water was wide across, trapped by the communication infrastructure, such as roads and railroad, and embankments. The culverts were inadequate in number and mostly found choked and hindered enormous sheet flows.

3.2.2 Performance of the Drainage System

While assessing the performance of the LBOD System it should be taken into account that between its upper reaches and Badin, the natural gradient reduces from 0.000118 to 0.000055, which substantially reduces the velocity of the storm water flows. If peak storm flows are not instantly evacuated out of the system, ponding effect is experienced in the lower reaches of the drainage system, and hence, lower reaches of the system need much higher evacuation rate than the upper reaches. Similarly the tail reaches of the two main branches of the LBOD namely KPOD and DPOD are four to seven feet below the sea level, retarding the conveyance velocity of the drain during high tide, particularly during the flood season.

In addition to this the operation of the irrigation system in the Mirpurkhas area, as observed during 2006 and 2011 floods has its bearing on the capacity and performance of the drainage system. During the months of July and August, the Nara-Jamrao system operate at the maximum level hence during floods a number of breaches occur in the irrigation system, causing secondary breaches in the drainage system, particularly in the sub-drains.

The abovementioned scenario is based on standard hydrological return period estimations using Log Pears III method and calculations of runoff using Soil Survey Curve Numbers (SSCN). Maximum capacity of LBOD is adopted from its actual functioning during the floods of 2011.

Despite siltation, the drainage system coped flows that were about two to three times higher than the design capacity. It suggests a generally good physical performance of the Spinal drain above the berm level. Considering the quantity of water that flowed through this section over a period of one month, physical breaches of the banks and berms were limited.

The Consultants made extensive visits to the flood affected areas, where ever accessible. It was noted with relief that the LBOD spinal drain performed fairly well despite breaches, overtopping in some areas, rain cuts on the banks and sloughing of the banks. The band aid repair of the spinal drain breaches by the concerned agencies was timely and effective. Specifically it was observed that:

i. the spinal drain was flowing at the maximum available depth covering primary and secondary berms after its junction with MMD at RD 297. The main sub-catchment tributary drains also performed satisfactorily;

ii. the Nawabshah East and West drains received normal flows of storm water from their respective drainage areas;

iii. the Sanghar sub-component also functioned below it maximum capacity; the canal escapes however, were discharging water to the spinal drain;

iv. the Mirpurkhas Main Drain (MMD) and its lower network was under the highest pressure, and was the first to suffer a breach on 12 August at RD 365, which received high quantities of runoff from the larger catchment of Mirpurkhas, and

most of its branch drains flowing at the top level or overtopping. It was also receiving high quantities of canal water from the Jamrao Canal, and MMD was flowing bank full at the crossing of Tando Jan Muhammad-Jhudo road overtopping the banks at several points upstream and downstream. The left bank of MMD downstream from the road bridge was submerged and it confluence with the Dhoro Puran water that was flowing adjacent to it;

v. the storm water accumulated in the Dhoro Puran upstream of Jhudo town overtopped into MMD. At one place the Dhoro Puran was passing through the culvert with insufficient capacity. This section has been narrowed due to encroachments that resulted in the overtopping of the banks.

Although the behavior of the branch drains could not be observed in detail, nonetheless, widespread over-flowing of the sub-drains indicated an overall capacity deficit of the branch system. About 40 breaches in the drains, as reported by the rapid assessment conducted by the Pakistan Red Crescent Society (PRCS), suggest the need for a follow up on field assessment. However, it was concluded that:

i. due to insufficient capacity of the sub-drains the Badin sub-component started surcharging first. On the 12th of August a breach in the Shadi-Bahader system was observed. The water was back flowing from the sub-drain with high velocity quickly submerged a large area;

ii. the surface ditch and culvert systems were observed to be inadequate to the requirement of conveying ponded water toward drains. Culverts to pass water under railways and roads were too few and of insufficient capacities;

iii. deep cuts made by the local populace to pass water from canal breaches even though a small culvert already was passing water, submerged the road connections, particularly in the Digri town in the Mirpurkhas district.

3.2.3 Drainage Behavior of LBOD System at Different Flood Levels

The LBOD drainage network provides drainage to the major areas of Shaheed Benizirabad, Sanghar, Mirpurkhas and Badin districts. This was built to drain the saline effluent of drainage tube wells and the storm water of 125 mm rain through outfall into sea. It was designed with an average drainage coefficient of about 2 cusecs per square mile. The maximum flows during the current floods show that the drainage network can achieve a coefficient of 3.5 cusecs per square mile, evacuating the same within four to five days, in an average rainfall year. Timely evacuation during this period is possible only if average rainfall in the catchment remains below 115 mm. The base flow from irrigation and vertical drainage is close to 3,000 cusecs, almost double of the design capacity.

Four canal escapes, two from Jamrao canal and one from Mithrao canal discharge into the LBOD, while one escape from Akram Wah discharge into DPOD. The discharge capacity of these escapes is about 1,000 cusecs. The main purpose of these escapes is to provide safety to the irrigation channels. During July and August, these escapes are frequently operated. The fishing in LBOD is another reason for operating these escapes

The post flood discharge measurements made by the Consultants show that despite the flows were above the designed capacity, more than 12,000 cfs was flowing in the LBOD tail reaches, without overtopping and breaching. Similarly, the discharges measured in the various main drains significantly surpassed the respective capacities. In the Shaheed Benazirabad district the drains accommodated about 4,446 cusecs against a designed discharge capacity of 1,651 cusecs, while Sanghar main drain carried a discharge of 3,314

cusecs against a designed capacity of 2,188 cusecs. Similarly the main drains in the Mirpurkhas and Badin districts carried about 2,067 cusecs and some 2,378 cusecs respectively, against a corresponding design discharges of 1,592, and 2,908 cusecs.

3.2.4 Impact of the Irrigation System Operation on the Floods

The management of the irrigation system also has its consequences on the performance of the drainage system. Despite the minimal demand for canal supplies during this period, there was considerable delay in suspending canal withdrawals exerting pressure on the drainage system. As the watercourses were blocked by most farmers, the actual water level exceeded the design capacity of the canals, that caused canal breaches in the distributaries and the larger Jamrao West Branch canal. Moreover, this exerted pressure on the canal escapes. During the critical five days August 12 through August 16, the canals continued to flow even though repairs were undertaken largely by local landowners. It was observed and noted that:

i. During the rainy season, wherever the canal system continued to operate, the farmers blocked the watercourses, that exerted pressure in the system;

ii. The canal escapes continued to discharge large flows into LBOD because, as noted above, the canal head works were not closed although many distributaries had been closed in upstream areas of the Nara and Rohri Canal Commands. Consequently, the main and branch canals of the Nara and Rohri systems were surcharged and had to continue operations even though breaches had occurred flooding the countryside; The breaches in the irrigation system started occurring since 12th August, while it was still raining. According to SIDA field data, eleven breaches in Nara canal distributaries and minors occurred on 11th and 12th of August. The obvious cause of these breaches was the closing of watercourses by the farmers, while the main canal system was still operational. Two breaches occurred in the Left Bank Canal Area. The water from nine minor canals of the Shadi sub-division (Akram Wah System) was disposed of to the sub, branch and the main drains of the LBOD system.

iii. On 11th of August, Akram Wah (Lined Channel) was closed, while, flows in Fuleli and Pinyari were reduced. The Pinyari and Fuleli canals were subsequently closed on 12th August. However, Jamrao and Rohri irrigation systems were not closed during the floods. Later on, as a response to the breaches and reduced water demand, some of the branch and distributary canals were closed but a number of breaches had to be repaired, while the main canals continued to operate. Nonetheless, the closure of the canals with breaches did reduce the flow outside the system. It was also observed with concern that in Badin District. Some of the drainage tubewells continued to pump the saline water into the LBOD spinal drain even though the adjoining areas were flooded by breaches.

3.3 The Lessons Learnt

The natural calamities and disaster despite the destruction and miseries also offers opportunities to plan coping mechanisms for a resilient future. It brings out weaknesses in the system and to adopt corrective measures. Disasters also trigger new dynamics and challenges the status quo of conventional inefficient management and governance of the resources and offers lessons for more responsive and responsible management. The 2011 storm water disaster is not an exception, and offered an opportunity to adopt proactive interventions for future, such as disaster preparedness, and remodelling and rehabilitation of infrastructure for climate proofing against the extreme weather event threats. Some of the lessons learnt are as

follows.

3.3.1 Under Designed Drainage Network

The existing drainage infrastructure was designed for 5 year return period and for a rainfall of 125 mm to be evacuated in 5 days. The last two decades have witnessed more frequent high rainfall events, and the flood disasters. The intensity of 2011 rains was unprecedented; about 5 to 6 times higher than the design capacity of the drainage system. The data on year wise rainfall and daily max/min rainfall suggests that the need to remodel and rehabilitate the existing drainage infrastructure on a 20 year return period basis so as to enable the system to timely and safely dispose the high intensity storm water flows.

3.3.2 Deferred Maintenance of Irrigation and Drainage Infrastructure

The stakeholders complained that the drains are clogged with weeds and siltation, and the banks have numerous rain cuts, and deliberate relief cuts by farmers during previous rains, which were not fixed. This increases the vulnerability and risk of breaches, which were witnessed during 2011 floods.

3.3.3 Encroachment in the Waterways

The major cause of timely disposal of the storm water flood was the obstructions in the natural waterways aka *dhora*s. These *dhora*s used to be operational before the construction of the LBOD system. The blockades include unauthorized construction of adobe and brick walled structures, and cultivation. It was also observed that the inadequate size of the drainage outlets, culverts, also caused ponding of flood water in the depressions and could not be evacuated due to barricades all around. It warrants provision of adequate drainage outlets, culverts, bridges, waterways to facilitate the prompt disposal of flood water.

In addition to this the intersecting roads, bridges, and the spinal drain further constrict the gushing storm water flows. This recognizes the need to provide siphons or super passages to facilitate the storm water flows through the *dhora*s. The GoS has recently enacted legislation in this regard, and it needs to be enforced and complied with.

3.3.4 Delayed Closure of Irrigation Canals

It was noted with grave concern that despite the prior prediction of the extreme rain event, the irrigation infrastructure remained open delivering regular irrigation water supplies in the main canal systems. This resulted in about 55 reported breaches in the main canals and the minors/distributaries while heavy downpour continued generating significant high storm water flows. Both combined caused miseries for the communities at large. There is exigent dire need for coordination between the Meteorology department and other functionaries responsible for disaster management to be proactive and to timely disseminate the information widely.

3.3.5 Absence of Trigger Mechanism for Disaster Management

Absence of a coordinated flood preparedness plan by the line agencies is one of the major concern, particularly access to space for make-shift shelter or arrangement, boats for rescue operations, pumping sets for evacuating flood water, access to food supplies, potable water, and medical facilities, fodder for animals and similar other supporting items essentially needed for flood affected population.

Due to the absence of a trigger mechanism to provide rescue, relief and rehabilitation strategy, timely support could not be provided to the flood affectees. An appropriate advance action would have diluted the miseries created by the floods of this event. Thus the line agencies including the PDMA, Irrigation Department, Food Department, Health Department,

Local Government Department, Education Department, Agriculture Department, Pakistan Army, District Governments, Local and International NGOs need to develop preparedness strategies to face such natural calamities.

3.3.6 Absence of Make Shift Shelters

Based on the reports of Intergovernmental Panel on Climate Change (IPCC), Pakistan is among the top ten countries most vulnerable to climate change. Therefore, as an immediate preventive measure, the raised platforms may be built at suitable places for the affected population to get temporary shelter in case of rain or river flood disaster for the people, livestock and their belongings.

3.4 Paradigm Shift (Change in the perception of the stakeholders)

Since its construction, a sizeable population of the Badin district maintained that the LBOD drainage network has brought significant miseries to them. They believed that priority was given to improving the productivity of Shaheed Benazirabad, Sanghar and Mirpurkhas districts at their cost. They felt that the disposal of drainage effluent generated from the vertical and surface drainage network, into the sea, passing through their districts has creating significant negative externalities for them. Consequently, this had an adverse impact on the productivity of farmland, fish potential, limiting livelihood opportunities. They also opined that due to the seawater intrusion and back flows in the drains rendering their once fertile lands saline and water logged, thereby severely irreversibly impairing the coastal environment. This resulted in decrease in the natural resource bases, dwindled livelihood thereby significantly increasing the poverty.

During the 2011 floods, the consultants made a number of field visits to identify the issues and problems faced by the communities in the flooded areas, and to observe the performance of the drainage system.

The devastating floods brought a change in the perception of the stakeholders about the effectiveness of the drainage infrastructure, and its utility, and need for its rehabilitation and remodeling where required. This has softened the opposing stance and negative perceptions amongst the stakeholders in the Badin and Thatta districts. Most people in the field now tacitly acknowledge that the LBOD system played a role in evacuating 2011 flood waters, as the LBOD system accommodated three times more flows than its design capacity, notwithstanding few incidents of overtopping and/or breaches.

Most persons now accredit that the drainage network did depress the flooding disaster. They concede that without which the losses to the lives and property would have been manifold. Most of the communities have realized that drainage infrastructure needs to be revamped to provide timely evacuation of the storm water. While talking to the communities, it was noted that the negative perceptions of the stakeholders has been watered down, and has dented the complete rejection of the drainage system, while appreciating is positive aspects.

3.5 Policy Makers Guidelines for the Regional Plan Focus

After a briefing to the President of Pakistan by the Chief Minister, Minister for Irrigation, Minister for Food, Secretary IPD, MD SIDA and other senior officials, officers of Military 5 Corp, and the Consultants held on 30 October, 2011, the President commented that ‘we cannot afford revisit of such a catastrophe’ and directed that a field visit should be forthwith undertaken to review the situation and preparation of an action plan and its implementation before the advent of 2012 monsoon, so as to ensure a safe and timely disposal of storm water drainage from the left bank of Indus.

After a joint review mission by the ministers, Secretary IPD, MD SIDA, officers of the Engineering 5 Corp, and the Consultants, visited the area. The assessment and recommendations were presented to the President in subsequent meetings for approval. The President desired that the recommendation should be fast tracked and emergency works to be in place by the end of June 2012. He also emphasized that emergency works to relieve from the ponded storm water in the low lying areas, and repair and rehabilitation of critical infrastructure including *dhora*s so as storm water is timely and safely drained in the event if 2012 rains of last year intensity.

In a follow up meetings with the Minister of Irrigation, Secretary Irrigation, and MD SIDA desired that the strategy of the regional plan being prepared by the Consultants should now focus on: i) the repair, rehabilitation of LBOD and Kotri Barrage drainage network within the left bank; and ii) diversion and offloading flows in LBOD to Thar Desert through revived *dhora*s.

In compliance of the directives of the President of Pakistan a perspective plan for the drainage system improvement was formulated by the Consultants in consultation with SIDA, and WAPDA officials, and got approval from the policy makers.

The objective of the perspective, as guided by the President is to restore and enhance the discharge capacity of existing drainage system, and restoration of old and existing *dhora*s, both to cater for 20 years return period flood.

The salient elements of the strategy are:

i. rehabilitation and strengthening of the existing vulnerable and damaged drainage infrastructure on emergency basis and its completion by the end of financial year 2011/12;

ii. clearance of obstructions and encroachment of *dhora*s, and reactivation of the *dhora*s to off load storm water pressure on the LBOD;

iii. remodeling and enhancing of the discharge capacity of existing drainage network, and retarding sea water intrusion; and

iv. construction of surface drains to safely pass the storm water in areas outside the LBOD areas.

The detail of the action plan and time frame for different activities is mentioned in the following sections 5.3.1 and 5.3.2.

4 HYDROLOGY AND HYDRAULIC SIMULATIONS AT A GLANCE

The hydrology analyses aims at updating the key hydrological parameters and understanding rainfall patterns causing floods. An integrated hydraulic assessment of the LBOD system has been carried out for the first time. The results of hydrology and hydraulic simulations were adopted as determining the design parameters for the drainage system rehabilitation and integration of dohras as a disposal vehicle and diverting storm water to the depressions in the Thar Desert.

4.1 Hydrology Simulations

Objectives

The hydrology analysis aims at:

i. A review of the rainfall patterns causing moderate and heavy floods in LBOD catchments; and

ii. Updating hydraulic parameters used at the design stage of the drainage network

4.1.1 Methodology

The hydrological analysis includes daily monsoon rainfall patterns, estimation of rainfall frequency in terms of return periods, rain- runoff and drainage coefficients for different LBOD sub-catchments.

The rainfall frequency has been estimated employing Log Pearson (LP) Type-III for the daily maximum rainfall. The daily maximum rainfall is the consistent set of data available from all meteorological stations. However, it is not the same as 24 hour maximum storm, hence a distinction should be made. Based on literature review, factors used to convert different frequency storms are presented. The LP III distribution is a recommended method to model the flood flows and precipitation for return period estimation (*Guidelines for Determining Flood Flow Frequency* - Federal Agencies USA*).*

The runoff has been estimated using already adopted Curve Number (CN) Method to convert storm-rainfall into runoff. These curves are developed by Soil Conservation Service (SCS) USA and have been adopted globally. Selection of CN values considers soil classification and land use characteristics. However, factors intercepting rainfall before it falls to the land surface, evaporation and infiltration are considered outside the CN values. Only three rainfall stations exist in large LBOD service area. By using their point rain over large irregular sub-catchments, another important assumption on uniformity of the rainfall is made.

The time series data on rainfall include 70 years data for Badin, and 44 years data for Shaheed Benazirabad (Nawabshah), and Mirpurkhas districts (adopted from Chorr station).

4.1.2 Rainfall Patterns

A review of daily monsoon rains during flood years of 1994, 2003, 2006, 2011 identifies following patterns:

i. heavy and prolonged downpour, with a recurrence pattern during late August and early September caused major floods in the years 1994, 2006, and 2011. Historical

data shows that the rains may spread over few days to a couple of weeks. Given the discharge capacity of the drainage system, the runoff generated for two successive days would inundate a large area. The limiting cushioning capacity of the local depressions, dhands, dhoras, and aquifer is quickly consumed. Hence, prolonged storms can exponentially increase the drainage volume;

ii. for the year 2011, the weighted average monsoon rains in Sindh is 272 percent higher than normal. All the four districts sub-catchments had more than 400 mm rain during one month (11th of August to 13th of September) and about 300 mm during one week. A combination of more than one hydrological system, concurrent wind direction from the Bay of Bengal, and cyclones in the Arabian seas generated severe monsoon intensity in 2011.

iii. the intensive and prolonged rains in the upper catchment area exerted considerable pressure on the capacity of the LBOD network throughout its length. This caused overtopping, breaches, and inundation of the low lying areas. The runoff from the adjacent areas outside the LBOD command also entered into the LBOD system.

iv. continued irrigation flows during the 2011 floods also caused canal breaches in many reaches resulting in the inundation of agriculture lands and unauthorized interventions by the farmers.

v. medium and low floods of 2006 and 2010 indicate a combination of four factors that help in managment of the flood flows and damages to the Badin area:

- heavy rains are not wide spread or not occur across the LBOD sub-catchments at the same time. As a consequence, flood peaks are not simultaneously generated in all sub-catchments, and the drainage effluent from the main and branch drains is accommodated by the spinal drain, KPOD and DPOD;
- breaches and relief cuts in the middle section remain in the manageable range, practically offloading LBOD Spinal and reducing flood volumes reaching to the tail section of Spinal and KPOD;
- irrigation system is closed on time and flows from irrigation canals through breaches or direct diversion not enhance the rain-runoff quantities, efficient disaster management measures help in minimizing the local damages.

4.1.3 Rainfall Frequency Analysis

The recurrence frequencies were estimated for 5 to 500 years return periods. The return periods of 10 and 20 years are selected for estimation of capacity related variables. For the return periods of 10 and 20 years, precipitation values for Shaheed Benazirabad are 107 mm and 126 mm, for Chorr 127 mm and 145mm, and for Badin 152 mm and 165mm, respectively.

The return periods for two days storm have been estimated for Badin district over a 15 years period. Expected 2 days storm, rainfall for 10, 15, and 20 year return periods are 273 mm, 297 mm and 312 mm respectively, which is about 80 percent higher compared to a one day storms. The small dataset used here seems biased towards the wet years. However, two days storms are important and needs to be estimated for three stations using larger datasets.

A large arid basin, with local storage potential and high sub-surface water movement, can have a only a part of runoff converted into floods, especially at low rainfalls. The reduction factors used to convert runoff into flood-flows are empirical and need calibration for local conditions. For the LBOD catchments, the empirical coefficients adopted by WAPDA and the National Drainage Manual were used (NESPAK 2008, National Drainage Manual), which estimates that about 33 percent of the runoff is converted into the drainage flows. A five day evacuation period is considered appropriate for the standing crops. This suggests that if about 33 percent of the gross runoff is evacuated within five days, crop damages would be the minimum.

The gross drainage flows from LBOD catchment for return periods of 10 and 20 years have been estimated, respectively as 7,000 cfs and 9,200 cfs. These values indicate accumulated drainage quantities at RD 159 of the spinal drain. From Badin, about 50 percent storm water flows directly into the KPOD, hence not accounted at RD 159. For 7,000 cfs, contributing sub catchments will be Shaheed Benazirabad 1,851 cfs, Sanghar 1,431 cfs, Mirpurkhas 1,636 cfs, of Badin 2,125 cfs. For a 9,200 cfs runoff flow at RD 159-LBOD, Shaheed Benazirabad would account for 2,558 cfs, followed by 2,104 cfs from Mirpurkahs, 1,973 cfs from Sanghar, and 2,550 cfs from Badin district.

For a 9,000 cusecs drainage discharge, drainage coefficients (in cusecs per square mile) from the catchments will be Shaheed Benazirabad 2.62, Sanghar 2.98, Mirpurkhas 3.58 and Badin 5.82 respectively. These are more than double of the design values for Badin and three to four times higher for three upper catchments. The capacities of the tertiary and the secondary drainage networks have been estimated considering drainage coefficients of each catchment, representing flow rate (cubic feet or cusecs) from a catchment of one square mile. The drainage coefficients are important in determining capacities of the secondary drainage channels. At the tertiary level, gross capacities of the field drains are normally kept lower than the estimated discharge coefficients, to avoid excessive flows into the secondary system. High volume of sheet-flows during floods can convey more water into the secondary system, exceeding gross capacity of the controlled drainage inlets. The final selections for the capacity are influenced by economic benefits vis-à-vis cost of the project on a long term bases.

4.2 Hydraulic Simulations

Objectives

Hydraulic analysis has been carried out to address the following:

i) Evaluation of hydraulic behavior of LBOD network and its post-design trends to provide guidelines for physical and operational changes;

ii) Assessing hydraulic response of the key physical components and proposed interventions under full operational range; and

iii) Calibration and validation of a model, which could be used at a later stage to recap performance of the drainage network.

4.2.1 Methodology

An easily replicable and robust methodology has been adopted by developing a mathematical hydraulic simulation model to represent the design and post design physical conditions of the LBOD system. Analytical scenarios were developed and simulated for the existing operational range. These scenarios can be easily modified to compare different options or historical developments. The one-dimensional model HAC-RAS was applied to model three sets of physical parametersof LBOD original design, pre-flood situation and proposed modifications to cater drainage flows at ten and 20 years return periods. The model has been calibrated and validated using standard procedures. The design and actual cross-sections were defined in detail, including berms a inspection paths. Standard design templates were developed for each reach, maintaining geometrical details such as the lower section of LBOD, main prism having 1V:3H side slope, and the upper section between the banks and the inspection paths. For scenario analysis four discharge ranges have been identified; the base flow, design discharge and flows at 10 years and 20 year return periods. For each discharge range, drainage contribution from each of catchment area has been estimated and further divided into discharges of the main and branch drains.

Calibration results for the LBOD, the confluence reaches, and the KPOD are encouraging. Simulated water surface profiles and depth-discharge curves closely conform to the design values, reflecting the accuracy of cross-sections, bed slope and roughness coefficient. The model can be further used to test the physical or operational interventions.

4.2.2 Simulation Results

4.2.2.1 Design characteristics of LBOD

Four flow distribution patterns (1,300 cfs, 4,400 cfs, 7,000 cfs and 9,000 cfs) has been simulated for the LBOD spinal drain, KPOD, DPOD and the outfall drains. Simulation results indicate design flexibilities and limitations of the system, performance of the drainage network under different hydrological conditions and highlight the scope for improvements. For example, at the base flow of1,300 cfs, about 26 percent capacity of the spinal drain is utilized, while hydraulic depth varies from 35 percent to 60 percent of the design depth in different reaches. At the low flow levels, the velocity does not remain consistent in different reaches, while, local storage occurs in the tail reach. The hydraulic parameters for all the reaches of LBOD at four flow levels has been estimated, including discharge, cross sectional area, water surface elevations, velocity, depth, top-width and free board.

The simulation results also indicate the capacity margins available in different sections of the LBOD. The weak sections of the Spinal Drain (because of bank elevation and capacity constraints) have been identified. The simulation results indicate that most of the spinal drain (with design parameters) could function without overtopping at 7,000 cfs flow levels. Examples of model output show its potential and scope for further applications.

4.2.2.2 Backwater flow from LBOD to main/branch drains

Under the normal conditions, drainage water levels in the spinal drain are two to three feet lower than the out-falling main and branch drains. The spinal drain was designed at the lowest available ridge, while elevation of the out-falling drains is governed by their service

areas. During flood operations, all the structures become submerged. Increased water levels in the LBOD and relatively lower levels in a branch drain can make the working head negative causing a backwater flow from the Spinal to a secondary drain. During floods, this situation may continue for many days. The high bank-full volume of water in the LBOD Spinal and a negative working head can push large volume of water back into the secondary system causing overtopping and breaches.

4.2.2.3 Simulation of Actual Profile of LBOD

A detailed model was built to represent the actual physical parameters. The physical data was based on a cross-sectional survey undertaken by NESPAK in 2008 for preparing a rehabilitation study for LBOD, DPOD and KPOD. A comparison with limited survey in 2011 show that the physical data of 2008, adequately represents the pre-flood conditions of the network.

The cross-sections are entered as x-y coordinates at all critical locations; head and tail of each reach, upstream and downstream of outfalls. Actual sections show scouring, deepening and narrowing of the bed in some reaches, sediment deposition mostly along the left side and increase in the top width. Berms of the LBOD have been eroded or shifted along most of its length. The inspection path has been raised in the tail reaches after the floods of 2003 and 2006.

The simulations confirm the performance of the LBOD during floods of 2011 was satisfactory. Higher discharges could pass through the actual sections. However, increase in the capacity is not uniform, following variations in the size and shape of the new sections. Because of the geometrical changes, water surface profile, depth, top width and other hydraulic parameters show different patterns for the four flow ranges (1300 cfs, 4400 cfs, 7000 cfs and 9000 cfs). Changes in the hydraulic parameters have been compared with the design, and the changes in the top-width and depth at minimum and maximum flows has been discussed in the report.

A scenario is presented to develop an optimal cross-sectional profile of the spinal drain to accommodate 9,000 cfs flows in the tail reach. Starting from the actual section, new cross-sectional templates were developed for all the reaches. These simulations show that the LBOD can be restored to a new capacity level by adopting and regularizing already increased top-width and raised berms. All the hydraulic parameters for the new sections were calculated and compared with the existing geometry and presented as tables. The model can compute detail of physical changes with reference to any previous sections and can directly estimate cut and fill quantities for the changes confirmed by the user.

4.2.3 Simulations for Offloading Discharge of LBOD

To offload LBOD during floods, three diversion weirs are simulated comparing impacts on the discharges and the water levels. The weirs are placed in the reaches receiving runoff generated in the Sanghar, Mirpurkhas and Badin sub-catchments. To maximize water level control, weirs are kept 80 ft wide and shallow in depth. To represent high flood situation, downstream water levels were not fixed allowing submergence. The offloading of 3,000 cfs is targeted at the maximum flows. The diversions start at the design flows of 4,400 cfs by

diverting 450 cfs, because of increased water levels in the Spinal. About 2,000 cfs will be diverted at 7,000 cfs. The diversion weir at RD 203 would be the most effective. However, the diverted volume of storm water will be influenced by the relative drainage contribution from different sub-catchments and downstream water levels. The locations of a weir will also influence its role in water-level control. The weir parameters defined in the model can be easily changed to compare more options.

The hydraulic performance of the existing DPOD weir and bifurcation of LBOD at RD 159 has been analyzed for three weir crest levels, such as 12.8 ft, 10,3 ft and 8.3 ft. The discharge at RD 159 varies from 1,300 cfs to 9,000 cfs. Results include:

i) water distribution pattern between KPOD and DPOD,

ii) impact of weir height on the water levels in the LBOD, and

iii) scope of further lowering of the weir, if any

Unsteady state simulations are used for the analysis. Results include discharge and levels at which DPOD starts functioning, water division between KPOD and DPOD, and influence of submergence in DPOD. A gated structure replacing the existing weir will be more effective at low flows.

Evolution of water surface profiles in LBOD, KPOD and DPOD, from low to high flows at six hours interval has been plotted to show the combined influence of relative slopes and capacities available in the three channels. At high flows, submergence of the structure increases because of flat water profiles in DPOD. While, KPOD is much less submerged as its actual slope is relatively steep.

The hydraulic simulations show the potential of using a well calibrated hydraulic model for the selection of design parameters, understanding and managing optimal operations during floods and analyzing comparative performance over a historical period is highly promising.

5 THE PROPOSED INTERVENTIONS/PROJECTS

5.1 Interventions Proposed and Agreed by the Stakeholders

The participatory consultative approach was used throughout all consultations. The stakeholders were given detailed presentations on issues and problems identified during the first phase of the project. Based on the findings, the Consultants have considered and identified several interventions as solutions of the issues and problems. These are presented in the following table.

Table 1: Issues Problems and Proposed Solutions

Issue & problems	Proposed intervention / solutions
1. Rehabilitation and Improvement of LBOD Drainage Infrastructure	
• The outfall drainage system has caused significant degradation of natural resources such as farm land, wetlands, and has negative impact on quality of life and livelihoods in the tail reaches of LBOD. The reasons include overflow of storm water from the drainage network, tidal effect in KPOD and Badin area drains, sea water intrusion in the dhands, and ponding during foods the upper portions of Badin • Stakeholders located in some of the settlements along the KPOD felt threatened by overtopping of KPOD and desired fortification.	• Rehabilitation of Nawabshah, Sanghar, Mirpurkhas components, and Badin area Drainage systems. • Rehabilitation/remodeling of spinal drains • Rehabilitation of KPOD • Remodeling of DPOD for 4,000 cfs • Provision of structure with vertical sliding gates on KPOD at suitable location to check Tidal effects in KPOD and Badin area drains • Protection embankments be provided for settlements located along the KPOD.
2. Revival of Natural Waterways To Drain Out Storm water	
• The absence of uninterrupted natural waterways result in the ponding and delayed evacuation of storm water floods causing considerable damage to the standing crops, private properties, physical and productive, and communications infrastructure. Moreover, the storm water is lost to the sea, whereas it could be harvested and stored.	• Revival and reactivation of *dhora*s, and removal of encroachments to provide free passage to the storm water towards depressions in the Thar Desert; • Provision of bypasses to protect the urban settlements; • Provision of structures to off load pressure on LBOD system during high flood season; and • Facilitate timely evacuation of storm water flows from areas presently not served by the LBOD and or other drainage systems
3. Rehabilitation of LBOD and SCARP Tubewells	
The performance of SCARP tubewells is abysmal as more than 50 percent tubewells are dysfunctional or non-operational. At most places the pumps,	• Refurbishment of SGW SCARP tubewells, and its operation and maintenance.

Issue & problems	Proposed intervention / solutions
motors, electrical fitting, PMTs, and even the LTL and HTL has been vandalized. This is causing reversal of saline water table.	
4. Ghotki SCARP (Saline Zone)	
• The water logging and salinity situation is worsening in the Ghotki area, and needs a project to mitigate the situation. • A salinity control project was prepared by the Consultants hired by WAPDA. The stakeholders desire that drainage projects is implemented to control the rising water table to arrest the decreasing farm productivity.	• A review needs to be undertaken to assess the current situation and update the existing feasibility report and make recommendations accordingly, if the project is feasible. Also suggest any modification, if required.
• The stakeholders are generally not satisfied with the performance of the fresh ground water tubewells, and desired that their performance is improved.	• In pursuance of the policy of the GoS, that no further fresh groundwater will be funded, and the existing ones are divested. Also in areas where the FGW SCARP tubewells will be divested, credit line will be arranged to help farmers to invest in the development of private tubewells. A review of existing feasibility prepared by the consultants engaged for the purpose needs to be undertaken to update its findings and making recommendations accordingly
6. Second Line of Defense for the Left Bank of Indus d/s Kotri	
• Communities along the flood protection bunds feel vulnerable to flood havoc.	• Second Line of Defense for Indus River Bunds downstream of Kotri Barrage on Left Bank be constructed in two Stages, • Communities, particularly along the flood protection bunds and beyond, are apprehensive of unexpected breaches during floods, thy feel that they will be trapped between the two bunds and will suffer major and longer flooding; • Stakeholders also have reservations on the construction of additional bunds that would involve land acquisition and resettlement issues; • They proposed to strengthen the original band to avoid possible breaches in the area
7. Elevated Platforms for Flood Displaced Persons	
• Absence of any higher ground for taking refuge by marooned communities	Elevated platforms or widened sections along the roads, and canal bunds would also help in

Issue & problems	Proposed intervention / solutions
	refuging from inundation.
8. Rehabilitation of Coastal Wetlands	
• Failure of the Cholri Weir and breaches in the bunds have caused brackish water *dhands* turned into marine. • The entire ecosystem has changed affecting the fauna and flora of the dhand complex • The livelihood opportunities have dwindled • The LBOD/KPOD outfall infrastructure was not designed properly and has caused miseries to the communities in lower reaches • Stakeholder's are apprehensive of any reconstruction or extension of LBOD and/or KPOD	• The *dhands* shall be provided with a bund about 500 m from the Tidal Link to allow breathing space for the tidal water • This 500 m distance will be occupied by mangrove plantation and other local tree species to minimize the erosion due to rains and tidal effects • The bund shall extend from the northern end of the *dhands* moving southwards and westward cordoning the entire dhand complex with an embankment • From the KPOD side at RD(-12) a diversion canal shall be provided with a gated structure to allow the storm water from KPOD to enter in *dhands* to a manageable capacity. • From southern side, a sluice gate with a channel shall be provided to evacuate the *dhands* when the water in *dhands* reach to a risky level • Divert storm water from LBOD, reducing the discharge in the main drain, thus making it safer for the people and land in Badin and Thatta Districts. • Storm water of up to 2,000 cusecs will be offloaded from KPOD to the *dhands* through this arrangement. Thus the *dhands* will have water of good quality suitable for local fish species and for the reed grass for the livestock of the local communities. Likewise the environment of *dhands* will attract the migratory birds and water fowl nesting and breeding.
9. Protective Plantation of Mangroves in the Coastal Areas of Left Bank	
• Sea water intrusion is damaging crop lands, and fresh water bodies • Coastal erosion • Deforestation of mangroves • Decline of fish resource • Limited livelihood opportunities • Fragile coastal environment	• Raising of mangrove and salt resistant plant nurseries • Plantation of mangroves to protect wetlands and tidal link • Plant mangroves in blank mudflats in coastal areas (in backwater and frontage of sea) • Raising of salt tolerant tree species in supra tidal zone

Issue & problems	Proposed intervention / solutions
10 Use of Drainage Water for Forestation in the LBOD and Kotri Areas	
• Continuous deforestation is causing degradation of forest and agro ecosystems, thereby declining productivity of forest and farmlands • Shortage of tree resource and associated services • Lack of participatory approach and coordination • Decline in per ha vegetation cover • Limited livelihood opportunities	• Provision of drainage water for forestation in forest and farm lands close to the LBOD system; • Supplement fresh water with drainage water to reduce water shortage.
11. Biosaline Agriculture in Badin and Thatta Districts	
• Water scarcity below Kotri barrage has adversely affected the agro-ecosystems. • The persistent drought conditions since last decade has degraded lands • leaving the lands without crop for prolong periods induce desertification and reduce productivity • Reduced production resulted in decline in livelihood opportunities.	• Bio-saline agriculture can be practiced on marginal saline lands using brackish water for growing salt tolerant food and fodder crops, bushes and trees • Surface drains mostly carry pancho water from rice fields that has the TDS up to 2.0 dS/m and can be used for growing salt tolerant species of crops, grasses and halophytes. • This intervention can best utilize our water resources on one hand and can reduce load on drainage outfall on the other. • By growing crops, grasses and trees that help reduce the soil salinity will be grown to rehabilitate the salt affected soils on one hand and provide livelihood for the farmers on the other
12. Rehabilitation of Deh Akro II and Chotiari Wetland Complex	
• The ecosystem in the wetland is under severe threat causing damage to the wildlife and economy. The seepage from the Chotiari lake is causing water logging and salinity	• Revival of wetland complex with assured supplies allocated from the Nara canal system, and • Construction of interceptor drains to check seepage from the Chotiari lake
13. Shrimp and Mud Crab Farming in the Coastal Areas of Left Bank	
• Depleting fish resources in the coastal area has reduced livelihood opportunities, has also increased poverty.	Promotion of shrimp and mud crab production
14. Brackish Water Fish farming in LBOD Area	
• Livelihood for fishermen community of the area has declined, due to	• Construction of earthen fish ponds on private lands located in the command area of LBOD.

Issue & problems	Proposed intervention / solutions
degradation of fisheries resources due to deterioration of the *dhands* water quality	• Establish brackish water fish hatcheries • Involve fish farmers in identification of areas for fish ponds • Conduct on the job trainings to fish farmers for capacity building
15. Establishment of Disaster Management Cell in SIDA	
• Absence of community awareness regarding preparing and coping with water hazards. • Also there is no advance warning mechanism	• Establishment of a SIDA Disaster/Crisis Management Cell for preparing, training and coordinating plans for emergency response services in case of emergency situations and disasters within SIDA's ordinance. • Provision of training to the SIDA staff
16. Gender Mainstreaming In Irrigation and Drainage	
• The enabling environment for women to play active role in water management is missing, and the SIDA, AWB, and FOs need to be made aware of gender sensitivities	• Support to be provided to the Social section in SIDA to organize training courses to sensitize the stakeholders
17. Drainage Effluent Intrusion in the Ghotki Area from Southern Punjab	
• Drainage effluent intrusion from Southern Punjab into the Ghotki Area is causing degradation of land	• Analysis of the situation and identification of mitigation options, and actions to be taken at the intergovernmental level
18. Sugar Industry Effluent Treatment at Source	
• 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. • 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.	• Depending upon the resources available any of the physical, chemical or biological treatment technologies may be used to treat the wastewaters at source before disposing it off into streams. • Four stages of wastewater treatment are commonly employed all over the world for treating industrial wastewaters. These are: 1)Preliminary treatment 2) Primary treatment 3) secondary treatment and 4) Tertiary treatment • Up flow Anaerobic Sludge Blanket (UASB) system for treatment of highly concentrated wastewater from agriculture industries is increasingly popular and wastewater from sugar mills and distilleries can be treated for significant reduction in pollution levels. Methane gas produced in USAB system can be used as an energy source. • Lagoons have several advantages when used

Issue & problems	Proposed intervention / solutions
	correctly. They can be used for secondary treatment or as a supplement to other processes. While treatment ponds require substantial land area and are predominantly used by smaller communities.
19. Access to Potable Water in the Left Bank	
• Safe and clean drinking water is not available particularly in the saline underground water areas and in the delta and coastal areas. • 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.	• For small towns or villages the ultra filtration cell is a cost effective proposition. Each cell can provide about 500 gallons per hr safe drinking water to the surrounding community of say 2,000 people. The feed water to the plant, however, should not contain TDS more than 700 mg/l. • In study area, where the ground water is brackish & only source of drinking, there is a greater need to treat ground water to remove salinity (TDS) & other contaminants so that it is safe for dinking. The Reverse Osmosis (RO) technology is an appropriate for this purpose. This technology was expensive before but now is available at affordable cost.

5.2 Typology of the Approved Interventions

During the Phase II of the Study, pre-feasibilities were prepared for eight structural, six nonstructural, and two institutional interventions that were selected and agreed in the national workshop. In addition to this three position papers were developed to address and recommend actions required to the identified relevant issues. The following section outlines the salient features of the proposed interventions to be reviewed and selection, prioritized by the stakeholders. In the next phase of the study detailed feasibilities will be pursued for the selected ones. The list of the prefeasibility and the position papers prepared during this phase of the study are as under:

Table 2: Pre-feasibility Interventions / Position Papers

A	**Structural Interventions**
1.	Rehabilitation and Improvement of LBOD Drainage Infrastructure
2.	Revival of Natural Waterways to Drain out Strom Water.
3.	Rehabilitation of LBOD and SCARP Tubewells
4.	Ghotki SCARP (Saline Zone)
5.	Privatization of FGW SCARP Tubewells
6.	Second Line of Defense for Left Bank of Indus D/S Kotri
7.	Elevated Platforms for Flood Displaced Persons
8.	Rehabilitation of Coastal Wetlands
B	**Quasi Structural Interventions**
9.	Protective Plantation of Mangroves in the Coastal Areas of Left Bank
10.	Use of Drainage Water for Forestation in the LBOD and Kotri Areas

11. Bio-saline Agriculture in Badin and Thatta Districts
12. Rehabilitation of Deh Akro II and Chotiari Wetland Complex
13. Shrimp and Mud Crab Farming in Coastal areas of Left Bank
14. Brackish Water Fish Farming in LBOD Area

C Institutional Interventions

15. Establishment of Disaster Management Unit in SIDA
16. Gender Mainstreaming in Irrigation and Drainage

D Position Papers

17. Drainage Effluent Intrusion in the Ghotki Area from Southern Punjab
18. Sugar Industry Effluent Treatment at Source
19. Access to Potable Water in the Left Bank

5.3 Brief Description of Pre-feasibilities of Suggested Interventions

Following is a brief digests of the 16 prefeasibility and 3 position papers that were agreed in the last national workshops. For details please refer to the detailed pre-feasibilities presented in Volume II, of the Final Report.

5.3.1 Pre-feasibility 1: Rehabilitation and Improvement of LBOD Drainage Infrastructure

Introduction/Rationale

The LBOD network, serving Shaheed Benazirabad, Sanghar, and Mirpurkhas districts, and the Badin area drainage system was built during 1985 and 2003 to dispose off the drainage effluent aka the base flow generating from the tile drains and saline ground water (SGW) tubewells, and the storm water flows (SWF) generated by runoff in the catchment area.

The above mentioned drainage system provides relief to the cultural command area of about 1.73 million acres irrigated by Rohri, Nara and Akram Wah canal systems encompassing Shaheed Benazirabad, Sanghar, Mirpur Khas and Badin districts.

During the last three decades, particularly in 1994, 2003, 2006, and 2011, the left bank of Indus experienced repeated extreme rainfall events that caused colossal damage to human lives, agriculture, particularly standing crops, livestock, stored grains, private and public properties, productive and physical infrastructures. A large segment of population was marooned and or displaced constraining their access to social services, and livelihoods, till the return of normality. It is anticipated that due to climatic changes coming decades will witness occurrence of such extreme weather conditions more frequently. The situation is further exasperated by damage to tidal link and collapse of Cholri Weir, causing sea encroachment during high tides, degrading large tracts of productive land and depressing its productivity potential, and salinizing the fresh water bodies diminishing their fish production potential. This has led to loss of livelihood of considerable populace.

Box 1: Profile of Spinal Drain

Length (RD)	657
Discharge (cfs)	1240 – 4600
Bed width (ft)	85 -162
Depth (ft)	8.75 -13.33
Side Slope (-)	1:03
Berm width (ft)	20
Longitudinal Slope (ft/ft)	0.000118 - 0.00005

The drainage system is in dilapidated state, and the existing capacity of the LBOD and Badin area drains is insufficient to drain out the storm water within a period of three to five days. In the past years when the rainfall exceeded the designed capacity, causes inundation of the low lying areas, and the stagnation for longer periods. This is may be due to the deferred maintenance, and unauthorized breaches by the farmers along the drains and irrigation canals to dewater their stagnant water from their fields. The weak banks with lack of adequate free board (FB) are prone to breaches and flooding of the area. The situation is further exasperated due to the submergence of drains at point of outfall, blocking the flows in the network and resulting in overtopping and breaches and relief cuts. The irrigation water of canal escapes and breaches of channels adds to the pressure.

In August and September of 2011, most parts of left bank of Indus received ever maximum rainfall of 500 to 1,200 mm, inundated most areas with an average depth of three to four feet. The average rainfall of was about 300 mm within 24 to 48 hours and was two to three times exceeding the existing capacity of drainage system. The heavy rainfall in the Shaheed Benazirabad, Sanghar, and Mirpurkhas districts generated a runoff of about 15,000 cfs, while LBOD system was designed for a discharge of 4,600 cfs.

During the 2011 floods, despite less capacity of the drains, obstructions in the system, encroachments in the water ways causing overtopping and breaches at a number of places, the system performed better than anticipated. The high level of water in the spinal drain

caused submergence of the MMD and the LBOD branch drains resulting in the inundation of adjoining villages and towns, severely damaging the life and property. Many farmers gave relief cuts to the banks of the spinal and branch drains to evacuate the storm water. The damage to the drainage infrastructure was enormous and quite a few watercourse aqueducts collapsed and bridges were damaged.

To ensure the safe disposal of the storm water and to avoid the sea intrusion it is suggested that the proposed interventions are carried out in two phases. Consultants recommend that the emergency works be completed by June 2012, including desilting of the drain beds, restoration of the freeboard, repair of damaged inlets, and stone pitching at vulnerable points.

It is expected that the proposed intervention would decrease the inundation period and depth of submergence in a manner that would reduce the vulnerability to damage to the water hazards damaging the life and property of the communities along the drainage system, and does not disrupt their normal life and livelihoods. The provision of freeboard would also serve as an insurance to carry discharge like the one witnessed during 2011 rainy season. In addition to this, the intervention aims in reducing the negative impact of seawater intrusion.

Project Zone of Influence

The proposed project will rehabilitate surface drainage systems located in the districts of Shaheed Benazirabad, Sanghar, Mirpurkhas, and Badin.

Objective:

The main objectives are to:

i. ensure safe, timely, and unconstrained disposal of drainage and storm water;
ii. to rehabilitate and improve the existing LBOD infrastructure;
iii. to divert storm water to dhoras and Thar area under extreme rainfall events

Outputs

Following structural and nonstructural interventions will be in place by the end of the project implementation period. The structural interventions have been verified by using hydraulic model of HEC-RAS for optimization of the solutions by predicting water levels and discharge distribution in the network of spinal drain. The intervention of off-loading of 3,000 cfs from the spinal drain was simulated to optimize the location of weirs. The detailed feasibility of above interventions has been initiated, and would be completed during the Phase III of the study. The outputs are:

Table 3: Main Outputs of the Pre Feasibility No. 1

N°	Main Outputs	Start Date	End Date
1.	Restoration of Spinal Drain (RD 815 to 159) including Structure repair	4/2012	12/2013
2.	Restoration of DPOD (RD127 to RD 5)	4/2012	12/2013
3.	Restoration of KPOD (RD 159 to RD 0)	4/2012	12/2013
4.	Restoration of LBOD branches, KPOD, and other drains	4/2012	12/2013
5.	Restoration of Mirpurkhas component surface drains	4/2012	12/2013
6.	Restoration of Sanghar component Surface drains	4/2012	12/2013
7.	Restoration of Nawabshah component	4/2012	12/2013
8.	Restoration of Fulleli Guni drainage system	4/2012	12/2013
9.	Restoration of Karo Gungro drainage system	4/2012	12/2013
10.	Remodeling of LBOD drainage system for a return period of 20 years	7/2014	6/2020
11.	Remodeling of KPOD to discharge of 6,000 cfs;	7/2014	6/2020

N°	Main Outputs	Start Date	End Date
12.	Remodeling of Mirpur Khas Main Drain for Separation from Dhoro Puran.	7/2014	6/2020
13.	Converting Non-Inspection Path (NIP) of Spinal/Main & all Branch drains to par with IP	7/2014	6/2020
14.	Construction of All Weather Road from RD 159 of Spinal Drain to RD 815 of Spinal Drain. (131 miles)	7/2014	6/2020
15.	Providing Pumping arrangements at outfall points of Badin Drainage System	7/2014	6/2020
16.	Construction of New Bridges +WC Aqueducts on LBOD System	7/2014	6/2020
17.	Construction of new inlets to support of farm drainage	7/2014	6/2020
18.	Construction of Tidal Control Regulator at RD minus 12 of KPOD	7/2014	6/2020
19.	Construction of Head Regulator of KPOD RD 159	7/2014	6/2020
20.	Ancillary works undertaken	7/2012	12/2013
21.	Supervision Consultants appointed	4/2012	12/2013
22.	Site offices and residential quarters constructed	7/2012	12/2013
23.	Boats and vehicles procured	7/2012	12/2013
24.	Survey and scientific equipment procured	7/2012	12/2013
25.	Radio communication system procured and installed	7/2012	12/2013
26.	Early warning system established and operative	7/2012	12/2013

The outputs mentioned above include the emergency works, such as i) commencement of desilting of the drainage network, raising of the embankments to maintain minimum two feet freeboard; and iii) restoration of damaged structures. These works has already been commissioned and are to be completed by end of the financial year 2011/12.

Requisite interventions/Standard Operating Procedures

It is proposed that the following actions are strictly complied with: i) the main canals systems are closed at least one week before start of rainfall warning; and ii) each year the heavy earth moving machinery is mobilized at all the vulnerable points by the middle of July.

Outcome and Impact

The main impact of the interventions will be significant reduction in damages to the standing crops, livestock, private and public properties, and livelihood of the communities, particularly of farm and landless household. This would also ensure uninterrupted access to social services. In addition to this the arresting of the seawater intrusion will restore the productivity of the degraded land and water bodies supported livelihood of displaced farmers and the fisher folks.

Estimated Cost of Interventions

The total cost of the project is estimated as Rs.17.6 billion including Rs.1.6 billion allocated for the emergency repair and restoration works to be completed by June 2012. The detail of financial year (FY) wise expenditure on various interventions/subprojects is presented in the Table 4. After the completion of these interventions, a recurring annual expenditure estimated at Rs.500 million would be required for the O&M and monitoring of the system.

Table 4: Indicative Cost Estimates for the Rehabilitation and Remodeling of LBOD Infrastructure. (Rs. Million)

N°	Main Outputs	2011/12	2012/13	2013/14	2014/20	Total
1	Restoration of Spinal Drain (RD 815 to 159) including Structure repair	700	740	560		2,000
2	Restoration of DPOD (RD127 to RD 5)	100	200	274		574
3	Restoration of KPOD (RD 159 to RD 0)	60	40	31		131
4	Restoration of LBOD branches, KPOD, and other drains	40	280	245		565
5	Restoration of Mirpurkhas component surface drains	110	120	170		400
6	Restoration of Sanghar component Surface drains	95	140	65		300
7	Restoration of Nawabshah component	300	200	-		500
8	Restoration of Fulleli Guni drainage system	70	145	135		350
9	Restoration of Karo Gungro drainage system	30	154	40		224
10	Remodeling of LBOD drainage system for a return period of 20 years				4,000	4,000
11	Remodeling of KPOD to discharge of 6,000 cfs;				300	300
12	Remodeling of Mirpur Khas Main Drain for Separation from Dhoro Puran.				1,450	1,450
13	Converting Non-Inspection Path (NIP) of Spinal/Main & all Branch drains to par with IP				1,500	1,500
14	Construction of All Weather Road from RD 159 of Spinal Drain to RD 815 of Spinal Drain. (131 miles)				300	300
15	Providing Pumping arrangements at outfall points of Badin Drainage System				1,000	1,000
16	Construction of New Bridges +WC Aqueducts on LBOD System				1,350	1,350
17	Construction of new inlets to support of farm drainage				200	200
18	Construction of Tidal Control Regulator at RD minus 12 of KPOD				650	650
19	Construction of Head Regulator of KPOD RD 159				350	350
	Subtotal					**16,144**
	Physical and price contingency @ 2%					323
	Total					**16,467**
	Miscellaneous Support Costs					
20	Ancillary works		490	140		630
21	Supervision Consultants	25	45	32	181	282
22	Construction of site offices and residential quarters		30	20		50
23	Procurement of boats and vehicles	8	20	72		100
24	Procurement of survey and scientific equipment		15	5		20
25	Procurement of radio communication system			5		5
26	Unallocated			5		5
	Subtotal					**1,092**
	Physical contingency @ 2%					22
	Total					1,113
	Grand Total Cost					**17,580**

Project Viability

Based on estimated of damages reported by Provincial Disaster Management Authority (PDMA), for 2011 flood, it is anticipated that the project would be economically viable. The IRR estimated jointly for this intervention and revival of natural waterways indicates that the estimated internal rate of financial return of return (IFRR), based on financial prices, is about 18.1 percent. Nonetheless, detailed analysis and estimation of internal economic rate of return (IRR) will be undertaken during the Phase III of the study, based on sample surveys in the affected areas.

Proposed Implementation arrangements

The short term works of emergency nature and medium term measures are to be contracted out by following the normal tendering process; while the long term interventions will follow the international bidding route.

Safeguards

Notwithstanding with the technical requirements, detailed environment assessment and mitigation plan, and resettlement requirements and the resettlement action plan will be prepared in the phase III of the study, along with its costs.

5.3.2 Pre-feasibility 2: Revival of Natural Waterways to Drain out Storm Water

Introduction/Rationale

In Sindh there are many short and long reaches of the abandoned river courses on both sides of Indus. These abandoned river courses used to serve as waterways aka *dhora*s, for river and storm floods. Historically these *dhora*s braided with several small tributaries served as a network of natural drainage.

Over the time these *dhora*s have been obstructed by infrastructure such as roads, canals, drains and unauthorized settlements. Similarly, in many reaches these *dhora*s have also been interspersed by cultivation. These obstructions delay the evacuation of flood waters, causing ponding and inundation of standing crops, loss of livestock, and at times human lives, in addition to damage to infrastructure. The extreme rainfall event in the year 2011 was a wakeup call, which caused unparalleled loss to the human lives, marooning of settlements, standing crops, livestock, damage to the physical and productive infrastructure, means of communications, displacement of flood affected population and their livelihoods. According to the recent report of PDMA the estimated value of damages from the 2011 flood is about Rs.454 billion.

This calamity challenged the ability to cope with such a catastrophe, and warranted correction and mitigation measures to avert similar miseries, in the event of reoccurrence of rains of alike magnitude in future. This experience also provided an opportunity to evaluate the performance of the drainage network, need for its strengthening, and to explore ways to offload pressure on the drainage system. This also flagged the need for exploring ways to evacuate areas presently not served and connected to the drainage network. This state of affair also underscored the need to revive the network, removing obstructions, and diverting the flood waters to the natural depressions in the Thar Desert.

To address this issue, the Consultants evaluated the possibility of employing the dormant *dhora*s to ensure safe disposal of flood waters. During the course of the prefeasibility study, a number of such potential *dhora*s were identified, located in the area on the left bank of Indus. They include, Rainee Dhoro, Hussainabad-Mehrabpur Dhoro, Kandiaro-Moro Dhoro, Miranpur-Bachal Rahu Dhoro, Sohni Dhoro, Bhaikhan Dhoro, Puran Dhoro, Digri / Sarfraz Dhoro, Pangrio Dhoro, Hakro Dhoro, Naro Dhoro, and Pithoro Dhoro.

The field visits validated that the storm water from the catchment area ponds in these *dhora*s, spills over and inundates the crops and settlements, due to blockages, and absence of outlet for evacuating the ponded storm water.

To mitigate the situation, revival of these natural water ways is critical. The reactivation of these *dhora*s would not only dispose off the storm water, will also serve as interceptor drains to check the rising water table. Moreover, the storm water in the *dhora*s can be utilized by the farmers at the tails of deficit irrigation channels after lifting through pumps.

Project Objectives

The main objectives of this intervention are to:

i. facilitate evacuation of storm water flows; and
ii. offload the pressure on the existing drainage network;
iii. protect the settlements with bypasses where critical; and
iv. harvest flood waters and its storage in the natural depressions located in the Thar Desert

Project location

The project area will cover the command areas of Ghotki, Sukkur, and Kotri Barrages, particularly the areas that are presently not connected to any drainage network. This project area will also include parts of the Thar Desert where most potential depressions are located.

Project output

The main outputs that would be accomplished include:

Table 5: Main outputs of the Pre Feasibility No2

No	Main Outputs	Start Date	End Date
	Revival of Dhoras		
1	Activation of dhoras, Puran up to Shakoor dhand, Sohni dhoro & Bhai Khan *dhoro* and bypasses of Mirpurkhas, Jhuddo, Tando Ghulam Ali	4/2012	6/2020
2	Activation & Restoration of pocket *drains* along Hiral escape/ Pithoro Dhoro, Hakro Dhoro & Naro (Nabisar) *Dhoro* i/c Naukot bypass	4/2012	6/2020
3	Activation of Sarfaraz (Digri) *Dhoro*, including Digri bypasses	4/2012	6/2020
4	Excavation and revival of Pangrio, Kh' Gumbo & Roshanabad *dhoras*	7/2014	6/2020
5	Excavation and revival of Ghotki *dhoras*	7/2014	6/2020
6	Excavation and revival of Khairpur South dhoras	7/2014	6/2020
	Leftover Areas		
7	Construction of surface drains in T.Adam, T.Allahyar, T.M Khan and T.G. Ali area	7/2014	6/2020
8	Construction of surface drains in Digri area	7/2014	6/2020
9	Construction of surface drains in Umerkot, Farash and Khipro area	7/2014	6/2020
10	Construction of surface drains in Ghotki area	7/2014	6/2020
11	Construction of surface drains in Khairpur South area	7/2014	6/2020
	LBOD Escapes		
12	Construction of 3X Escapes on LBOD i/c Weirs and Link Channels	7/2014	6/2020

The outputs mentioned above include the emergency works, such as: channelization of the *dhora*s, provision of bypasses where needed, clearance of encroachments and land acquisition, and increasing the capacity of structures. These works have already been commissioned and are to be completed by end of the financial year 2011/12.

Outcome and Impact

It is expected that the revival and reactivation of *dhora*s and providing safe and uninterrupted passage to the storm water generated in the catchment areas presently not connected with the existing drainage structures will evacuate water with minimal disruption to human lives, damage to the standing crops, loss of livestock, damage to the public and private properties and infrastructure. It would avert the colossal loss to the economy and livelihoods. Timely evacuation of storm water will also provide continual access to social services, such as education, health, and drinking water supply.

Project Cost

The estimated indicative cost for activation of the proposed intervention is estimated at Rs. 42.7 billion. The detail of financial year (FY) wise expenditure on various major activities, including emergency works that are to be completed by June 2012, is presented in the Table 6.

Table 6: Indicative Cost Estimates for the Revival of Dhoras including bypasses (Rs. Million)

S.No	Main Outputs	2011/12	2012/13	2013/14	2014/20	Total
	Revival of Dhoras					
1	Activation of dhoras, Puran upto Shakoor dhand, Sohni dhoro & Bhai Khan dhoro and bypasses of Mirpurkhas, Jhuddo, Tando Ghulam Ali	65	615	1,320	16,409	18,409
2	Activation & Restoration of pocket drains along Hiral escape/ Pithoro Dhoro, Hakro Dhoro & Naro (Nabisar) Dhoro i/c Naukot bypass	30	180	200	4,303	4,713
3	Activation of Sarfaraz (Digri) Dhoro, including Digri bypasses	7	27	271	286	591
4	Excavation and revival of Pangrio, Kh' Gumbo & Roshanabad dhoras	-	-	-	703	703
5	Excavation and revival of Ghotki dhoras	-	-	-	2,160	2,160
6	Excavation and revival of Khairpur South dhoras	-	-	-	3,057	3,057
	Leftover Areas					
7	Construction of surface drains in T.Adam, T.Allahyar, T.M Khan and T.G. Ali area	-	-	-	4,668	4,668
8	Construction of surface drains in Digri area	-	-	-	1,149	1,149
9	Construction of surface drains in Umerkot, Farash and Khipro area	-	-	-	5,080	5,080
10	Construction of surface drains in Ghotki area	-	-	-	2,111	2,111
11	Construction of surface drains in Khairpur South area	-	-	-	434	434
	LBOD Escapes					
12	Construction of 3X Escapes on LBOD i/c Weirs and Link Channels	-	-	-	490	490
	Grand Total	**102**	**822**	**1,791**	**40,850**	**43,565**

Project Viability

The project and its subprojects are still in the design stage. However it is anticipated that the proposed intervention will have significant payoff in terms of losses averted and saved. This will also require intensive field surveys to account for benefits from individual subprojects. These will be accomplished during the preparation of detailed feasibility. Based on estimated of damages reported by Provincial Disaster Management Authority (PDMA), for 2011 flood, it is anticipated that the project would be economically viable. The IFRR estimated jointly for this intervention and rehabilitation of LBOD is about 18.1 percent. Nonetheless, detailed analysis and estimation of economic IERR will be undertaken during the Phase III of the study, based on sample surveys in the affected areas.

Implementation Arrangements

It is proposed that the project is implemented by SIDA in the AWB areas, and by the IPD in the areas outside the AWBs, coordinated by the WSIP PCMU.

Given the exigency of intervention, it is proposed that following emergency interventions are accomplished before the onslaught of 2012 monsoon season, completing the works by 30 June, 2012. The emergency works include:

i. activation of *dhora*s on left side of the LBOD spinal drain i.e. Hakro Dhoro, Naro Dhoro and Pithoro Dhoro / Hiral Escape;

ii. activation of the full length of Dhoro Puran from Mirpurkhas to RD 110 of DPOD including Mirpurkhas bypass.

iii. routing of MMD, Dhoro Puran through its natural path, siphoning it through spinal drain, and discontinuing its disposal into the LBOD system;

iv. reconstruction of Dhoro Puran sections integrated with the LBOD spinal drain;

v. construction of *dhora* bypasses proposed at Jhudo, Digri and Naukot towns.

Safeguards

The project is expected to have significant ramifications requiring a careful assessment of social and environment impacts. This intervention would also require land acquisition, and involuntary settlements, and preparation of action plan to mitigate any adverse environmental consequence, and a resettlement action plan for the displaced persons.

5.3.3 Pre-feasibility 3: Rehabilitation of SCARP and Drainage Tubewells of LBOD System

Rationale

In Sindh, the SCARP tubewells were installed in the left bank area to combat the twin menace of waterlogging and salinity. These tubewells significantly lowered the water table and reclaimed the affected land. However, the operational cost and maintenance of the SCARP tubewells manifold surpassed the *abiana/drainage c*ess collection, a heavy burden on the exchequer. Moreover, the unauthorized power leakages further exasperated the financial burden. With the passage of time, due to deferred maintenance, most of the tubewells, as reported by the beneficiaries, are either dysfunctional or nonoperational.

The ground situation, as reported by the stakeholders is alarming. They reported, and as verified by the Consultants during the field visits more than 60 percent SGW tubewells are dysfunctional, due to want of repairs and replacement, vandalizing of pumps, motors, electrical fittings, transformers, hookups, high or low tension lines, and deferred maintenance. As per PID records about 740 tubewells out of 1,798 number of tubewells are out of commission. The stakeholders in the workshops and the beneficiary farmers stated that this number is an understatement. They also voiced their concern about reversal of groundwater table, and loss of productivity, and desired that the concerned agencies to revamp these tubewells and need for timely repairs and control of theft.

Project Zone of Influence

The proposed project will only rehabilitate the LBOD tubewells located in the districts of Shaheed Benazirabad, Sanghar, Mirpurkhas, and Badin.

Objectives

The main objective of this intervention is to reverse the rising saline ground water level to restore the productivity of degrading lands through replacing the pilfered tubewells, and operationalizing the dysfunctional tubewells.

Output

The main output of the proposed intervention will be about 740 rehabilitated drainage tubewells.

Outcome and Impact

It is expected that the proposed intervention will increase the overall farm productivity and farm incomes by about five to ten percent in the overall project area.

Project Cost

The total cost of rehabilitating drainage tubewells is estimated at Rs.2,603 million, based on current prevailing prices.

Project Viability

The indicative IFRR is estimated at 16.8 percent. However, given the past history of vandalizing of removable parts, such as pumps, motors, electrical fittings, pole mounted transformers, hook up connections, and LHT and HTL lines, and unauthorized diversion of power for domestic use, it is apprehended that it is a very risky investment and not sustainable.

Safeguards

The reduction in the water table will have a positive effect on the environment, and does not require any resettlement.

5.3.4 Pre-feasibility 4: Ghotki SCARP (Saline Zone)

Rationale

In the Ghotki saline zone area is spread over about 222 thousand ha out of which some 25 thousand ha is severely waterlogged, and the water table is about 3 feet from the surface. One of the reasons for waterlogging is seepage from the canal system. The situation further worsened soon after mid-1970 when the canals started receiving perennial supplies.

In 1994, a feasibility of a project covering the severely affected area was prepared by Agrar-und-Hydrotechnik GMBH in association with NESPAK, commissioned by WAPDA. The feasibility considered four alternatives: i) construction of surface drainage system for the entire catchment area spread over 222 thousand ha, together with tile drainage system for 140 thousand ha; ii) provide tile subsurface and surface drainage only to the most affected 25 thousand ha, complemented by watercourse improvement program on 30 thousand ha; iii) construction of surface drainage to 222 the entire catchment area and lining of the irrigation network; iv) reversion to non-perennial system as originally designed. The feasibility Consultants opted for the second option.

During the workshops the stakeholders expressed an urgent need to implement the proposed salinity control and reclamation project, as the productivity of their lands is fast declining. As suggested by the stakeholders, the Consultants have reviewed the feasibility to assess its technical appropriateness and its viability at current prices.

It may please be noted that this Pre-feasibility is essentially a review of the feasibility prepared by the earlier Consultants. The information on benefits and costs mentioned in the feasibility has been updated for 2012 prices, assuming other parameters as same, and the rate of return was re-estimated to assess if the viability parameters still hold.

Objectives

The following were the main objectives of the project, as mentioned in the feasibility document, namely: were to: i) restore the designed cropping intensity and productivity by lowering the water table; and ii) disposal of the drainage effluent in an environmental safe manner.

Project Boundary

The project was expected to serve the canal irrigated area commanded by Ghotki canal system in saline area.

Output

The main outputs mentioned in the feasibility report under review included: i) a grid of tile drains serving the 25 thousand ha; ii) 900 km of surface drainage system; and iii) watercourse improvement on area covering 30,000 ha.

Outcome and Impacts

As per feasibility report, the Project was expected to increase the cropping intensity to 120 percent from 93.5 percent during the then base year in the area where tile drainage is provided. The project was expected to significantly increase the household income; and by lowering the water table, would reverse the process of environment degradation.

Estimated Cost

Based on the current prices, the tile drainage and associated infrastructure would cost about Rs.5.0 billion when updated for 2012 prices.

The review suggests that proposed project prepared by the abovementioned Consultants is unfeasible and hence it has been replaced by surface drainage network to evacuate the storm water flows, and has been included in the prefeasibility 2 as one of the subproject.

Project Viability

While re-evaluating the feasibility, only the cost and benefits from the tile drainage and associated infrastructure were taken into account, and the cost of OFWM improvement was excluded. It is estimated that at current prices, the IFRR of the intervention would be around 10.9 percent, and hence is not a sound investment.

5.3.5 Pre-feasibility 5: Privatization of FGW SCARP Tubewells

Introduction/Rationale

In Sindh, the SCARP tubewells were installed in the fresh water zones to combat the twin menace of waterlogging and salinity. These tubewells significantly lowered the water table and reclaimed the land in the fresh groundwater (FGW) zones, where installed. As intended, with the availability of additional water for conjunctive use, the cropping intensity and productivity in the zone of influence increased significantly. This also induced mushrooming of private tubewells. However, the operational cost and maintenance of the SCARP tubewells manifold surpassed the *abiana*/drainage *cess* collection, a heavy burden on the exchequer. Moreover, the unauthorized power leakages further exasperated the financial burden. With the passage of time, due to deferred maintenance, most of the tubewells, as reported by the beneficiaries, are either nonoperational or dysfunctional. As early as 1980s, the government decided to divest the public sector FGW SCARP tubewells, and offered the farmers to buy and operate these as individuals or jointly as an irrigator groups.

In 2008, a feasibility of a project covering the FGW SCARPS areas was prepared by BM Consultants (Ltd), commissioned by the IPD GoS. The feasibility indicates that proposed divestment of FGW and support to the private sector to install smaller capacity tubewells.

Given the policy of the government vis-à-vis divesting of these tubewells a feasibility study for transitioning theses tubewells was prepared in 1998. This study concluded that the divestment will have high payoff and would reduce the financial burden on the constrained O&M budget.

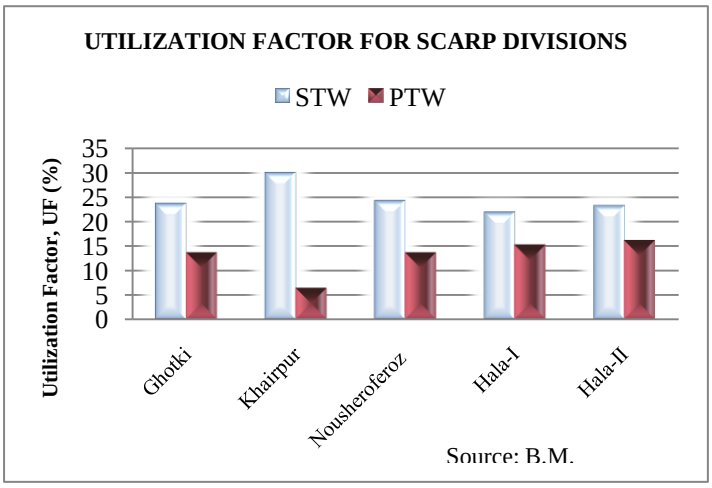


Figure 2: Utilization Factor for SCARP Division

In the stakeholder workshops, the beneficiary farmers voiced their concern about reversal of groundwater tale, and loss of productivity, and desired that the concerned agencies to take corrective measures.

It may please be noted that this Pre-feasibility is essentially a review of the feasibility prepared by the earlier Consultants. The information on benefits and costs mentioned in the feasibility has been update for 2012 prices, assuming other parameters as same, and the rate of return was re-estimated to assess if the viability parameters still hold.

Project Objectives

The objectives of the present study were: i) lowering of the water table to desired level to the desired level; ii) enhance farm productivity through conjunctive use of the underground water; iii) encourage and support small farmers groups to jointly own and manage tubewells ensuring economy of scale; and iv) recover a portion of the capital investment and relieve the public sector expenditure on O&M of the public sector FGWs.

Project Boundary

The project was to be located in the FGW corridors in Ghotki, Khairpur, Naushehro Feroze (north Rohri), and Shaheed Benazirabad (South Rohri), Sanghar, and Mirpurkhas districts.

Output

A total of about 3,160 tubewells were to be divested in various districts. About 1,110 tubewells are in Ghotki area, followed by, 275 in Khairpur, 575 in Naushero Feroze, and some 1,220 in Shaheed Benazirabad districts. In addition to this community mobilization and financial support were to be provided to develop some 9,052 privately individually or jointly owned tubewells.

Outcome and impact

The transition of SCARP tubewells to private sector would have relieved the government of the substantial burden of subsidizing well water and providing vertical drainage. It was expected that this would have improved the reliability of the water supply, and increased the farm productivity and net farm income. This would have been in line with the poverty reduction strategy of the government. With the financial support for fostering private tube wells it was expected that the increase in the water table would be arrested.

Estimated cost

It is estimated that if the project is implemented, the revised cost of the six year project would be about Rs. 8.3 billion in 2012 prices. The cost of private tubewells will be borne by the farmers for which a credit line would be arranged.

Project Viability

The feasibility study finalized in 2009, submitted by the BMC consultants did not estimate the IERR. The reassessment undertaken by present Consultants indicate an indicative IFRR of about 13.3 percent**.** However, the sensitivity analysis suggests that the project is sensitive to cost escalations, and reduction of benefits, and delays in the implementation, hence a risky investment.

Safeguards

Initial review suggests that the project would have improved the environment and does not indicate any negative environmental externalities that would need mitigation measures. Similarly, it would not require any involuntary resettlement.

5.3.6 Pre-feasibility 6: Second Line of Defense for Left Bank of Indus D/S Kotri

Introduction

Bunds along the Indus River in Sindh Province are breached during occurrence of large floods, either: i) intentionally to protect vital structures, usually barrages, or ii) without intention due to unfavorably high discharges and development of adverse hydraulic conditions even though the bunds were well designed and constructed. The August 2010 breaching of the MS Bund, some 50 miles downstream from Kotri, afforded an opportunity for the LBG/Indus team to investigate first hand possible reasons for a breach, effects of resultant flooding that affected agriculture, commerce, populations, cities and villages, and infrastructure including canals, roads, structures, homes and communications. The history of breaching In this 50 mile long reach of the Indus River is manifested by the six loop bunds, a system of spurs that extend one mile from the town of Belo to the Ranto Loop Bund and as confirmed by the record of breaches listed in the Bund Manual.

The major benefit of construction of a second line of defense, providing an embankment inland from the river along the entire 50 mile vulnerable area, would be disaster avoidance through restriction flooding to areas, largely rural lands, along the existing bunds, should a river bund breach.

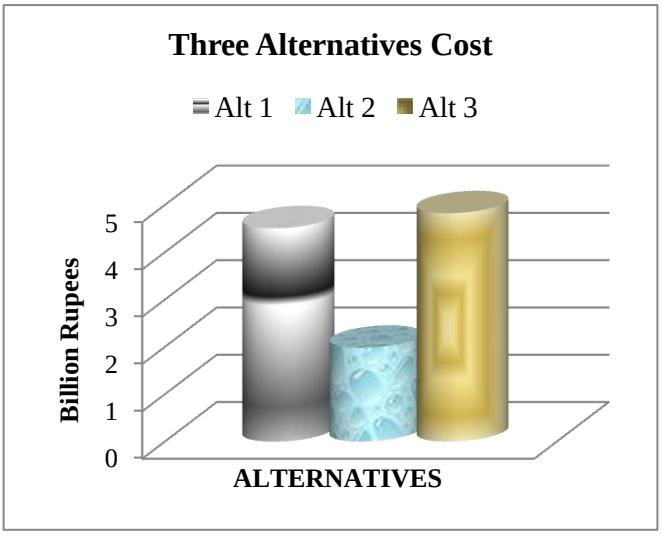


Figure 3: Three alternative costs

Currently, neither the national nor the provincial government has capacity to fund or organize first responders to simultaneously address the destruction of the lives and livelihoods of tens of thousands of persons across isolated tracts of lands that have been flooded to depths of 5 to 20 feet. This proposed element of the regional plan addresses this issue for a 50 mile reach of the river that would be protected through avoidance rather than periodic inadequate costly response. Beyond this initial project, a program that would extend to the entire left bank and right bank regions would greatly alleviate and possibly eliminate the disastrous effects of floods along the Indus River in Sindh Province. The proposed works would have provided protection from inundation to the communities in the left bank along the Pinyari feeder lower and the Daro Branch.

Estimated Cost

It is estimated that the financial outlay of the proposed intervention would be about Rs. 2.0 billion.

Project Viability

The participants of the three AWB workshops the opinion about its social acceptance was mixed. However, in the stakeholder consultative workshops at the district level, the proposal was overwhelmingly rejected. It validated the opinion of the communities along the proposed alignment. Given this, the proposal is considered not socially acceptable. Also, given the exorbitant cost of intervention, it does not seem to be an economically viable intervention. The stakeholders suggested that instead the existing bunds should be rehabilitated and strengthened.

5.3.7 Pre-feasibility 7: Elevated Platforms for Flood Displaced Persons

Rationale

Water disasters including river flooding, overflow of drains from combined drainage water and flood water discharge, and high water from coastal storms and storm surge frequently inundate low lying areas of the delta and coastal areas of the Indus river in the left bank. Given the flat terrain of the delta and the coastal, in the event of floods most communities are marooned for considerable period, and have limited access to high grounds, except for roads, canal and drain embankments, which are also under threat of failing.

As reported by the National Disaster Management Authority (NDMA) released on 28 November, 2011, about 30 thousand villages located in 520 union councils spread over 15 districts in the left bank of Indus were affected by monsoon rains of 2011. Out of which about 24 thousand villages in about 240 union councils were severely affected. The catastrophe directly affected about 52 thousand population. The report also mentions that some 250 persons lost their lives, and 460 persons were injured. Also some 65 thousand livestock succumbed to the floods in the seven most affected districts.

The floods completely destroyed 450 thousand houses, while 414 thousand houses were partially damaged, rendering them shelter less, and sought refuge in the safer areas. Some of them were shifted to government schools; whereas the majority of them constructed their temporary shelters on road side berms, non-operational railway lines, and banks of the canals and the drains. The stakeholders suggested that a suitable number of elevated platforms could provide temporary shelter where they could shift in better living and hygienic conditions. It was agreed that the Consultants will consider the possibility of constructing elevated platforms to facilitate make-shift arrangements, where access to the social services is possible. In addition to this the communities desired that the possibility of widening the existing roads and bund sections to accommodate the displaced persons.

In countries experiencing similar flood hazard, introduction of elevated platforms has provided relief to the affected communities. The elevated platforms provided about 40 square meter (430 square foot) area for each household. In addition to this ten percent area will be allocated for livestock and about 20 percent space for water and sanitation.

Each elevated platform will accommodate 16 to 20 households/families. It will also include , sixteen Two blocks of four wash rooms each are to be provided for 16 to 24 households, with common wash room facilities, separate for men and women. A common area for livestock will be located at the end of each platform. Space will also be reserved for NGO's and other relief agencies at the entrance, along with the space for daily provisions.

Objectives

The main objective is to provide adequate hygienic make shift shelter to the flood displaced population, till the normalcy returns. The purpose is to provide: i) temporary shelter for human and livestock; ii) access to water and sanitation, uninterrupted education facilities to children, and health facilities, and iii) access to relief and rehabilitation agencies.

Output

It is proposed that each year, for the next five years, about 1,000 elevated platforms, accommodating 20 households each of about 5 to six family members, are constructed, and about 1,000 running km of the roads and embankments are widened.

Impact and Outcome

The elevated shelter will improve the quality of life with safe hygienic conditions, and will

reduce the incidence of diseases, loss of livestock, and access to social services including relief operations.

Estimated Project Cost

The consultants evaluated three construction type options: i) type A - with stone pitching and compaction; ii) type B - without stone pitching and compaction; and iii) type C - without stone pitching and compaction with Murom. Similarly, three sizes per household were considered, namely, 400, 225, and 150 square foot each for one family. A 400 square foot with type A construction would cost about Rs.60 thousand per household, while B and C type construction would reduce the cost by 50 percent, and 67 percent respectively. Similarly, reduction in space per household to 225 square foot would further reduce the cost by 50 percent, while further reducing it to 150 square foot per household would reduce the cost by to 67 percent in each type of construction. The Consultants recommend that 20 household shelters complex should provide for 400 square foot of space with type A construction for each household.

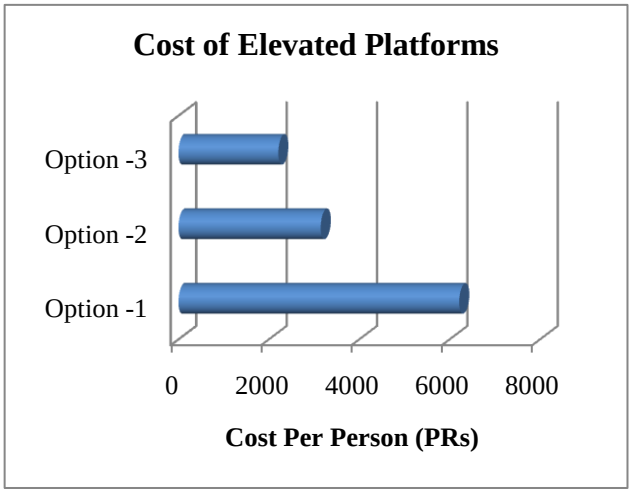


Figure 4: Cost of Elevated Platform

It is estimated that each shelter accommodating 20 household would cost about Rs.1.2 million, and the proposed 1,000 shelter complex would cost Rs.1.2 billion.

Proposed Implementation Arrangements

It is proposed that construction of elevated platforms is implemented by the PDMA, while widening of road embankments is implemented by the roads department, while the district administration assumes the responsibility of its upkeep and unauthorized occupation, when not in use by the flood displaced person.

Project Sustainability

It is apprehended that the facilities, in particular the elevated platforms would have risk of unauthorized occupation and other uses after the flood water recedes, particularly during years when they are not required for sheltering flood displaced persons. During these periods its maintenance and upkeep would be of low priority. During floods, even the illegal occupants would require shelter and would be difficult to evict them on humanitarian grounds, and might not be available to the flood displaced person influx; defeating the purpose. This may require a prior evacuation and allotment plan and designation of household with first right.

5.3.8 Pre-feasibility 8: Rehabilitation of Coastal Wetlands

Rationale

In the left bank of Sindh, about 90 wetlands of varying sizes, serve as repository of wildlife, flora and fauna, and biodiversity. The wetlands are important natural resource base of economic importance. They provide livelihood opportunities, mainly fishing, for the local communities. The coastal wet lands, particularly Sanhro and Mehro dhands - the Ramsar sites, were recharged by flows from storm water runoff and surface drainage system in the southern districts (Badin and Thatta). To avoid KPOD drainage effluent discharges into the abovementioned two dhand complexes, a 42 km long tidal link canal was built to detour the outfall into Shah Samando creek. In addition to this at Cholri dhand, a weir was constructed to protect the *dhands* from excessive drainage flows and back flows into the tidal link during high tide.

With the collapse of Cholri weir and breaches in the tidal link due to cyclone 2 A in 1999, the salinity level of the *dhands* has been compromised due to back flows from the sea. With the salinization of these *dhands,* the fish productivity capacity has been severely impaired. Also during the low tides, the *dhands* drain out into the tidal link, causing sedimentation and lowering the storage levels in the *dhands*.

The communities whose livelihood has been severely affected strongly expressed the need to revive the *dhands* by arresting the seawater and KPOD drainage polluting the *dhands*. They perceived that this would reinvigorate the livelihood opportunities for the communities dependent on these *dhands*.

It is proposed that the dhand complex spread over 67 thousand acres be fortified with an embankment, with a dead storage of 300 thousand acre feet, ensuring significant increase in the fish production. The design of the embankment would also include a gated structure to divert about 2,000 cusec of storm water flowing through the KPOD during high rainy season.

Objectives of the Project:

The main objective is to i) revive the *dhands* as a source of livelihood; ii) restore and improve the ecosystem; through protecting the *dhands* from seawater and drainage effluent intrusion.

In addition to this seed of good quality local species of fish will be introduced in the *dhands* to improve the quality and yield of the fish. The reed grasses will also be grown to create better environment/habitat for the waterfowls and migratory birds.

Project Outputs

The following are the main outputs of the proposed intervention:

i. an embankment, about 500 meters from the tidal link extending all around the *dhands* constructed to allow breathing space for the tidal water constructed;

ii. five gated structures at: i) RD minus 12 to block the backflows from sea; ii) at upstream of RD minus to divert storm water flowing above the base flow level; iii) at Karo Ghungro outfall, iv) at Guni Phuleli drain outfall, and v) at southern side to regulate excess water in the dhand complex.

iii. fish seed of appropriate species introduced in the *dhands*.

The mangrove and local tree plantation in the space in between the bund and the tidal link will protect its erosion from rains and tidal effects. This activity is included in a separate Pre-feasibility, presented later in the report.

Project Outcome and Impact

This intervention is expected to improve and revive to a larger extent the ecosystem of the *dhands* and would enhance the household income of the communities that are dependent for their livelihoods from these wetlands. The main outcome of the project includes:

i. about two thousand mt of fish produced annually;
ii. refuge to local water fowl, migratory birds;
iii. production of 5,000 thousand mt of fodder for livestock;
iv. improved ecosystem and better environment for the wild life and biodiversity;
v. irrigation supplies water from the *dhands* during water scarcity conditions.

The project will also provide employment to local communities, and would reduce the poverty incidence to 50 percent from the current estimated level of 75 percent.

Project Cost estimates

The cost of the embankment around the *dhands*, the gated structure for incoming water from KPOD, and the five outfall gated structures will approximately cost about Rs.8.4 billion.

Project Viability

Despite its enormous environment benefits, the project is not a financially or economically justifiable proposition.

Safeguards

This is an environment friendly option to revive the badly degraded ecology of *dhands*, will create employment opportunities for local communities, improve the salinity of *dhands* and will help conserve valuable water resource presently wasted to the sea through drainage. There are numerous social benefits including better livelihood opportunities, favorable environment for migratory birds and fodder for livestock thus raising the socio-economic wellbeing of the communities.

5.3.9 Pre-feasibility 9: Protective Plantation of Mangroves in the Coastal Areas of the Left Bank

Rationale

Thatta and Badin are the two major hazard-prone districts of Sindh. In the last four decades cyclones, heavy rains, transport of hazardous industrial waste, inundation due to breaches in LBOD system, further exasperated by the damage to tidal link and collapse of Cholri weir causing seawater intrusion, resulted in several multidimensional issues. These hazards caused salinization of farmland and water bodies and wetlands, including underground water resources, resulting in the shrinkage of productive farm land, and loss of fish resources in the delta and the coastal area. In addition, these impediments also had a negative impact on the environment, ecology, and biodiversity. The situation has severely weakened the local economy compromising the livelihoods of delta and coastal are communities. The degradation process is furthering due to unchecked widening and extension of the creeks.

Mangroves serve as green wall screen and play a key role in combating natural and manmade induced hazards in coastal areas. They act as first defense line against the onslaught of tidal waves and protect the coastal areas from the seawater intrusion, and high surges of tides. The extensive root system and the bushes retard the storm water runoff and support fish spawning. Mangroves also provide fodder for animals, fuel wood, and small woods for roof thatching material for the dependent communities.

The coastal communities strongly feel that the main issues are: i) erosion and degradation of coastal productive land; ii) salinization of water bodies and *dhands*; iii) decline in fish resource; v) and absence of mangroves as a source for fodder, fuel wood, and roofing material, thereby constraining the livelihood opportunities.

This intervention will revitalize the mangrove plantation along the coast, a critical and complex coastal ecosystem severely threatened due to over exploitation, constrained fresh water flows, and disposal of industrial pollutants and drainage effluent. It will arrest the seawater intrusion, increase fishing potential, improved access to fodder, fuel wood, roofing material, and will be a source of livelihood for local communities. The establishment of mangrove plantation is also in line with the CDM initiatives, and will act as carbon sink.

Project Objectives

The main purpose of the project is to i) to arrest seawater intrusion; ii) protection and restoration of productivity of farm land and the water bodies; iii) ensure availability of fodder, fuel wood, and roofing material to local communities and sustainable livelihoods; iv) protect the ecosystem and act as carbon sink.

Provide protection to the coastline and the delta ecosystems ensuring sustainable livelihoods to the local communities. The project has been so designed that it would create a biological screen to protect the lower reaches of the drainage system, engineering structures, farmlands, wetlands/water bodies and arrest coastline erosion and sea water intrusion. In addition, the proposed intervention will support fish production, provide fuel wood and fodder to local communities, and improve their livelihoods.

Project Location

The project will be located in coastal area of district Badin and Thatta district (left bank of Indus), comprising of coastal Talukas (sub-districts) namely Badin and S.F Rahu of Badin district and Jati and Shah Bander Talukas of Thatta district where potential areas/mudflats will be identified.

Project Outputs:

By the end of the 2017, the main outputs of the proposed intervention will accomplish:

i. 10,000 ha mangrove plantation on the blank mudflats in the frontage of sea and backwater;

ii. 8,000 ha of plantation of mangrove belts along the wetlands and the tidal link;

iii. 5,000 ha planted with salt tolerant species in supra tidal zone and around the perimeters of wetlands and *dhands*.

Project Outcome and Impact:

The main impact of the intervention will be:

iv. reduction in the coastal erosion and seawater intrusion and backwash, and further degradation of fertile land;

v. enhanced fish production in the wetlands and *dhands*;

vi. reduction in damages from cyclones/tsunami;

vii. reclamation of productive lands in the coastal area;

viii. secured livelihood for the local communities; and

ix. improved environment through carbon development mechanism.

At the full development stage the annual production of wood is expected to be 10.90 mt with an approximate value of Rs 24.6 million, and fodder with an approximate value of Rs. 6.20 million. In addition to this the green walling and arresting sea intrusion will reclaim about 137 thousand ha, with an annual value of farm production increased by about Rs.10,000 Per ha. Similarly, the annual fish production will increase by two and a half thousand mt fetching about Rs. 25 million to the communities.

Project Cost

The total estimated cost of the project is Rs.733 million. The estimated costs is based on existing price structure and adopted from the ongoing mangrove rejuvenation projects, in the coastal areas of Sindh. The estimated cost will be refined further if approved and selected for detailed feasibility in the phase III of the study.

Project viability

The preliminary indicative IFRR is about 17.1 percent. The net value of present value of the incremental benefits is expected to be Rs.409 million, with a benefit cost ratio of 1:1.5. These estimates will be firmed up at the detailed feasibility stage, along with sensitivity analysis.

Proposed Implementation Arrangements

The proposed project will have positive impacts on the social aspects of the society such as poverty reduction, income distribution, employment generation, livelihood opportunities and gender mainstreaming. With the development of this project and its execution through integrated and participatory approaches the coastal people will be mobilized, organized and act as executing team will get direct and indirect employment and sources of livelihood which will ultimately alleviate poverty and distribute benefits equitably. Furthermore, the communities will own the project. Women will also be involved in all the processes of the project

The implementation period for the proposed intervention is five or seven years. The proposed project will be implemented through participatory approach by involving all stakeholders from project preparation, execution and benefit sharing. Due to participatory approach the local communities will be involved from initial stages of project development, survey, selection of sites, planting, maintenance, protection and distribution of benefits

The executing agency will be Sindh Coastal Development Authority (SCDA) and the Sindh Forestry Department (SFD) is proposed to be responsible for the implementation. On the state lands SFD will be responsible for the development and operational and management arrangements, while on communal lands and around the wetland a public-private-partnership arrangements will be established through NGOs and civil society organizations for community mobilization.

Safeguards

The intervention is environment friendly and does not require any resettlement. The project being developed under CDM will generate carbon credits which will be owned by the Government and will be used for other CDM projects. Hence, the project has several environmental benefits and is environment friendly project.

5.3.10 Pre-feasibility 10: Use of Drainage Water for Forestation in the LBOD and Kotri Areas

Introduction

Forest cover is an important source for timber, fire wood, fodder, and non-timber products. In the riverine area, they also act as barrier to protect from banks erosion. Most stakeholders felt that denuding of forest cover has impaired the availability of timber, forage, and other forest products of economic importance, overall environment, and has depressed the income of communities dependent on forests.

The stakeholders also suggested that the vast area that is out of cultivation due to limited irrigation supplies, can be brought under forest cover, if additional irrigation supplies are available. They proposed that the drainage effluent should be diverted, where possible, from the adjacent drains to support establishing forests and or grazing lands, in conjunction with the fresh water, on the public and private lands.

Conjunctive irrigation refers to mixing of irrigation and drainage waters to the areas for tree plantations. The irrigation water will be sweet water and the drainage water will be saline quality. In order to utilize drainage water for forestation both the waters will be mixed in required quantities to reduce salinity level of brackish water to sustain tree growth

Project location

The proposed project will include two geographic areas namely i) LBOD command area located in Shaheed Benazirabad, Sanghar and Mirpurkhas, and parts of Badin district; and ii) Kotri Surface Drainage System located in Thatta and Badin districts.

Project Scope and objectives

The objectives of the project are to i) increase the livelihood of communities by utilizing the culturable waste through establishing forests on the private and public lands; ii) releasing pressure on the drainage system by offloading the drainage effluent; and iii) to improve environment through carbon sequestration.

Project outputs

The expected outputs of the project include forest plantation on 5000 ha of private and public lands. The project will raise nurseries of 15.0 million plants which will be supplied to interested farmers on subsidized rates.

Project Outcome and Impact

At the full development stage annually about 25 thousand cft of wood, valued at Rs 295 million. It will provide employment to about 4,500 persons. Similarly the farming community will be provided with forage for their livestock. In addition to this these forest will produce non timber products. This would also reduce waterlogging and salinity in these lands reclaiming their productivity. It would also generate income to Pakistan from carbon sequestering. The details will be worked at the time of feasibility stage of the study in phase III.

Project Cost Structure

Total cost of the project is estimated to be Rs. 225.0 million

Project Viability

The financial analysis was undertaken for all the production parameters i.e. grasses, fuel wood, small construction wood and industrial wood, at an aggregated output level. The

project viability was assessed for the project as whole.

The overall IFRR for the project is 15.8 percent, while the NPV for the cost at 12 percent is Rs.256 Million, and NPV for the incremental benefits is estimated Rs.346 million. The cost benefit ratio of the project is 1:1.35 on overall basis.

Implementation arrangements

It is proposed that the FD executes and implement this intervention in coordination with the IPD, SIDA. The FD will implement this on the forest lands, while it will provide support to the private farm land owners with the support from NGOs for community mobilization.

Project Safeguards

The proposed project is environment friendly on the grounds that it will not have any adverse impacts on any green infrastructure of the areas, will utilize the drainage water for growing trees and crops, will improve degraded lands and increase their productivity and will improve the physical and chemical structures of the degraded soils. This intervention does not involve any resettlement issues.

5.3.11 Pre-feasibility 11: Bio-saline Agriculture in Badin and Thatta Districts

Rationale

The drainage of effluent Kotri command area is carried through 18 major drainage systems. These drainage systems are carrying drainage effluent into sea except for three drains which are out falling into river Indus. One of these drainage systems Kadhan Pateji Outfall Drain (KPOD) is connected to LBOD and Tidal Link for outfall into Sea. The total design discharge capacity of the whole system on left bank is about 8,050 cusecs. The salinity level of the drainage effluent is about 2 ds/m which is suitable to grow most crops on marginal lands.

The drainage effluent if used for bio saline agriculture, would supplement farm incomes, and would release pressure on the main drainage system. Evidence from Pakistan and elsewhere show that the salt tolerant crops (glycophytes) irrigated with the brackish water grown on marginal lands has shown promise. These crops include salt tolerant varieties of wheat, barley, oilseeds, cotton, and different vegetables.

The communities in the coastal area, particularly in the Badin district reported that since their natural resource base has degraded, support is needed to increase their farm productivity. It was suggested that if they are given access to the drainage water through public lift pumps, they would be able to grow salt tolerant crops.

In response to this, the Consultants a Pre-feasibility was prepared to support and introduce bio-saline agriculture along the drainage network.

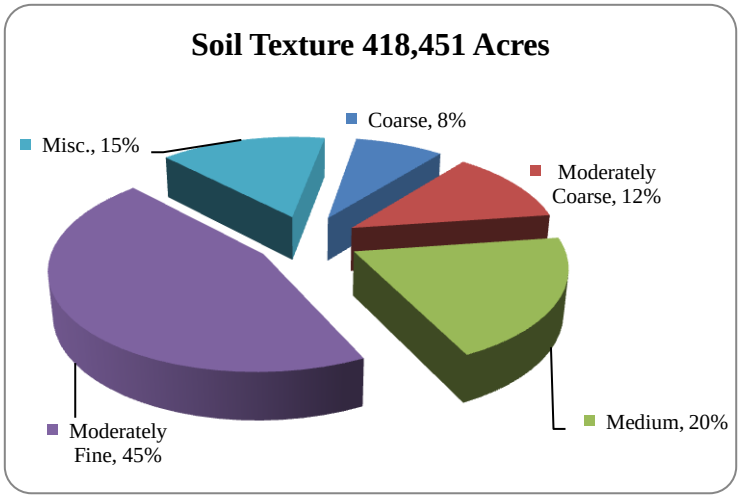


Figure 5: Soil textures in Thatta and Badin Districts

Objectives

Following issues will be addressed; i) reduction of culturable waste, ii) arresting further degradation and desertification; iii) off load pressure on the main drainage system; iv) improve the environment, and v) increase farm income.

Outputs

The main outputs will include: i) by the end of the 5 year project period, 625 community based lift pumps will be installed, each supporting 200 acres; ii) distribution channels will be laid out to deliver water to participating farmers.

Outcome and Impact

It is estimated that selected salt tolerant crops, grasses, and trees will be grown on about 125,000 acres, generating an annual net farm income of Rs.5,000 per acre per year. This will not only increase the farming intensity, will also enhance the household income of participating farmers, and will also provide additional employment to landless labor.

The proposed project will also have several indirect benefits, such as increased availability of better nutrition to household members, will also help in the availability of fodder and forage for the livestock, and would arrest further degradation of soils.

Proposed implementation arrangements:

Since the drains are flowing below the ground level the water at suitable points will be pumped into purpose built channels along the drains. All the operations of the project will be executed through participatory approach. The SIDA/IPD will procure and install the lift pumps, and the community groups will operate and maintain the lift pumps. An NGO will be engaged for community mobilization. The agriculture department will provide support for soil testing and identification of appropriate crops and varieties.

Cost Structure

The total cost of intervention is estimated as Rs.2.4 billion. This includes cost of procurement and installation of lift pumps at Rs.50,000 each, cost of laying out distribution system, land clearance at Rs.10,000 per acre, and cost of community mobilization.

Economic Viability

The preliminary analysis suggests an indicative IFRR of 13.3 percent. Nonetheless, the project has been designed based on the assumption that the hazardous effluent originating from sugar mills and other sources discharged into the drains completely terminated, else the drainage effluent is not usable for bio-saline agriculture, and farmers will be reluctant to use this water. Hence if the drains are not kept free of the sugar mills effluent, the project has a high risk of failure.

Safeguards

The proposed project is environment friendly as it will not have any adverse impacts on any green infrastructure of the areas. Any salinity build up in the marginal soils due to application of the saline drainage water would be washed off with the rain water flows. Moreover, only those crops, grasses, and trees will be selected that help reduce soil salinity.

5.3.12 Pre-feasibility 12: Rehabilitation of Deh Akro II and Chotiari Wetland Complex

Introduction/Rationale

Wetlands are the storehouses of globally endangered biodiversity of flora and fauna because of their extensive and rich food webs and biodiversity. It is also an import source of livelihood for the wetland dependent communities. The wetlands are ecosystems that provide goods and services that have an economic value, not only to the local population but for the downstream beneficiaries. Within the study area, there are three inland wetland complexes. They are i) Deh Akro II in Shaheed Benazirabad district; ii) Chotiari reservoir and wetlands in Sanghar district; and iii) the coastal wetland complex in the Badin district.

Deh Akro II is also a wildlife sanctuary consisting of four major habitats; desert, wetland, marsh and agricultural. It is a natural inland wetland ecosystem, which supports a variety of rare and endangered wildlife species predominantly crocodiles. This area hosts a considerable number of rare fauna. Many indigenous fish species are also found. During the last decade, a persistent dry spell adversely affected the area. The Chotiari wetland complex extends over 20 thousand ha and includes about 36 lakes, of which five are freshwater and 31 brackish water, fed by seepage from the Nara Canal and its Jamrao offshoot. This Pre-feasibility offers a corrective intervention for Deh Akro II and Chotiari reservoir and associated wetlands. A separate prefeasibility has been prepared and included in this document.

These wetlands are under threat due to lack of awareness of its economic importance, and poor management. The stakeholders during the consultative workshops reported that in Deh Akro II the major issue is the shortage of water required for the survival and growth of the wildlife species. Most wetlands are water stressed causing serious threat to the wildlife species available in these wetlands.

Box 2: Profile of Chotiari Reservoir

Length	7.8 miles
Width	9.6 miles
Surface	45,000 acres
Capacity	0.71 MAF
Live Storage	0.67 MAF

Ideally, the original water allocation for wetlands needs to be restored in order to avoid the degradation process. Notwithstanding the shortages in the irrigation supplies, a reasonable allocation needs to be made to avoid continual damage to wetlands. The stakeholders suggest that supply of water to head lakes through an underground pipe off taking from the Nara Canal, operating during the peak flow months. In addition to this, the stakeholders suggested dredging of silted lakes whose storage capacity has been reduced over time. Other issues include over growth of predators, and indiscriminate hunting in this wetland complex.

In Chotiari Wetland Complex consist of: i) the Chotiari Reservoir; and ii) the Chotiari Wetlands. The entire area is managed by the IPD for irrigation purposes. With the construction of reservoir seepage has become a serious problem threatening its banks and creating waterlogged conditions in the hinterland agriculture. During consultations many a stakeholders considered the waterlogging due to seepage from the reservoir is a serious threat to their livelihoods and emphasize its control.

The stakeholders concurred with the proposed solution of dig moats along the western and southern embankments of the reservoir. These moats would intercept seepage water before these can reach farmland areas. Alternatively, a grid of surface drains is laid to prevent the topsoil from becoming waterlogged or even flooded.

A few participants of the workshops also suggested that there is an urgent need to prepare and implement a regional wetland management strategy and an action plan. They also suggested that a separate authority is established to manage the wetlands, and monitor the progress.

Objectives

The principal objectives of the proposed intervention are:

i. revival of wetlands through assured supply of minimum requirement;
ii. increase farm productivity through control of seepage causing waterlogging;
iii. protection of biodiversity; and
iv. preparation of a regional wetland management strategy and action plan.

Outputs

The main outputs by the end of the plan period include:

i. by the end of 2014, a regional plan study is completed along with action plans for all the wetlands in Sindh, and presented to policy makers for approval;
ii. by the end of 2014 the wetland authority is established;
iii. by the June 2015, about ten km long piped linkage between Nara canal and head of the lake in Deh Akro II is constructed and operative;
iv. by 2015, dig moats or grid interceptor drain are in place along the Chotiari reservoir complex;
v. communities mobilized and are effective in monitor illegal hunting.

It is anticipated that the interventions will increase the household income of the communities dependent on the wetlands, particularly farmers through reclaiming of the waterlogged areas. It will also improve the environment and create a rich habitat for reversing biodiversity losses. This will also foster introduction of ecotourism.

Outcome and impact

The intervention will arrest the seepage to the lands adjoining the Chotiari lake restoring its productivity, and improved habitat of the wetlands for wildlife and migratory birds.

Estimated Cost

The total estimated cost of the proposed project is Rs.40 million.

Economic Viability

As the main benefit is improvement of the environment, the intervention was not evaluated for economic viability.

Proposed Implementation Arrangement

SIDA will be the executing agency, while Wild Life Department (WLD) will implement the Deh Akro II restoration related interventions in collaboration with EPA and IUCN. The Chotiari reservoir and wetland complex will be implemented by SIDA in collaboration with WLD, EPA, and IUCN.

After initial studies have been launched and the necessary institutional and legislative analysis have begun to produce their first results, an embryonic Regional Wetland Management “entity” will start taking shape. From thereon it should gradually assume more and more responsibilities in the management of the wetland complexes.

Safeguards

The proposed solutions will not have any negative environmental issues. The proposed intervention is environment friendly as it will not create any environmental problems but will

improve the existing environmental problem of waterlogging in the area. and wetland complexes, The interventions may involve resettlement. This aspect will be addressed during the detailed design stage, if selected.

5.3.13 Pre-feasibility 13: Shrimp and Mud Crab Farming in Coastal Areas of Left Bank

Introduction

Coastal fishery is the mainstay of livelihoods of the coastal communities. During the last three decades, fish productivity has dwindled due to sea intrusion, contamination of the wetlands with drainage effluents, overfishing, and use of illegal nets. Further, due to recent floods and damage to tidal link the seawater intrusion has altered the topography of area near Zero point Badin and is suitable for shrimp and fin fish culture including crabs and lobster.

Mud crab (*Scylla serrata*) named Koko is very famous in taste in south East Asian countries. At present so many parties are exporting crabs to European and Fareast Asian countries which are on rise. The following species of crabs are exported in shape of crab meat, canned and alive.

The stakeholders during the workshops expressed their predicament and suggested public sector support to restore the fish potential and interventions to support the livelihoods in the area. As the shrimp and mud crab farming is feasible and has potential in the area, and communities with technical support can benefit from this enterprise.

The ponds can be built within the intertidal low lying areas, receiving tidal water into the pond through gravity flow during high tide. The seed is available from the shrimp hatchery at Hawks bay in Karachi, maintained by the Fisheries Department, GoS. Small size crabs can be collected from sea mostly purchased from fishermen engaged in this trade.

Project location and boundaries

The project will be located in the coastal areas of Badin and left side of Thatta districts comprising of Badin, Shaheed Fazil Rahu Talukas of Badin district and Jati, Shahbander and Kharochan Talukas of Thatta district.

Project scope and objective

The main objective is to exploit the livelihood potential through introduction of the shrimp and mud crab farming as a niche activity in the area.

Project Outputs

The project will help farmers to establish ten shrimp farms, and ten mud crab farms, in Shahbander, Jati, Badin, and SF Rahu talukas.

Project Outcome

The proposed project will generate employment and will help in reducing poverty of landless and unemployed.

Project Cost

Since it is a private sector project, would require a credit line of about Rs.123.5 million.

Project Viability

Fir the proposed enterprise, the estimated indicative IFRR is 12.8 percent.

Implementation Arrangements

The farms/ponds will be owned and managed by private enterprisers/farmers. Sindh Fisheries Department will provide extension and advisory services.

Safeguards

This is an environmental friendly intervention as it will not create any adverse impacts on

flora and fauna, soil, water, land use, climate etc. The proposed project will be executed in the mangrove areas, ensuring protect to the mangrove plantation, as due to increase in human activity it is apprehended that the mangrove resource will be deteriorated on the cost of shrimp farming. Resettlement is not required for this activity.

5.3.14 Pre-feasibility 14: Brackish Water Fish Farming in LBOD Area

Introduction

The province of Sindh is blessed with all kind of water resources i.e. marine and brackish and fresh water. Despite its potential, the growth of this subsector is constrained by lack of supply of seed and knowledge base amongst the potential farmers. Thousands of acres of waste and water logged land is available in the LBOD project area and surroundings which can be converted into productive fish ponds, and is lying waste.

There is ample area and depressions in the command area of LBOD system which is un-utilized due to salinity problem of the water available in the depressions. In such areas it is not possible to grow fresh water fish. In addition, the LBOD drainage water is available in ample quantity in the spinal, lateral and tertiary drains where brackish water fish could be introduced and propagated. The fish seed is available from fish hatcheries and will be stocked and grown in the fish ponds and will be stocked and grown in the fish ponds constructed under the project.

The stakeholders expressed the need to support fisheries in the area to enhance income of the communities located along the drainage network.

Project Area

The proposed project is suggested to be located in the districts of Shaheed Benazirabad, Sanghar, Mirpurkhas, and Badin, along the drainage network.

Objectives

The objective of the proposed project is to introduce the brackish water fish along the drainage network where the quality of water is brackish. The specific objectives of the proposed project are as under:

Project outputs

A total of 80 ponds will be established, of which half will be the Tilapia noliticus and half for the Lates calcarifer (Dangri). These will be divided between the four districts.

Outcome and Impact

With this the alternative opportunities for improved livelihood will enhance in the farming community and ultimately the poverty will be alleviated. The proposed project is socially acceptable as it will enhance job opportunities, reduce poverty, provide livelihood to the local population and will increase economy of the people and the province. The project will generate employment opportunities for rural people especially fishing and farming communities during construction and execution phases and onwards. It will create direct and indirect jobs for both men and women.

Cost structure

Since it is a private sector project, would require a credit line of about Rs.545 million.

Project Viability

The estimated IFRR of this activity is 13.2 percent. As this is a private sector activity, the intervention, does not need allocation of funds, except.

Implementation Arrangements

The farms / ponds will be managed by land owners. Sindh Fisheries Department will provide extension and advisory services.

Safeguards

The proposed project will not create any environmental issue during its construction and implementation phases but rather address the existing environmental issues such as water logging and salinity, water quality aspects, degradation of agricultural lands, decline in fish resources, and loss of biodiversity and decline in natural resources habitats. This is an environmental friendly project as it will not create any adverse impacts on flora and fauna, soil, water, land use, climate etc. The proposed project will be executed in the command areas of LBOD system the care shall be taken to protect the existing wild vegetation of un-economic value. In fact such un-economic and un-utilized lands will be made productive due to introduction of brackish water fish.

5.3.15 Pre feasibility 15: Establishment of Disaster Management Unit in SIDA

Introduction

Southern Sindh 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 Badin July 2003 precipitation (303.9 mm), which caused major flooding and destruction, was estimated to have a 66 years return period. In 2011 on the 11th and 12th August the precipitation recorded in Badin added together was 297 mm which when looked as one 48 hours event the corresponding return period is near 100 years. Also, the highest ever monthly precipitation record in Badin was surpassed in August 2011 with 331 mm corresponding to more than 80 years return period. Moreover, if a 30 days period is observed from 10 August to 9 September 2011, Badin experienced 512 mm of rainfall in one month.

The devastation experienced by the people of Sindh requires proper planning of the disaster. It is implied within the Law in Sindh Province that, SIDA is to assume the flood management activities within the command areas of its three AWBs and is responsible to the National Disaster Management Agency.

This unit would develop, on a periodic basis, a strategy statement for improvement of irrigation and drainage services, integrated water management including drinking water, water distribution in times of drought, flood protection within its command and catchment areas setting goals and objectives, formulating implementation policies and identifying priority and other actions.

In addition to this would be responsible to issue flood warnings and warnings to all the stakeholders that are likely to affected, if it has cause to believe that damage or harm shall result from the use of any water flowing within its area of jurisdiction. The other functions would include: i) monitoring of the disposal of toxic or noxious effluent safely and with minimum pollution of water resources; ii) ensure repairs of flood protection works in the pre-flood season; iii) review the plan for regulation of the canal supplies during the rainy season; iv) ensure positioning of the machinery and materials near vulnerable points for emergency repairs; and v) inspection of the vulnerable breaching of sections.

Objectives

The main objective of this study is to implement a SIDA Disaster/ Crisis Management Cell for preparing, training and coordinating plans for emergency response services in case of emergency situations and disasters within SIDA's ordinance. The Disaster Risk Management Cycle (Disaster Cycle) consists of four phases: Prevention/Mitigation and Preparedness in the pre-disaster stage, and Response and Rehabilitation/Reconstruction in post-disaster stage.

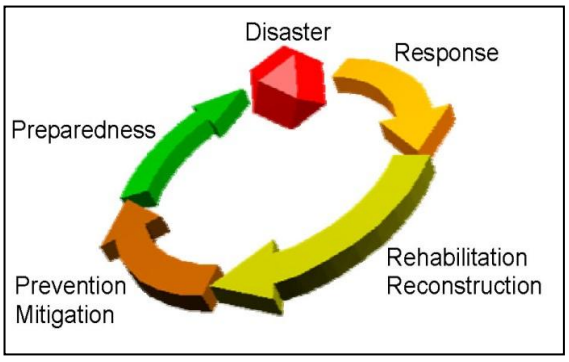


Figure 6: Crises Management Cycle

Output

A Disaster Management will be established by 2014, and is functional. Standard operating procedures or protocols will be developed to trigger timely flood protection and preparedness

measures in consultation with vulnerable communities in the pre-disaster stage, and response and rehabilitation/reconstruction in post-disaster stage.

Impact and Outcome

The establishment of the Disaster Management Cell would i) develop the capacities of SIDA to mitigate floods and droughts, particularly during calamities, such as breaches, floods or extreme weather conditions such as cyclones, the SIDA shall have a coordinating role in taking all necessary measures.

Estimated Project Cost

The estimated cost of the DMU is about ten million, with and annual operational expenditure of Rs.20 million. The annual operating costs after the first year, once the Cell is fully established, can be reduced as less number of staff will be required to operate the Cell.

Proposed Implementation Arrangements

The Sindh Water Management Act of 2002 assigns SIDA specific responsibilities related with disaster management and related environmental issues. Therefore, SIDA has the obligation to develop, on a periodic basis a strategy statement for improvement of irrigation and drainage services, integrated water management, flood protection, prevention of sea water intrusion, water distribution in times of drought and wetland management within its command and catchment areas setting goals and objectives, formulating implementation policies and identifying priority and other actions. It requires continued updating of strategies for flood protection, prevention of sea water intrusion and drought management.

5.3.16 Pre feasibility 16: Gender Mainstreaming in Irrigation and Drainage

Introduction

> *"No nation can rise to the height of glory unless your women are side by side with you; we are victims of evil customs. It is a crime against humanity that our women are shut up within the four walls of the houses as prisoners. There is no sanction anywhere for the deplorable condition in which our women have to live." Mohammad Ali Jinnah 1944*
> *(US Library of Congress report "Pakistan - A Country Study")*

Despite important role played by women in the agriculture, and other economic activities, they are generally perceived as beneficiaries, and not as partners in the management of assets and resources, and the development process. They are silent bystanders in the planning, implementation and operation stages of the development activities. They, along with children are the first victims in disaster, such as flood disasters. Moreover, the property rights are not well defined and transparent.

The situation is not different vis-à-vis irrigation and drainage subsectors. This is evident from their minimal presence in the water management institutions, such as Water Users Associations (WUAs), FOs, AWBs. Here they are represented by their male family members, as their guardians. Similarly, in the development process their aspirations and problems, or their rights are not adequately represented or articulated.

During the consultations at the village and district levels, the women participant showed their dismay on the lack of their involvement, and absence of registering their apprehensions and aspirations in the planning, implementation, and management of the irrigation and drainage infrastructure, flood preparedness management, and desired an active role.

Current SIDA's framework advocates increased participation of women in the water management reforms. Although SIDA has a gender policy, they need to draw a well laid out way forward to ensure women participation in water management. Nevertheless, SIDA's has made a considerable achievement in engaging women farmers and registering them as members of the Water Course Association (WCA), FOs, and AWBs.

However, the limited women membership in the FOs does not indicate their active involvement in the water management. Out of 383 FOs, only 146 have women representation, but the overall participation of women in the FOs, and AWBs is less than one percent.

To main stream women participation in the water management, it is proposed that the Social Cell organizes a five year gender sensitizing and training program to foster an active role in the organizational and water management activities..

Objectives

To mainstream an active and representative women inclusion in the participatory water management actives, and to sensitize all the line agencies dealing with the water management and preparedness in flood management.

Project Output

The main outputs of the strengthening and training program are:

i. Gender mainstreaming strategy and action plan formulated and implemented;
ii. 60 staff of SIDA trained in gender mainstreaming;
iii. 90 field staff of AWBs trained in gender mainstreaming;
iv. 450 persons in line agencies in 15 districts trained for gender mainstreaming;

v. 500 field staff in AWBs trained in gender related conflict resolution and negotiation skills;

vi. 1,400 members of the FOs trained in gender awareness of issues;

vii. 6,500 community members trained in flood preparedness;

viii. 9 campaigns at AWB level, 6 TV programs, 12 radio programs, and 12 newspapers supplements organized to disseminate information related to the drainage issues.

Impact and Outcome

The training program would strengthen the capacity of the SIDA, AWBs, FOs, and rural communities in ensuring active participation of the women in the management of irrigation and drainage systems, and addressing gender concerns.

Estimated Project Cost

The estimated cost of training and awareness campaigns is estimated at about Rs.21 million.

Proposed Implementation Arrangements

It is proposed that a Social Cell of SIDA is entrusted to organize the trainings.

5.4 Position Papers

5.4.1 Position Paper 1: Drainage Effluent Intrusion in the Ghotki Area from Southern Punjab

During the stakeholder consultations concern was shown by the farmers in the Ghotki area about the drainage effluent flowing in from the northern adjoining district of Rahim Yar Khan, Punjab. The seepage from the evaporation ponds, draining out in the Ghotki area has severely degraded considerable land creating marshy conditions. Significant cropped are has been ruined into wasteland.

In Punjab, the evaporation ponds were constructed under the Salinity Control and Reclamation Project (SCARP) VI for the disposal of the highly saline drainage effluent from the irrigated areas of Rahim Yar Khan and Bahawalpur Districts. The gross area of the Project is [1]1.46 Million acres (590,862 ha) out of which 1.267 Million acres (512,755 ha) are culturable commanded by Punjnad and Abbasia Canals. SCARP VI comprise of 514 tubewells of varying capacity from 1.5 to 3 cusecs (43 to 85 lps) to lower and maintain the water table over the area. In the first stage[2], 391 tubewells were installed along four drains: Abe-Hayat, Khanpur Main, and Manthar and, Pattan Manara. In the second stage 123 tubewells were installed along Tarukari Drain and the operation of the 514 tubewells started in 1989.

Due to the lack of hydraulic head towards the Indus River the option to outfall into the River was discarded and the option of saline drainage water disposal through evaporation ponds along the fringe of the Cholistan Desert area was adopted in SCARP-VI scheme.

The evaporation ponds were developed taking advantage of the inter-dunal depressions and old *dhora*s along the fringe of Cholistan Desert. The area is barren1 and without irrigation, but used for animals grazing. The subsoil water has been reported as saline. Dykes were provided between the dunes to shape up the ponds, which consist of series of elongated reservoirs joined together by man-made connecting channels, converting them into a contiguous series of ponds. Since commissioning of these evaporation ponds in 1989, waterlogging and salinization have occurred in the adjacent lands.

To dispose the drainage effluent of the 514 deep drainage tubewells two series of ponds were initially designed. Stage I with an initially designed area of 8,400 acres (3,400 ha) and Stage-II also with an originally designed area of 24,600 acres (9,956 ha) to make a total of 33,000 acres (13,356 ha). However, in year 2001 the active pond area was in the range of only 13,000 acres (5,261ha).

The visits made by the Consultants to ground truth the situation observed that the intrusion if unchecked and the negative externality arising from SCARP VI will further shrink the productive land. This will deprive the farming communities in the affected areas of their productive land, rendering them homeless, and even landless. The objective of the visit was also to consult with the local communities to solicit a perceived solution to reclaim the degraded lands.

Most stakeholders felt that the issue cannot be resolved unless the Punjab government shows recognition of the problem and its mitigation. Various suggestions indicated i) replacement of SGW tubewells with tile drainage in the SCARP- VI area; ii) installation of desalination plant

[1]IWASRI.Environmental impact of disposal of drainage effluent to evaporation ponds. M.N. Bhutta, M.F.K. Niazi, N. Ahmed. Sep. 2003

[2]Proceedings of a roundtable meeting.IPTRID Secretariat - FAOLahore, Pakistan 10–11 November 2000

to desalinize the drainage effluent; iii) make provision of irrigation water from Rainee canal to supply the channel which connects different ponds of the Rahimyar Khan SCARP project area; and iv) provide tile drainage network system within the affected parts of Ghotki district.

Purpose of the Study

The main objective of the present study was to have an opinion on the issue by the Master Plan Consultants, by visiting the area, conducting literature review and analyzing the technical problems in an effort to contribute in the search for a common solution between the Governments of Sindh and Punjab.

Main Points of the Analysis

IPTRID Secretariat referred to the SCARP VI effluent as *"It is clear that the water is hazardous and cannot be used for irrigation"*.

The annual effluent inflows entering the evaporation ponds were originally estimated to be 487,000 acre-ft (601 Mm^3). The present expected annual discharge into the ponds is of the order of 230,000 acre-ft (284 Mm^3).

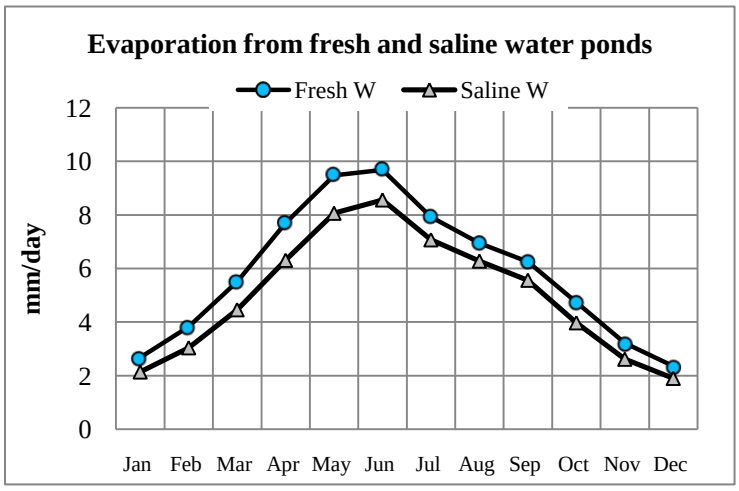


Figure 7: Evaporation for Fresh and Saline Water Ponds

The original proposal suggested a system of ponds gross area of 160,000 acres (64,752 ha). This evaporation area was latter on re-estimated to be 67,000 acres (27,115 ha) but, it was further reduced to about 13,000 acres (5,261 ha).

The volume of water that evaporates out of the series of ponds is between 35 to 40% of the SCARP VI saline effluent that outfalls into the system of lagoons. Therefore, it is concluded that the system of evaporation ponds has efficiencies of similar magnitude, 35 to 40%.

Conclusions and Recommendations

The water balance shows that the ponds are neither socially nor environmentally sustainable, unless the volume of the incoming water from SCARP VI is reduced and/or, the evaporation area (not the depth) of the ponds is increased to make them more efficient. The Provinces should jointly seek for solutions of the problems caused by the effluents of SCARP VI project to the people of the Ghotki affected area.

The relation *Pond evaporation area/Saline inflow* from SCARP VI is resumed at different stages of the evaporation scheme as:

- Original design 0.33 acre/acre-ft
- Revised design 0.14 acre/acre-ft
- Actual 0.06 acre/acre-ft

The figures above clearly indicate that the implementation of the project diverted from its original design or has not been fully implemented as per original plans. The surface area provided is about one fifth of the initial estimate and, less than half the revised assessment.

The Consultants recommend implementing the relation *Pond evaporation area/Saline inflow* from SCARP VI as per the revised design, as it should substantially increase the evaporation and reduce the damaging infiltration effect. This should be done in the Punjab, at no cost to the Sindh Province.

5.4.2 Position Paper 2: Sugar Industry Effluent Treatment at Source

Introduction:

Of the 33 sugar mills in Sindh, 30 of them are located in the left bank of Indus. Sugarcane is grown on about 250 thousand ha and annually produces about around thirteen million metric tons annually. A sugar mill with 6,000 mt per day crushing capacity generates about 5,300 mt of highly toxic effluent, which is mostly dumped into the canals, and the drainage network, where available, without treatment. It is estimated that during the crushing season, these sugar mills release about 160 thousand m^3 per day.

The provincial EPA regulation requires that the sugar mills to process the generated effluent within the sugar mills and should not be released out of sugar mills without treatment. However, the restriction is not complied with due to lack of effective enforcement.

There are over 800 village settlements along the LBOD drains. During the water stress periods, the polluted drainage water is pumped out by the farmers for supplementing irrigating supplies. This toxic water not only adversely affects the soil but also causes high mortality of fishes in the drains. This has reduced the availability of fish to the local communities for their consumption. Whatever quantity of fish survives is consumed by the communities, despite detrimental to their health. Also the toxic water is consumed by the local livestock causing diseases, and higher toxicity in the dairy products. The polluted also emits a strong foul smell, a menace for people residing along the drains. The level of toxicity released is higher when the effluent from sugar mill distilleries is added.

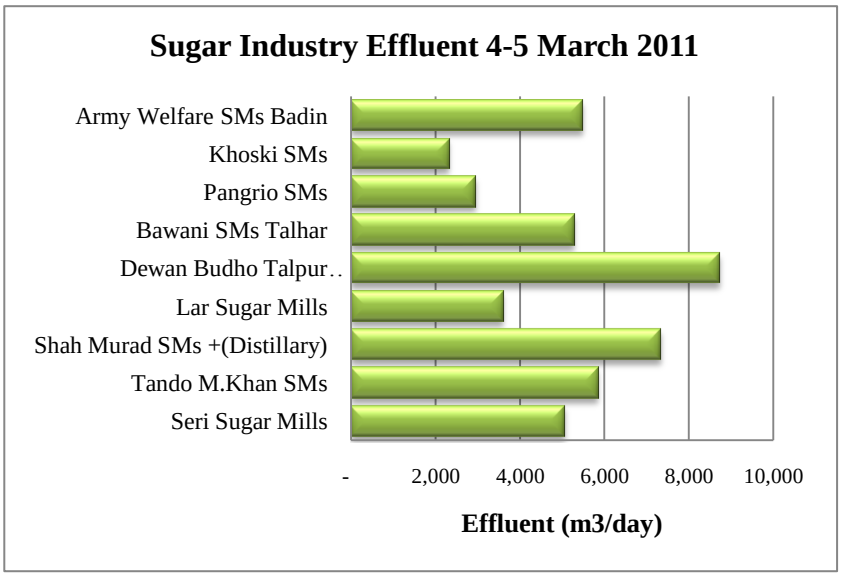


Figure 8: Quantity of Sugar Mills Effluent Flows

Wastewater from sugar mills is basically organic with its high BOD rapidly depletes available oxygen supply when discharged into water bodies endangering fish and other aquatic life. The high BOD also creates septic conditions, generating foul-smelling hydrogen sulfide, which in turn can precipitate iron and any dissolved salts, turning the water black and highly toxic for aquatic life. The smell of the effluent is so irritating that people cannot breathe and sleep well. The polluted drain water finds its way into the wetlands near coast like Nareri Dhand (a Ramsar Site) and the dhand complex adjoining the KPOD. These *dhands* were the source of livelihood for thousands of fishermen in the vicinity.

Analysis of effluent from sugar mills have depicted that the values of DO, BOD, COD and TSS are higher than permitted by the WHO standards. Therefore, there is need to treat the effluent prior to its disposal in water bodies or for use in agriculture.

Sindh province is already shortage of fresh surface water and its groundwater is mostly saline. Therefore, it is very necessary that irrigation and drainage infrastructure are fully

protected from the disposal of untreated wastewater. Furthermore, necessary steps must be taken for the recycling of available wastewater through primary treatment for use in agricultural and industrial sectors.

USAB system for treatment of highly concentrated wastewater from agriculture industries is increasingly popular and wastewater from sugar mills and distilleries can be treated for significant reduction in pollution levels. Methane gas produced in USAB system can be used as an energy source. This system is both technical and cost effective.

The overall advantage of establishing the treatment plants and ensuring disposal of the treated effluent are manifold. These include:

i. The drainage system now completely polluted and with high levels of BOD, COD, organic materials, toxic chemicals will be free from these pollutants and can harbor fish and other biotic life.

ii. Communities now very much annoyed of the awful smell of the distillery effluent will get rid of this problem.

iii. Livestock will be saved from toxic effects of chemicals

iv. The water of the drains will be utilized for bio-saline agriculture. This will enhance production thereby increasing the income of the communities

v. Marine life now under the influence of the toxic effluents will be relieved of the polluting effects of the drain water, and the fish catch will increase from both inland and marine areas.

vi. Water fowl will be attracted by the slightly brackish drain water so the population of migratory birds will increase.

The EPA should monitor that the sugar mills comply with the Environmental Protection Law 1997, and install the treatment plants in the vicinity of the mills so that the generated effluent is of expected level, safe for other uses, such as conjunctive use of water, watering livestock, and safe for the survival of fishes in the drains, and free from foul smell.

5.4.3 Position Paper 3: Water Quality for Human Consumption

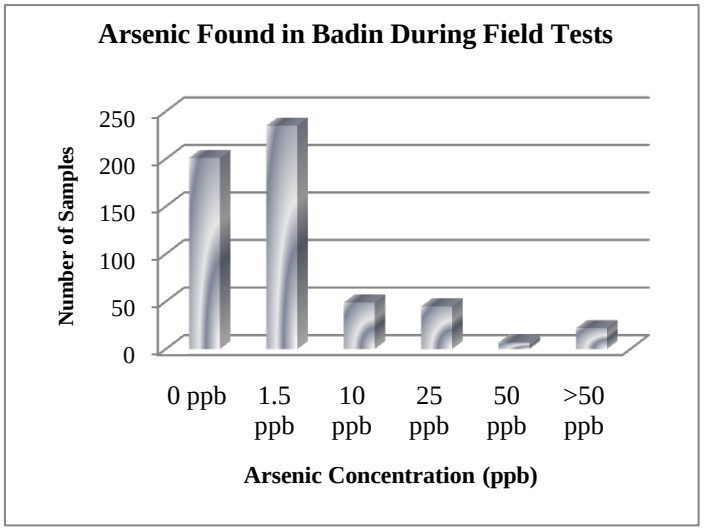
Introduction

In Sindh, especially in study area, there are many challenges to maintain the water quality potable. These include adequate public sector investment in ensuring clean water supplies, and ineffective compliance to check pollution of the fresh water resources.

The availability of safe and sweet drinking water has always been a major problem in the coastal areas of both the districts of Badin and Thatta, where the underground water aquifers is brackish, particularly close to the coast where seawater intrusion has worsened the situation. The situation is even worse for the fisher folks living in and around the creeks. They have to haul drinking water from significant distances, and for other requirements depend on the brackish water.

Due to diversions of irrigation water at the various barrages has decreased the water availability downstream of Kotri. The situation has been further exasperated by the release of industrial pollutants and saline drainage effluent directly into the river. This has severely impaired the quality of the water in the river downstream of Kotri.

The coastal villages, other than those living in the creek area, depend on the irrigation channels and minors for drinking water, which is also stored in the ponds for use when the supplies are low. As the carrying capacity of the irrigation system has been reduced due to poor maintenance, the availability of the drinking water is constrained in the tail reaches.



Source: PCRWR, DRC, Tandojam

Figure 9: Arsenic Contamination in Badin District

This situation has been further worsened due cyclones that damaged the tail reaches of the irrigation network, as close as 20 km from the coast. The Public Health Engineering Department operated water supply system is mostly inoperative salinization of aquifer. Following issues and problems need attention and its mitigation.

i. lack of awareness for safe drinking water amongst coastal communities;
ii. unchecked industrial pollution in the fresh water bodies above WHO standards;
iii. inadequate filtering and disinfecting arrangements in the public drinking water supply installations;
iv. unchecked pollution from clothes washed in the irrigation channel,
v. unchecked pollution from animals bathing in the canal system;
vi. unacceptable level of salinity, fluoride and or arsenic contamination in the underground water;
vii. unacceptable level of bacterial contamination.

Following are the recommendations to ensure access to safe water drinking supplies in the rural communities:

i. construction of water filtering plants in the areas without access to safe drinking water supplies;

ii. establish a water quality monitoring and surveillance system;

iii. promote appropriate technologies for rain water harvesting;

iv. effective monitoring for the compliance of treatment of effluent entering the freshwater bodies;

v. introduction of low cost "clay pitcher arsenic removal" method amongst the communities dependent on underground water laden with arsenic contamination;

vi. introduction of low cost chemical treatment method amongst the communities; dependent on underground water laden with fluorides;

vii. in study area, where the ground water is brackish & only source of drinking, the Reverse Osmosis (RO) technology is a preferred option. This technology is now available at affordable cost. For a small community, requiring 500 GPD of potable water, the RO plant may cost up to Rs 400,000;

viii. the Environmental Protection Agencies (EPAs) may take the responsibility to ensure that the water bodies are safe from pollution. It is further recommended that the "Integrated Water Management Committees" (IWMCs) may be formed by the SIDA or irrigation department at canal level representing all the concerned departments and NGOs to manage the water resources sustainably.

6 PROPOSED REGIONAL PLAN STRATEGY AND RECOMMENDED INVESTMENT PLAN

6.1 Proposed Regional Plan preparation Process

Understanding that a Master/Regional Plan is a proposed organizational strategy of a specific territory, of a consented vision of a group of stakeholders that look at the development of the territory in the long term and; in close coordination between the Consultants, SIDA and partner NGOs; a consultative process which emphasizes the active participation of stakeholders from each of the regions was designed and implemented. This allowed the direct participation during the process of consultations through 35 workshops, visits to 231 villages and the direct involvement of 9,077 participants. Among the stakeholders there were government officials, community leaders, villagers, representatives of different institutions and NGOs, universities and private sector.

The consultation process took place in two phases. A first phase of diagnosis, in which the stakeholders defined the fundamental issues and problems they have to face in their daily lives and a second phase, in which the stakeholders were consulted again to validate the proposed strategies and determined the priority of each of the actions. With the interactive sessions with the stakeholders, high priority interventions were identified, thus building from a systemic approach achieving participatory consensus facilitated the Consultants to formulate the proposed Master/Regional plan strategy. Figure 11 below presents the different activities conducted in the preparation of the plan.

6.2 Proposed Regional Plan Strategy

As guided by the scope of work and terms of reference for the regional plan study for the left bank of Indus, delta, and coastal areas, the Consultants propose a following strategy to combat waterlogging and salinity and to ensure safe and timely disposal of drainage effluent, and storm water into the sea and or natural depressions in the Thar desert.

Since last three decades, consequent to extreme weather changes, localized and widespread riverine and storm water flooding has frequented the province of Sindh. The unprecedented rains experienced in the year 2011 exposed the inadequacy and inability of the drainage infrastructure to cope with the massive runoffs. This resulted in loss of life, substantial damage to urban and rural property and infrastructure, public utilities and colossal loss of agricultural crops and lands. The main causes were simultaneous heavy rains in most of the drainage basins, deferred maintenance of the drainage network, encroachments of natural waterways, trapping of water. Despite the construction of reservoirs and major investments in flood protection, there is still a considerable flood hazard. It is estimated that the total losses from floods were about Rs.454 billion, and about 500 lives lost.

In developing the proposed regional plan strategy, the Consultants followed an extensive stakeholder consultative approach, and organized consultative workshops at community, district, and regional levels to register their perceptions about the drainage disposal related issues and problems, and to solicit their perceived solutions and aspirations and identification of priority interventions. The findings were disseminated widely through print and electronic

media for wider awareness and feedback. Based on this, the prefeasibilities were prepared and prioritized in consultation with stakeholders, and this lead to the formulation of regional plan and action/implementation plan.

The five main pillars of the proposed strategy are:

1. Safe and timely disposal of surplus drainage effluent, and storm water flood.
2. Combating waterlogging and salinity in non-LBOD areas.
3. Environmental mitigation
4. Institutional Strengthening and capacity building of SIDA
5. Livelihood support to water hazard affected communities.

The graphic representation of the strategy is depicted in the following figure, followed by brief explanation of rationale of the abovementioned five pillars of the strategy.

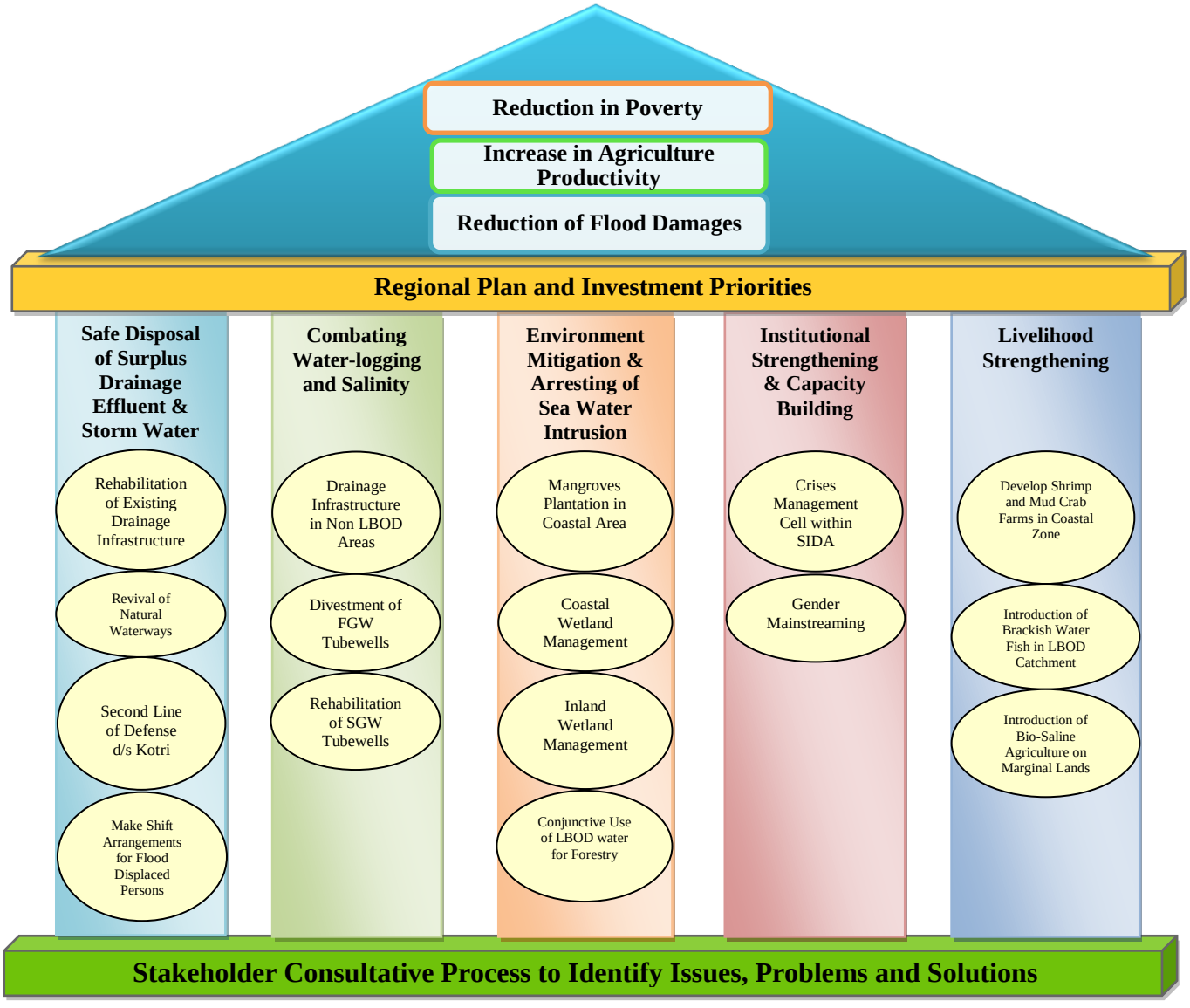


Figure 10: Strategy for Regional Plan for the Left Bank of Indus Delta and Coastal Zone

6.2.1 Pillars of the Strategy

1. Safe and timely disposal of surplus drainage effluent, storm water, and riverine flood

The main reasons that exasperated the losses in 2011 include the lack of reduction of disposal capacity of the drainage and flood protection system over time due to clogging of the system due to deferred maintenance, relief cuts, unauthorized tampering of the system, and constrictions due to physical infrastructure and encroachments. This warrants rehabilitation of existing drainage structure and revival of natural waterways to relieve pressure on the LBOD, and divert and harvest surplus storm water flows in the depressions in the desert areas.

The main interventions/elements of the strategy include strengthening and rehabilitation of the LBOD system, revival of natural waterways. These structures will ensure safe and timely disposal of the storm water and avert the massive losses to the economy, if similar extreme precipitation pattern re-occurs or persist.

The plight of the 2011 flood displaced persons suggest that the drainage system be complemented with raised make shift shelters on higher grounds, and along the canal banks, roadside, etc. to provide relief from marooning.

2. Combating waterlogging and salinity in non-LBOD areas

The increasing water table and the associated salinity in areas outside the LBOD catchment is a tale tell for the declining farm productivity. The situation is precarious not only where there is absence of drainage structures, but also in areas where existing saline and freshwater drainage tubewells are nonoperational. The major reason is deferred maintenance and vandalizing of the more than 50-60 percent of the tubewell machinery, and electrical hook up system.

To control the water logging and salinity and to revive farm productivity, the need for installing drainage system in the areas outside SCARP and LBOD, rehabilitation of the nonfunctional tubewells, in the saline groundwater zones, and divestment of public sector tubewells in the fresh groundwater areas and its replacement with a fostering program development of private tubewells.

3. Environmental mitigation

The LBOD system had some unintended negative consequences, due to failure of the outfall structures, mainly the collapse of Cholri weir, and tidal link, due to onslaught of the 1999 cyclone, and high tide trends. This led to intrusion of the seawater that degraded the freshwater bodies and agricultural lands in the coastal areas, and to some extent in the lower reaches of the LBOD system. This resulted in loss of farm productivity and salinization of the freshwater bodies eroding the fish catch potential.

To arrest the seawater intrusion would require control structures in the lower reaches, and biological screening through the plantation of mangroves and other salt tolerant species in the potential coastal areas including around the tidal link and coastal wetland complex.

In addition to this the inland and coastal wetlands also require attention to ensure improvement of the local environment. Similarly, forest plantation will be established in LBOD network areas and Kotri drainage system by using saline and fresh water in either conjunctive of cyclic ways. This would serve as an instrument for improving the local climate.

4. Institutional Strengthening and Capacity Building of SIDA

During the 2011 floods, SIDA played an important role in managing the disposal of the storm water floods, and coordination with a vast array of agencies. The responsibility was not commensurate with the available resources. It highlighted the need for creating a crisis management cell with the SIDA, as a hub for coordination between agencies, and serve as clearinghouse for the storm water flood related information system, including early warning system, and rescue and relief operations. In addition to this, the women stakeholders felt that most of the SIDA field staff is not adequately gender sensitive, and gender concerns need to be mainstreamed for inclusive participatory irrigation management.

5. Livelihood support to rural communities

The livelihood of stakeholders, particularly those residing in the lower reaches of the LBOD system, were adversely affected due to degradation of agricultural land due to seawater encroachment and decrease in the fish production due to salinization of freshwater bodies. This has rendered many household into economic deprivation. Stakeholders emphasized the need for introducing appropriate income generating enterprises to gainfully engage the unemployed persons. Following this exigent need, various income generating activities need to be supported.

6.3 Screening, and Ranking of Proposed Interventions

A ranking procedure with the evaluation criteria for possible solutions, considering, costs, economic returns, technical, social and environmental feasibility was developed and submitted to SIDA and the PCMU for their comments and input. As mentioned above, the method proposed contemplates five major criteria and a number of sub-attributes. These are: i) social accessibility; ii) financial soundness; iii) environmental benefits; iv) socio-economic impact; and; v) sustainability. The description and interpretation of each of the criterion and sub-attributes is given in Volume II Annexure A.

Each of the sub-attribute identified by stakeholders for each of the interventions was evaluated according to the expected impact. The impacts being positive or negative were classified from none to very high in a scale that goes from 0 to +4 for the positive effects and from 0 to -4 for the negative effects expected.

In the workshops of Phase-II, the stakeholders input were pursued as part of the evaluation criteria for the ranking method. Input such as the social acceptability of specific schemes. The details of the workshops are given in Volume IV of this report.

The ranking is calculated based on the statistical parameter known as “standardization z” (also known as “z score”), which in statistics is defined as a standard score to express the number of standard deviations an observation is above or below the mean. “z” is a dimensionless parameter calculated by subtracting the population mean (μ) from an individual raw score (x) and then dividing the difference by the population standard deviation (σ). This dimensionless value (z) allows us to combine the scores of the five different

components of the ranking process, regardless of the total possible points that each component can achieve.

The score recorded for each of the sub-components is presented in Volume II, along with the computation details of the addition and standardization of sub-components and each of the five main components of the ranking method. In a first instance all components were assigned the same "weight" (W = 1). The results are presented in the table below:

Table 7: Ranking Based on Standardized Z scores

N°	Prefeasibility	$W^+ = 1$ Total $w^+ z^*$	Rank
1	Rehabilitation and improvement of LBOD drainage infrastructure	5.850	**1**
2	Revival of natural waterways to drain out storm water	4.842	**2**
9	Protective plantation of mangroves in the coastal areas of left bank	3.002	**3**
5	Privatization of FGW SCARP tubewells	2.302	**4**
3	Rehabilitation of LBOD and SCARP tubewells	2.156	**5**
15	Establishment of Disaster Management Cell in SIDA	0.769	**6**
11	Bio-saline agriculture in Badin and Thatta districts	0.325	**7**
12	Rehabilitation of Deh Akro II and Chotiari wetland complex	0.195	**8**
16	Gender mainstreaming in irrigation and drainage	-0.748	**9**
10	Use of drainage water for forestation in the LBOD and Kotri areas	-0.776	**10**
4	Ghotki SCARP (saline zone)	-1.478	**11**
7	Elevated platforms for flood displaced persons	-2.235	**12**
14	Brackish water fish farming in LBOD area	-2.284	**13**
13	Shrimp and mud crab farming in coastal areas of left bank	-3.007	**14**
8	Rehabilitation of coastal wetlands	-3.404	**15**
6	Second line of defense for left bank of Indus d/s Kotri	-5.509	**16**

* Standardized Index
\+ Weight

Sensitivity analysis was also run increasing the weight of the social component in order to see the effect on the ranking. The social component "z" value was increased by 50% and the other four components were left unchanged. The results show that the first seven schemes continued to have the same ranking position.

6.4 Proposed Prioritizing and Sequencing of Interventions

6.4.1 First Priority Core Interventions

It is proposed that given the exigency of the intervention, and considering their quantifiable and non-quantifiable benefits, five of the above pre feasibilities are recommended for undertaking detailed feasibilities, as core projects of high priority. They include:

i. Rehabilitation and improvement of LBOD drainage infrastructure (ranked 1);
ii. Revival of natural waterways to drain out storm water (ranked 2);
iii. Protective plantation of mangroves in the coastal areas of left bank (ranked 3);
iv. Establishment of Disaster Management Cell in SIDA (ranked 6); and
v. Gender mainstreaming in Irrigation and Drainage (ranked 9).

The first two have direct bearing on the aversion of flood disaster, if the high rain events relapse. They are expected to ensure timely and safe evacuation of storm water floods, and would save colossal loss and damage to standing crops, livestock, private and public properties and infrastructure, and more importantly human lives, and quality of life of rural communities, and miseries thereof.

The third intervention will complement the safe outfall of the drainage effluent into the sea, protect the outfall drainage infrastructure, and arrest and retard sea encroachment and salinization of productive farm land and water bodies in the coastal areas. It would also support livelihood of the coastal communities through restoration of fish potential.

Given the magnitude of the flooding risk and the inadequate capacity of the SIDA to cope with the water disasters, may it be storm water flood or river floods, the need for creating a vibrant and efficient Disaster Management Cell is overbearing, to coordinate the rescue, relief, and rehabilitation work in conjunction with PDMA and other relevant agencies.

It is proposed that to ensure the role of women in the participatory water management approach, the overarching mandate of SIDA, the social cell within SIDA also assumes the responsibility of ensuring main streaming in the organization, and adopt the recommendations of the pre-feasibility for the purpose which has been ranked nine in the selection criteria mentioned above.

Although the "Gender Mainstreaming in Irrigation and Drainage" sub-project was ranked at 9th place due to no assigned points for financial and environmental components, the Consultant proposed the scheme for implementation due to numerous unquantifiable benefits of investing in the development of human resources. Numerous studies and donor organizations including the World Bank advocate for women's participation in various programs to enhanced efficiency: 'Women who are trained to manage and maintain community water systems often perform better than men because they are less likely to migrate, more accustomed to voluntary work, and better entrusted to administer funds honestly' (World Bank 1992: 113). 'Investing in women' has been critically described as instrumentalist by scholars, noting how women have been taken on board insofar as they could contribute to productivity objectives, yet sidestepping deliberate advances towards achieving gender equality or transforming existing gender/power structures (Jackson 2000; Cleaver 2003)'. (Women and water management: an integrated approach", Dublin Principle 3, International Conference on Water and the Environment Development Issues for the 21st Century, (Dublin, 1992., http://fiesta.bren.ucsb.edu/~idgec/papers/Babette_Resurreccion.pdf)

6.4.2 Second Priority Interventions

i. Privatization of FGW SCARP tubewells (ranked 4); and

ii. Rehabilitation of LBOD and SCARP tubewells (ranked 5).

The review of the feasibility for the divestment of FGW tubewells Project (prepared by Consultants engaged by PID), was undertaken to reassess and evaluate its technical and economic viability in the current situation suggests that the project is still viable. Nonetheless, since the completion of the feasibility, the number of private tubewells has surged, and the demand for additional tubewell should have declined. Therefore the emphasis should be on divesting the existing public sector tubewell and facilitating the farmers to develop their own tubewells.

Similarly, the pre-feasibility of rehabilitation of the dysfunctional and non-operative SGW tubewells suggests that the investment will have a positive payoff. Notwithstanding its benefits the sustainability of investment is in question. It is reported by the beneficiaries, and

observed by Consultants during the field visits, that more than 50 per cent of the tubewells are closed, mostly due to vandalizing of the pumps, motors, electrical fixtures, PMT, LTL, and HTL. The farmers apprehend that without safeguards for their protection, they would be closed down before the objective of lowering the water table is achieved. Hence is a risky investment.

Rather than reinventing the wheels, PC-Is, may be formulated by SIDA and PID within their jurisdictions, using the current prices, and submit for approval to the relevant forum, subject to availability of funds and if included in the development plans.

6.4.3 Third Priority Interventions

The following three projects, despite their technical feasibility, are marginally economic viable, and the rate of returns are not robust, and seems sensitive to variations in costs and benefits.

i. Bio-saline agriculture in Badin and Thatta districts (ranked 7);
ii. Use of drainage water for forestation in the LBOD and Kotri areas (ranked 10);
iii. Rehabilitation of Deh Akro II and Chotiari wetland complex (ranked 8).

The pre feasibilities of the first two abovementioned interventions suggest that the investments has modest rate of returns, however are sensitive to changes in cost and benefit structures. As these are directly relevant to the facilitating timely and safely disposal of the storm waters, and also not within the preview and mandate of the SIDA or PID, should be entrusted to the relevant agencies for its development into the respective development programs i.e. (i) above to Agriculture Department and (ii) above to Sindh Forest Department.

The analysis of the prefeasibility for the Rehabilitation of Deh Akro II and Chotiari wetland complex suggests that the main benefits is restoration of wildlife, and ecology of the wetlands, with limited quantifiable benefits from intercepting seepage from the Chotiari lake and preparation of a management plan for above wetlands.

It is recommended that the detail formulation and implementation of these interventions should be entrusted to the relevant agencies i.e. Wildlife Department for Deh Akro II and Irrigation Department for Chotiari. A co-ordinated effort will be required to implement these interventions as for Deh Akro freshwater will be required from Nara Canal to revive the dhandhs and for Chotiari Irrigation department and SIDA will be involved.

6.4.4 Interventions Not Recommended for Implementation

Following pre feasibilities were prepared and the analysis and it is recommended that they do not merit further considerations, for reasons mentioned below. They proposed interventions evaluated are:

i. Ghotki SCARP - saline zone, (ranked 11);
ii. Elevated platforms for flood displaced persons (ranked 12);
iii. Brackish water fish farming in LBOD area (ranked 13);
iv. Shrimp and mud crab farming in coastal areas of left bank (ranked 14);
v. Rehabilitation of coastal wetlands (ranked 15);
vi. Second line of defense for left bank of Indus d/s Kotri (ranked 16).

The review of feasibility of Ghotki SCARP (1994), prepared by the Consultants engaged by WAPDA suggests that the proposed intervention is not economically viable now (price level

of 2012), and will have enormous negative environmental consequences, mitigation of which will have high cost, which would further depress the economic viability. Moreover, the prefeasibility for the revival of *dhora*s includes construction of surface drainage network to flush out storm water flows from the Ghotki area.

The prefeasibility of the elevated platforms, prepared by the Consultants, suggest the proposed intervention has a very high cost (about Rs.1.2 billion), and would provide refuge to some 20,000 families or about 100 to 120 thousand souls. Moreover, it would be expensive to maintain these elevated platforms when not use. In addition due the threat of unauthorized occupation for other purposes, its sustainability is extremely unlikely. However, the widened drainage banks and canals, and sections of roads, if widened and strengthened could be cost effective, and will be accessible to a large number of flood displaced persons.

The prefeasibility of two interventions i.e. brackish water fish farming in LBOD area, and Shrimp and mud crab farming in the coastal areas of left bank indicate that the interventions have modest rate of return, but sensitive to changes in cost and prices. As the proposed interventions are essentially a private sector activity, the Sindh Fisheries Department could provide back up support to the interested potential fish farmers.

The prefeasibility of rehabilitation of coastal wetlands shows that intervention will not yield enough returns to justify investment, will have high risk of failure due to cyclones of the magnitude of 1999 cyclone 2A and will not be sustainable. In addition, the sugar mills effluent laden water from Karo Ghungro and Guni Phuleli drains will kill the local fish proposed to be promoted in dhand complex. Hence the intervention needs to be dropped for further considerations.

Similarly, second line of defence intervention was found technically viable, but is not socially acceptable. The communities along the proposed alignment vehemently opposed its implementation, as it entails risk of flood disaster. Hence, it is recommended that this does not warrant further considerations.

6.5 Implementation Chronogram

Two ten implementation chronograms were prepared. The first one considering all 16 identified solutions, including the unfeasible interventions according to the ranking conducted. Occasionally some financially/economically unfeasible schemes can be chosen if they are socially needed or because the country might have specific interests.

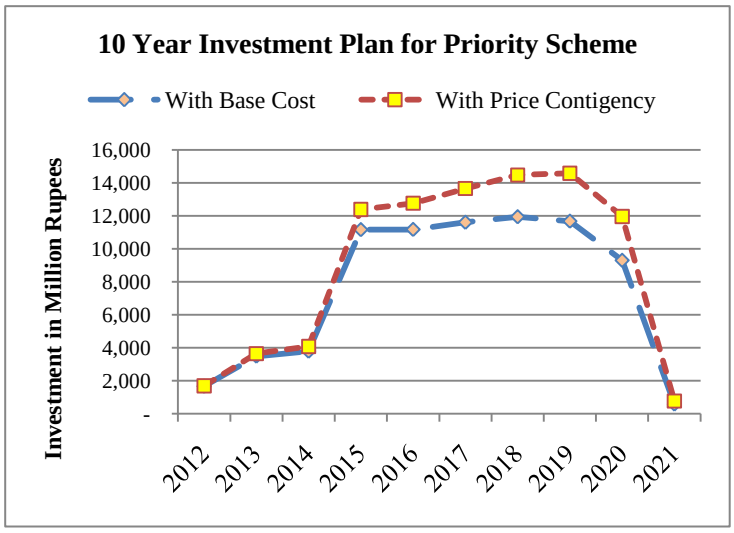
Two first priority interventions recommended by the Master/Regional Plan Consultants have been questioned. SIDA instructed that no further work should be conducted in the study of the *Establishment of the Disaster Management Cell in SIDA*, therefore the work already done on it is reported along the other feasible schemes, but will not be included in Phase-III.

The Panel of Experts also expressed their dis-conformity about the high priority scheme according to the Consultants criterion: *Gender Mainstreaming in Irrigation and Drainage*. Therefore the work already done this particular intervention is reported along the other feasible schemes, and will not be included in Phase-III, unless SIDA issues specific instructions to do so.

The implementation chronogram including all sixteen schemes is presented below:

	10 years Implementation Plan Feasible Schemes	Investment (Rs. Million)	1 2012	2 2013	3 2014	4 2015	5 2016	6 2017	7 2018	8 2019	9 2020	10 2021
A	**First Priority Core Interventions**											
1	Rehabilitation and improvement of LBOD drainage infrastructure.	17,580										
2	Revival of natural waterways to drain out storm water	43,565										
3	Protective plantation of mangroves in the coastal areas of left bank	733										
4	Establishment of Disaster Management Cell in SIDA (5 years plan)	108										
5	Gender mainstreaming in irrigation and drainage (5 years plan)	420										
	Subtotal	**62,406**										
B	**Second Priority Interventions**											
1	Privatization of FGW SCARP tubewells	8,290										
2	Rehabilitation of LBOD and SCARP tubewells	2,603										
	Subtotal	**10,893**										
C	**Third Priority Interventions**											
1	Bio-saline agriculture in Badin and Thatta districts	2,350										
2	Use of drainage water for forestation in the LBOD and Kotri areas	225										
3	Rehabilitation of Deh Akro II and Chotiari wetland complex	585										
	Subtotal	**3,160**										
	Grand Total	**76,459**										

6.6 Implementation Strategy for the Rehabilitation and Improvement of LBOD



LBOD was originally designed for a rainfall storm of 5 years return period (Tr) magnitude, reported by the World Bank in 2005, *"...the design criteria provided an available capacity to drain 125 mm rainfall of 5 days duration in a 5 days period."* The Master/Regional Plan Consultants conducted a risk analysis of this particular storm magnitude and concluded that the probability that an event of Tr = 5 years will happened within 3 years period is 50%. This is the equivalent to tossing a coin every three years and hoping it will fall heads up.

As explained above, the original capacity of LBOD was limited, which –partially- explains the recurrent flooding experienced by the people of the lower areas. The maintenance and desilting practices of LBOD have increased the cross sectional area of the channel, increasing its water removal and conveyance capacity.

As a result of the extraordinary rainfall recorded during 2011, a series of meetings with the relevant institutions were held, where it was decided to prepare short and long term plans to minimize the periodically recurring negative flooding effects and to increase the capacity of the channel in order to be able to convey and dispose waters of significantly larger storms, enlarging the recurrence period.

The total cost of the civil works have been worked out based on initial survey work, discharge measurements during storm water flood of 2011 and adopting unit rates of existing infrastructure in the Sindh Province. The budget details for the short and long term measures, including miscellaneous support costs, such as the fees of the supervision consultants and

others, are presented in detail in table 4. The total costs estimated for the civil works are about Rs. 16.5 Billion and Rs. 1.2 Billion for miscellaneous expenditures, making a total of about Rs.17.6 Billion.

6.6.1 Short Term Structural Measures

Following are the suggested short term measures for implementation in a period of 1to 3 years:

i. Raising Banks of Spinal Drainage to Free Board for storm level of 2011.
ii. Rehabilitation of Nawabshah (Shaheed Benazirabad) component of drainage network.
iii. Rehabilitation of Sanghar component of drainage network.
iv. Rehabilitation of Mirpur Khas component of drainage network.
v. Rehabilitation of Badin component of drainage network.
vi. Rehabilitation of Fulleli Guni Drain.
vii. Rehabilitation of Karo Ghungro Drain.
viii. Rehabilitation of KPOD Outfall Drain.
ix. Rehabilitation of DPOD Drain.
x. Construction of inlets at sites of relief cuts.
xi. Reconstruction of damaged Water Course Crossings and Bridges.
xii. Raising of deck slabs of Submerged Bridges by 2 to 3 feet and also providing additional water way by adding 1 to 2 spans through bypass culverts/bays.
xiii. Providing stone pitching upstream and downstream of all structures on Spinal, KPOD and all Branch and Main drains in a length of 500 ft (200 ft upstream and 200 ft downstream).
xiv. Rising of Banks of Main Drain/Branch Drain at outfall points by 3 to 4 ft in a length of 10,000 ft to create surcharge storage.

6.6.2 Long Term Structural Measures

Following are the suggested long term measures for implementation in a period of 4 to 6 years:

i. Remodeling of LBOD Drainage Network for a return period of 20 years.
ii. Remodeling of KPOD to a discharge of 6,000 cs.
iii. Remodeling of LBOD Branch Drain to 2,000 cs.
iv. Remodeling of Main Mirpur Khas Main Drain.
v. Converting non inspection path of spinal/main and all branch drains as per IP.
vi. Construction of all weather Road from RD 159 of Spinal Drain to RD 815 of Spinal Drain.
vii. Providing gated structures at outfall points of drains along KPOD.
viii. Providing pumping arrangement at outfall points of Badin drainage system.
ix. Construction of New Bridges/Water Course Aqueducts on LBOD system.

x. Construction of additional Inlets to support On Farm drainage at field level.

xi. Off-loading of spinal drain discharge by a minimum of 3,000 cusecs into old Dhoras/Dhands.

xii. Construction of Tidal Control Cross- Regulator at RD (-) 12 of KPOD.

xiii. Construction of Head Regulator at RD 159 of KPOD/DPOD.

xiv. Providing additional drainage culverts/causeway at crossing points of road network.

6.6.3 LBOD rehabilitation construction chronogram

The construction activities are planned to be implemented in two phases. The reparation and deferred maintenance works as short term activities to enhance the conveyance capacity of the channel, aiming at protecting the population from the waters coming in the next monsoon season and the long term undertakings to complete the works as per the design of the present Consultancy Agreement. The gross chronogram of activities is presented below.

LBOD Proposed Gross Implementation Activities Chronograph		Quarters and Years								
No	Main Outputs	2012	2013	2014	2015	2016	2017	2018	2019	2020
1.	Restoration of Spinal Drain (RD 815 to 159) including Structure repair									
2.	Restoration of DPOD (RD127 to RD 5)									
3.	Restoration of KPOD (RD 159 to RD 0)									
4.	Restoration of LBOD branches, KPOD, and other drains									
5.	Restoration of Mirpurkhas component surface drains									
6.	Restoration of Sanghar component Surface drains									
7.	Restoration of Nawabshah component									
8.	Restoration of Fulleli Guni drainage system									
9.	Restoration of Karo Gungro drainage system									
10.	Remodeling of LBOD drainage system for a return period of 20 years									
11.	Remodeling of KPOD to discharge of 6,000 cfs;									
12.	Remodeling of Mirpur Khas Main Drain for Separation from Dhoro Puran.									
13.	Converting Non-Inspection Path (NIP) of Spinal/Main & all Branch drains to par with IP									
14.	Construction of All Weather Road from RD 159 RD 815 of Spinal Drain.									
15.	Providing Pumping arrangements at outfall points of Badin Drainage System									
16.	Construction of New Bridges +WC Aqueducts on LBOD System									
17.	Construction of new inlets to support of farm drainage									
18.	Construction of Tidal Control Regulator at RD minus 12 of KPOD									
19.	Construction of Head Regulator of KPOD RD 159									
20.	Ancillary works									
21.	Supervision Consultants									
22.	Construction of site offices and residential quarters									
23.	Procurement of boats and vehicles									
24.	Procurement of survey and scientific equipment									
25.	Procurement of radio communication system									
26.	Establishment of early warning system Cell									

6.7 Implementation strategy for the revival of natural waterways to drain out storm water

The 2011 unprecedented rainfall observed in Sindh was a wakeup call regarding the flooding issues that the Province has been experiencing for a number of years. The floods experienced in year 2011, revealed that the Left Bank area of Indus River has no outlet, except for LBOD, which performed beyond its capacity. The water ponded for weeks despite the efforts of SIDA, the Irrigation Department, the military and other authorities to dispose the rain water off, because the natural waterways (dhoras) had been hindered by canals, drains, roads, and encroachments of various types.

The conclusion after several meetings with the relevant authorities was that the natural waterways (dhoras) had to be activated. Accordingly, the Master/Regional Plan Consultants have developed and recommend the plan described below:

6.7.1 Suggested implementation plan for drainage in lower Sindh

In view of huge cost involved in the activation of natural waterways it is proposed that the plan may be implemented in phases according to the availability of funds priority of works.

6.7.2 Top priority works before forth coming monsoon rains

i. Activation of dhoras on left side of LBOD Spinal Drain i.e. Hakro Dhoro, Naro Dhoro and Pithoro Dhoro / Hiral Escape.

ii. Activation of full length of Dhoro Puran from Mirpurkhas to RD 110 of DPOD including Mirpurkhas bypass.

iii. Separate outfall for Mirpurkhas Main Drain carrying highly polluted effluent, into LBOD Spinal Drain.

iv. After separation of MMD, Dhoro Puran shall be routed to its natural path under passing LBOD Spinal Drain.

v. Reconstruction of Dhoro Puran sections which have been utilized in the alignment of LBOD Spinal Drain to provide clear passage to storm water.

vi. Construction of dhora bypasses proposed for Jhudo, Digri and Naukot towns.

6.7.3 Priority-2 works

i. Providing drainage to cutoff portions of Dhoro Puran on right side of LBOD Spinal Drain and Mirpurkhas Main Drain by providing under passes / siphons across Mirpurkhas Main Drain and LBOD Spinal Drain.

ii. Activation of Digri Dhoro, Sohni Dhoro and Bhai Khan Dhoro and connecting them with Dhoro Puran by constructing under passes across Mirpurkhas Main Drain and LBOD Spinal Drain.

iii. Construction of dhora bypasses proposed for Digri and Tando Ghulam Ali towns.

6.7.4 Priority-3 works

i. Construction of adequate sized structures across the dhoras based on 20 years return period. The construction of numerous structures can take longer time and cannot be completed before monsoon 2012. As such, in the event of any heavy rainfall in the monsoon 2012, relief cuts to roads with inadequate sized culverts could be given to smoothly pass storm water. However, boats will be required to facilitate local people on either side to cross the dhoras.

ii. Construction of drainage network including structures, proposed for the left over areas of Umarkot, Digri, Tando Adam, Tando Allahyar and Tando Ghulam Ali outside the catchment of LBOD system.

6.7.5 Activation of natural waterways chronogram

The construction activities are planned to be implemented in two phases or two terms. The most important ones as short term activities to protect the population from the waters coming in the next monsoon season and aiming at minimizing the potential flooding damages as soon as it is possible to be implemented and, the long term undertakings to complete the works as

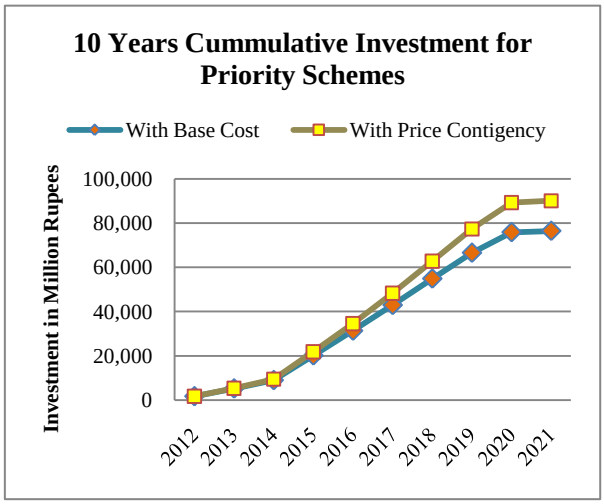
per the design of the present Consultancy Agreement. The gross chronogram of activities is presented below.

Gross Chronogram of Activities for the Activation of natural Waterways (dhoras)

N°	Main Outputs	Start Date	End Date	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Revival of Dhoras											
1	Activation of dhoras, Puran up to Shakoord dhand, Sohni dhoro & Bhai Khan *dhoro* and bypasses of Mirpurkhas, Jhuddo, Tando Ghulam Ali	4/2012	6/2020									
2	Activation & Restoration of pocket *drains* along Hiral escape/ Pithoro Dhoro, Hakro Dhoro & Naro (Nabisar) *Dhoro* i/c Naukot bypass	4/2012	6/2020									
3	Activation of Sarfaraz (Digri) *Dhoro*, including Digri bypasses	4/2012	6/2020									
4	Excavation and revival of Pangrio, Kh' Gumbo & Roshanabad *dhoras*	7/2014	6/2020									
5	Excavation and revival of Ghotki *dhoras*	7/2014	6/2020									
6	Excavation and revival of Khairpur South dhoras	7/2014	6/2020									
	Leftover Areas											
7	Construction of surface drains in T.Adam, T.AllahYar, T.M Khan and TG ALI	7/2014	6/2020									
8	Construction of surface drains in Digri area	7/2014	6/2020									
9	Construction of surface drains in Umerkot, Farash and Khipro area	7/2014	6/2020									
10	Construction of surface drains in Ghotki area	7/2014	6/2020									
11	Construction of surface drains in Khairpur South area	7/2014	6/2020									
	LBOD Escapes											
12	Construction of 3X Escapes on LBOD i/c Weirs and Link Channels	7/2014	6/2020									

6.7.6 Activation of Natural Waterways Investment Costs

The estimated indicative cost for the proposed activation of the dhoras is presented in table 6, where besides the costs of the civil works, the costs related to the required supervision consultants at 2% of the cost of the civil works were added, plus a gross estimate of the land acquisition and resettlement activities.



6.8 Policy Issues

6.8.1 Deferred Maintenance

One of the reasons for the poor performance of the existing drainage system has been deferred maintenance and allocation of budgets for the purpose. It is recommended that adequate budget should be allocated to ensure best practices and a watch dog committee comprising of representatives from the relevant AWBs, representatives of the civil society, and SIDA and PID officials to monitor the upkeep of the system.

6.8.2 Effective compliance of environmental protection laws

The discharge of toxic effluent from the sugar mills into the drainage system is a major cause of concern expressed by the stakeholders. Apart from the foul smell it emits from the drains, its toxicity is detrimental to aquatic life in the drains and the water bodies along the KPOD and tidal link. This environmental hazard needs to be monitored and checked by the relevant provincial agencies, particularly Environmental Protection Agency (EPA) in the province.

A review of the existing regulatory mechanism suggests that the sugar mills find it cheaper to pay the fine, if imposed, than to invest in treating the effluent plant within the sugar mills. It is rather an incentive to breach the compliance. It is recommended that following the

'pollutant to pay principle' the punitive default charge is enhanced to encourage the sugar mills to refrain from dumping untreated effluent into the drainage or irrigation canals.

6.8.3 Cost Recovery Policy

The main benefit from the investment in rehabilitating, remodeling, the drainage system including reviving of *dhora*s is to ensure safe disposal of the storm water (for storms of 20 years return period or less magnitude) and reduction of flood damages losses to all the sectors of the economy (for larger storms). There is an urgent need for a policy to recover the capital cost or at least the annual expenditure on operation and maintenance of the drainage system. It is proposed that a pricing policy is articulated and formulated for enforcement of drainage cess.

As the benefits of the drainage system improvements is not limited to the agriculture and livestock sectors, it creates significant consumer surplus for the population in general, and hence all the beneficiaries should contribute to the repayment of the capital and or operation and maintenance cost, commensurate with share in the benefits. A study should be entrusted to an economic research outfit and is financed by the Planning and Development Department to estimate the benefits to different sectors and to assign a fair share to the direct and indirect beneficiaries, considering the repayment capacity. The analysis should also recommend an administratively easy mode of assessment and collection.

6.9 Summary Recommendations

The main objective of the Phase-II study was to i) identify structural and non-structural solutions/options and interventions; ii) prepare pre feasibilities of the interventions selected through stakeholder consultative process, detailing rationale, output, impact, along with technical and economic viability, sustainability, and socially acceptability. Based on the criteria developed the pre feasibilities have been ranked and prioritized. Following are the recommendations for the consideration of SIDA, PID, and the GoS.

A. Core Projects be Selected as First Priority

The following pre feasibilities are recommended for formulating detailed feasibility during the Phase-III.

i. rehabilitation and improvement of LBOD drainage infrastructure;
ii. revival of natural water ways (*dhora*s) to drain out the storm water;
iii. protective plantation of mangroves in the coastal areas of left bank;
iv. establishment of Disaster Management Cell in SIDA; and
v. gender mainstreaming in irrigation and drainage.

B. Preparation of PC Is for the Second Priority Projects

It is proposed that the following second priority interventions are considered for preparing revised PC Is by the PID, and submitted for the approval of the GoS.

i. Privatization of FGW SCARP tubewells; and
ii. Rehabilitation of the LBOD and SCARP tubewells,

C. Projects to be Processed by the Relevant Line Departments

Following the third priority interventions should be entrusted the relevant line agencies for further processing. These include:

i. Bio-saline agriculture in Badin and Thatta districts

ii. Use of drainage water for forestation in the LBOD and Kotri areas

iii. Rehabilitation of Deh Akro II and Chotiari wetland complex.

D. Projects Not Recommended for Further Pursuing

The analyses of six of the prefeasibility suggest that they do not merit considerations for further pursuing, either they are unfeasible, or private sector activity, socially not acceptable, and or risk of sustainability. They are:

i. Ghotki SCARP in saline zone (unfeasible);

ii. Rehabilitation of coastal wetlands (unfeasible);

iii. Elevated platforms for flood displaced persons (not sustainable); however widened and strengthened drain and canal banks, and raised and widened section of roads could be a cost effective alternative.

iv. Brackish water fish farming in LBOD area (feasible, but a private sector activity);

v. Shrimp and mud crab farming in coastal areas of left bank (feasible, but a private sector activity); and

vi. Second line of defence for left bank of Indus d/s Kotri. (Socially not acceptable).

E. Non Structural Interventions/Pre Requisites

i. In addition to this, SIDA and PID should ensure that the irrigation canals are closed at least one week before the rain warning.

ii. It is further recommended that before the ensuing monsoons, the heavy machinery should be mobilized to vulnerable point on the drainage network by July 30 each year,

iii. As it is anticipated that that the coming years will experience high level of precipitation of about 2011 magnitude, SIDA/PID should ensure that the information regarding expected floods and its intensity is widely and timely disseminated, and coordinate with PDMA, district administrations, and relevant NGOs for flood preparedness.

F. Effective Compliance and Enforcement of EPA regulations for Sugar mills.

i. The EPA should monitor that the sugar mills comply with the environmental protection laws, and do not dump their untreated toxic effluent directly into the water bodies including drains.

ii. EPA should also rationalize the fines on the sugar mills for non-compliance.

G. Initiation and Facilitation of Inter-Provincial Dialogue

To address the concerns expressed by the stakeholders located in the northern strip of Ghotki, regarding the encroachment of saline effluent from SCARP VI adversely affecting the fertile cropped lands, the environment water table and quality of ground water, SIDA needs to initiate and facilitate an interprovincial dialogue, at the appropriate level. The Consultants recommend implementing the project as per the original design.

6.10 Indicative Financial Outlay of Master Plan

The indicative cost of interventions was estimated for all the pre-feasibilities using current 2012 prices. The base costs include a two per cent provision as physical contingency. Total cost was also computed accounting for three per cent as price escalation for construction industry.

It is estimated that the overall base cost of recommended and not recommended intervention is about Rs.93.8 billion. With the provision of price contingency the total cost is about Rs.111 billion. Out of this, the estimated base cost of the recommended interventions is about Rs.76.5 billion, and the total cost inclusive of price contingency is Rs.90.1 billion. It may be noted, that the total cost includes 17.5 per cent as taxes, suggesting that the net financing requirement will be reduced by about Rs.15.8 billion.

Following table summarises the financial outlay for the priority interventions. The detailed year wise expenditure, both for base costs and with price contingency of 3 per cent is presented in annex 1 and annex 2 respectively.

Table 8: Indicative Financial Outlay of Master Plan

	Prefeasibility	**Investment (Rs. Million)[a]**
A	**First Priority Core Interventions**	
1	Rehabilitation and improvement of LBOD drainage infrastructure [b]	17,580
2	Revival of natural waterways to drain out storm water [b]	43,565
3	Protective plantation of mangroves in the coastal areas of left bank	733
4	Establishment of Disaster Management Cell in SIDA	108
5	Gender mainstreaming in irrigation and drainage	420
	Subtotal	**62,406**
B	**Second Priority Interventions**	
1	Privatization of FGW SCARP tubewells	8,290
2	Rehabilitation of LBOD and SCARP tubewells	2,603
	Subtotal	**10,893**
C	**Third Priority Interventions**	
1	Bio-saline agriculture in Badin and Thatta districts	2,350
2	Use of drainage water for forestation in the LBOD and Kotri areas	225
3	Rehabilitation of Deh Akro II and Chotiari wetland complex	585
	Subtotal	**3,160**
	Total Base Cost of Intervention	**76,459**
	Price contingency @ 3% yearly for construction sector escalation	**24,434**
	Total Investment cost	**90,083**

a: These costs are base costs and include provision of 2 percent for unforeseen and physical contingency.
b: includes Rs.1,500 million and Rs.102 million cost to be incurred as emergency works respectively for LBOD and Dhoras during April 2012 and 30 June 2012

6.11 Investment Chronogram

The two implementation alternatives were analyzed from the investment perspective, looking at the annual and the cumulative budgets required for each alternative, putting special emphasis on the first priority interventions, as these cover the main schemes, rehabilitation of LBOD and revival of dhoras. The latter includes the investment of storm drainage provision to the left over areas.

The first priority interventions, recommended by the Master/Regional Plan Consultants contemplate an annual maximum investment of nearly Rs. 7 Billion per year during eight financial years. The annual investment required and the nine years cumulative investments are presented in the chart.

The ten years investment plan for all sixteen schemes requires an average annual investment of about Rs.5 Billion a year, concentrating most of the disbursement in the first nine years due to the works to be carried out at the LBOD and dhoras. The peak investment obviously falls in the first priority schemes and is of the order of Rs.9 Billion in year 2018, which corresponds to the seventh year of the implementation component of the project. The cumulated investment is about Rs.92.3 Billion. The details of the budget required and chronogram are given in Annexure A of this chapter.

Annex 1: Base Cost estimates of all Schemes

	1	2	3	4	5	6	7	8	9	10	Total
A. First Priority Core Interventions											
1. Rehabilitation and improvement of LBOD Drainage Infrastructure	1,568.0	2,670.0	1,834.0	1,918.0	1,918.0	1,918.0	1,918.0	1,918.0	1,918.0	-	17,580.0
2. Revival of natural waterways to drain out storm water	102.0	823.0	1,792.0	6,808.0	6,808.0	6,808.0	6,808.0	6,808.0	6,808.0	-	43,565.0
3. Protective plantation of mangroves in the coastal areas of the left bank	-	-	53.0	163.0	174.0	177.0	166.0	-	-	-	733.0
4. Establishment of disaster management cell in SIDA	-	-	30.0	20.0	20.0	19.0	19.0	-	-	-	108.0
5. Gender mainstreaming in irrigation and drainage	-	-	84.0	84.0	84.0	84.0	84.0	-	-	-	420.0
Subtotal	1,670.0	3,493.0	3,793.0	8,993.0	9,004.0	9,006.0	8,995.0	8,726.0	8,726.0	-	62,406.0
B. Second Priority Interventions											
1. Privatization pf FGW SCARP tubewells	-	-	-	1,658.0	1,658.0	1,658.0	1,658.0	1,658.0	-	-	8,290.0
2. Rehabilitation of LBOD and SCARP tubewells	-	-	-	520.6	520.6	520.6	520.6	520.6	-	-	2,603.0
Subtotal	-	-	-	2,178.6	2,178.6	2,178.6	2,178.6	2,178.6	-	-	10,893.0
C. Third Priority Interventions											
1. Bio-saline agriculture in Badin and Thatta districts	-	-	-	-	-	190.0	540.0	540.0	540.0	540.0	2,350.0
2. Use of drainage water for forestation in the LBOD and Kotri areas	-	-	-	-	-	45.0	45.0	45.0	45.0	45.0	225.0
3. Rehabilitation of Deh Akro II and Chotiari wetland complex	-	-	-	-	-	195.0	195.0	195.0	-	-	585.0
Subtotal	-	-	-	-	-	430.0	780.0	780.0	585.0	585.0	3,160.0
Total Baseline Cost (Priority Interventions)	**1,670.0**	**3,493.0**	**3,793.0**	**11,171.6**	**11,182.6**	**11,614.6**	**11,953.6**	**11,684.6**	**9,311.0**	**585.0**	**76,459.0**
D. Not Recommended for Pusuing Further											
1. Ghotki SCARP (Saline Zone)	-	-	-	-	-	1,350.0	1,563.0	1,280.0	752.0	98.0	5,043.0
2. Elevated platforms for flood displaced persons	-	200.0	200.0	200.0	200.0	200.0	200.0	-	-	-	1,200.0
3. Brackish water fish farming in LBOD area (credit line)	-	-	-	-	-	109.0	109.0	109.0	109.0	109.0	545.0
4. Shrimp and mud carab farming in coastal areas of letft bank (credit line)	-	-	-	-	-	24.8	24.8	24.8	24.8	24.8	124.0
5. Rehabilitation of coastal wetlands complex	-	-	-	-	-	1,688.0	1,688.0	1,688.0	1,688.0	1,690.0	8,442.0
6. Second line of defense for left bank of Indus d/s Kotri	-	-	-	-	330.0	331.0	331.0	331.0	331.0	331.0	1,985.0
Subtotal	-	200.0	200.0	200.0	530.0	3,702.8	3,915.8	3,432.8	2,904.8	2,252.8	17,339.0
Total Baseline Cost (Priority and non recommend interventions)	**1,670.0**	**3,693.0**	**3,993.0**	**11,371.6**	**11,712.6**	**15,317.4**	**15,869.4**	**15,117.4**	**12,215.8**	**2,837.8**	**93,798.0**

Annex 2: Cost estimates of all Schemes including Price Contingency

	1	2	3	4	5	6	7	8	9	10	Total
A. First Priority Core Interventions											
1. Rehabilitation and improvement of LBOD Drainage Infrastructure	1,591.5	2,791.4	1,974.9	2,127.3	2,191.1	2,256.8	2,324.5	2,394.3	2,466.1	-	20,117.9
2. Revival of natural waterways to drain out storm water	103.5	860.4	1,929.6	7,550.9	7,777.4	8,010.7	8,251.0	8,498.6	8,753.5	-	51,735.7
3. Protective plantation of mangroves in the coastal areas of the left bank	-	-	57.1	180.8	198.8	208.3	201.2	-	-	-	846.1
4. Establishment of disaster management cell in SIDA	-	-	32.3	22.2	22.8	22.4	23.0	-	-	-	122.7
5. Gender mainstreaming in irrigation and drainage	-	-	90.5	93.2	96.0	98.8	101.8	-	-	-	480.2
Subtotal	1,695.1	3,651.8	4,084.4	9,974.3	10,286.1	10,597.0	10,901.6	10,892.9	11,219.6	-	73,302.7
B. Second Priority Interventions											
1. Privatization pf FGW SCARP tubewells	-	-	-	1,838.9	1,894.1	1,950.9	2,009.4	2,069.7	-	-	9,763.1
2. Rehabilitation of LBOD and SCARP tubewells	-	-	-	577.4	594.7	612.6	630.9	649.9	-	-	3,065.5
Subtotal	-	-	-	2,416.3	2,488.8	2,563.5	2,640.4	2,719.6	-	-	12,828.6
C. Third Priority Interventions											
1. Bio-saline agriculture in Badin and Thatta districts	-	-	-	-	-	223.6	654.5	674.1	694.3	715.1	2,961.6
2. Use of drainage water for forestation in the LBOD and Kotri areas	-	-	-	-	-	52.9	54.5	56.2	57.9	59.6	281.1
3. Rehabilitation of Deh Akro II and Chotiari wetland complex	-	-	-	-	-	229.4	236.3	243.4	-	-	709.2
Subtotal	-	-	-	-	-	506.0	945.3	973.7	752.2	774.7	3,951.9
Total Project Cost (Priority Interventions)	**1,695.1**	**3,651.8**	**4,084.4**	**12,390.6**	**12,774.9**	**13,666.5**	**14,487.3**	**14,586.1**	**11,971.8**	**774.7**	**90,083.2**
D. Nont Recommended for Pusuing Further											
1. Ghotki SCARP (Saline Zone)	-	-	-	-	-	1,588.5	1,894.3	1,597.9	966.9	129.8	6,177.3
2. Elevated platforms for flood displaced persons	-	209.1	215.4	221.8	228.5	235.3	242.4	-	-	-	1,352.5
3. Brackish water fish farming in LBOD area (credit line)	-	-	-	-	-	128.3	132.1	136.1	140.1	144.4	680.9
4. Shrimp and mud carab farming in coastal areas of letft bank (credit line)	-	-	-	-	-	29.2	30.0	30.9	31.9	32.8	154.9
5. Rehabilitation of coastal wetlands complex	-	-	-	-	-	1,986.2	2,045.8	2,107.2	2,170.4	2,238.1	10,547.7
6. Second line of defense for left bank of Indus d/s Kotri	-	-	-	-	377.0	389.5	401.2	413.2	425.6	438.4	2,444.8
Subtotal	-	209.1	215.4	221.8	605.5	4,356.9	4,745.8	4,285.2	3,734.9	2,983.5	21,358.1
Total Project Cost (Priority and non recommend interventions)	**1,695.1**	**3,860.8**	**4,299.7**	**12,612.4**	**13,380.4**	**18,023.4**	**19,233.1**	**18,871.4**	**15,706.7**	**3,758.2**	**111,441.3**

Attachment 1

STAKEHOLDER CONSULTATION PROCESS

A central point in the preparation of the WSIP-I 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.

Therefore preparation of the Master Plan followed the consultative process at all stages of the study, namely, identification of the issues and options and preparation of pre feasibilities, and detail designing. The consultations with communities and other main stakeholders were organized at multiple levels.

The main purpose of the workshop was to present solutions proposed during the consultations with communities and stakeholders in the Phase-1, and to solicit additional suggestions and solutions if any; and their endorsement of the proposed solutions, mainly to resolve issues related to drainage, flooding, environment, natural resources, socio-economic and institutional issues, and to prioritization the proposed interventions.

To ensure full and equal involvement of men and women of all ages, backgrounds and social status, a wide range of stakeholders were invited to participate in the workshops in project area based on fifteen districts of Sindh, three area water boards including national potential stakeholders. Several interventions were proposed and presented to the stakeholders for the identified problems related to drainage, flooding, environment, and socio-economic issues.

The main objective of this process of community consultations was to identify structural and non-structural environment friendly solutions/interventions, ranking and detailed designing of selected interventions. The solutions to the problems/issues identified during the phase I, have been compiled, discussed, ranked and endorsed by the stakeholders at intensive Phase II consultations.

Overall, the phase II consultations were comprised of the workshops organized at three levels i.e.: i) twelve district level workshops; ii) three Area Water Board level workshops; and iii) one national/regional level workshop.

The workshops at the district level were organized in the following districts: Ghotki, Sukkur and Khaipur, Noushero Feroze, Shaheed Benazirabad, Mirpurkhas and Tando Allahyar, Sanghar, Hyderabad and Matiary, Badin, Thatta, Tando Muhammad Khan, Tharparkar and Umerkot. In addition, one workshop was organized for each of the three Area Water Boards (Ghotki Feeder Canal AWB, Nara Canal AWB and Left Bank Canal AWB). The final wrap up workshop was conducted in Karachi with participation of regional and national stakeholders.

The participants included representations from the farmers, and line agencies, such as departments of agriculture, livestock, fisheries, forestry, farmer organizations (FOs), Abadgar Board, (AWBs), SIDA, civil society. Women were especially encouraged to participate. These workshops were organized in coordination with fifteen local partner NGOs and Consortium teams. Based on these consultations and stakeholders' suggestions, the Consultants have formulated several interventions to mitigate the issues and problems mainly pertaining to drainage, flooding, environment, natural resources, socio-economic and institutional issues in the left bank of Indus, delta and coastal area. The stakeholders were

given the opportunity to discuss, endorse or reject those interventions with adding alternative solutions according to their opinions.

In order to disseminate the preparation of master plan process, project fliers in local languages were distributed prior to the community consultations. About 10,000 project pamphlets each in Sindhi and English languages were distributed, along with 81 news cuttings published in the local media in English, Urdu and Sindhi languages. In addition to this, six TV programs about the preparation of the master plan and related issues were organized local TV channels. In order to reach a wider community, a questionnaire to identify problems and solutions was published in the Sindhi and English newspapers. The feedback received from stakeholders indicates stakeholder's satisfaction and keen interest in the participatory process. This also helped the consultants in understanding the perceptions and aspirations of the stakeholders.

The total number of participants in the workshops held during the two phases was 9,077, of which female participants were 2,455 (about 27 percent). Out of these women 229 were women active in the professional fields.

In the district level workshops held during the second phase of the study, 1,442 stakeholders were invited. Of them 1,014 (70 percent) participated in the workshop. Of those who attended, twelve percent were women (121).

During and after the 2011 storm water floods, the social team visited each district in the project area, assessed the situation and consulted with the flood affected communities. The team visited 89 villages in fifteen project area districts and consulted with 1,740 persons in order to assess the losses/damages of villages, crops destruction, people and livestock affected, chicken and fish farms destroyed, diseases spread, government/private assistance provided, source of income available etc. In each district, the team has a partner NGO that gave us the first hand information about the situation on the ground, suggested villages and communities to be visited and accompanied our team on each visit. Their work in affected areas and information and help given to our team are indispensable.

The detailed description of the participatory process, and district wise representation and participation, and proceedings of the workshops is presented in Volume IV of the Phase II report.

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