ISLAMIC REPUBLIC OF PAKISTAN
FEDERAL FLOOD COMMISSION (FFC)

TECHNICAL ADVISOR ON FLOOD MANAGEMENT IN ISLAMIC REPUBLIC OF PAKISTAN

Final Report

September 2023

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.

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As of September 2023.

Disclaimer: This map is only for illustrative purposes and does not imply any opinion of JICA on the legal status of any country or territory, the borderline of any country or territory or its demarcation, or the geographic names.

PROJECT LOCATION MAP

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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ADP	Annual Development Programme
AJ&K	Azad Jammu and Kashmir
CCI	Council of Common Interests
CDWP	Central Development Working Party
DG	Director General
D.G.	Dera Ghazi Khan
D.I. Khan	Dera Ismail Khan
EAD	Economic Affair Division
FATA	Federally Administrated Tribal Areas
FEWS	Flood Early Warning System
FFC	Federal Flood Commission
FFD	Flood Forecasting Division
FMC	Flood Management Committee
FPSP	Flood Protection Sector Project
GB	Gilgit-Baltistan
GIS	Geographical Information System
GLOF	Glacial Lake Outburst Flood
GoP	Government of Pakistan
IFM	Integrated Flood Management
IRSA	Indus River System Authority
JICA	Japan International Cooperation Agency
KPK	Khyber PakhtunKhwa
LiDAR	Laser Illuminated Detection and Ranging
LS	Lump Sum
MMF	Masajid & Madaris Foundation
MoCC	Ministry of Climate Change
MoEA	Ministry of Economic Affair
MoPS	Ministry of Planning, Development and Spatial Initiative
MoWR	Ministry of Water Resources
M/P	Master Plan
NDMA	National Disaster Management Authority
NDMP	National Disaster Management Plan
NESPAK	National Engineering Services Pakistan
NFPP	National Flood Protection Plan
NPO	Non-Profit Organization
O&M	Operation and Maintenance
PC	Planning Commission
PCIW	Pakistan Commissioner for Indus Waters
PDNA	Post Disaster Needs Assessment
PDMA	Provincial Disaster Management Authority
PID	Provincial Irrigation Department
PMD	Pakistan Meteorological Department
PSDP	Public Sector Development Program
SOP	Standard Operating Procedure
SUPARCO	Space & Upper Atmosphere Research Commission
TOR	Terms of Reference
UNDP	United Nations Development Programme
WAPDA	Water and Power Development Authority
WB	The World Bank

CHAPTER 1 OUTLINE OF THE PROJECT

1.1 Background

Pakistan is hit by natural disasters such as floods, earthquakes, landslides and cyclones frequently. Among the disasters, floods have caused tremendous damage, such as the 2010 Flood, when approximately 2,000 people died and 20 million people were affected. Under the circumstances, the Government of Pakistan prepared the Fourth National Flood Protection Plan (hereinafter, the "NFPP-IV"), the 10-year plan from 2015 to 2025.

However, the Federal Flood Commission (hereinafter, "FFC"), the executing agency, has not systematically implemented flood control projects based on the NFPP-IV. Therefore, the Government of Pakistan requested the Government of Japan to provide advice and technological assistance in solving its perennial flooding problem. In response, the Japan International Cooperation Agency (JICA) decided to dispatch a technical advisory team on flood management, to promote FFC's flood control projects through the analysis of implementation issues and provide advice on the implementation of future flood control project plans, identify priority flood control projects in the NFPP-IV, and strengthen the capacity to plan, implement and manage flood control projects.

Pakistan and Japan share similar problems on frequent natural disasters and both are at high risk of climate change. Therefore, based on the "Sendai Framework for Disaster Risk Reduction 2015-2030" adopted at the Third United Nation World Conference on Disaster Risk Reduction, Pakistan is also expected to reduce disaster risks through Japanese assistance, utilizing Japanese technology and knowledge.

1.2 Project Objectives

(1) Overall Goal

In Pakistan, importance of appropriate plan and implementation of flood control measures will be understood, and consequently, the investment in flood control measures will be expanded to a level where human and economic losses can shift to a declining trend.

(2) Objective

The objective of this advisory activity is to address issues to expand planned investments on flood disaster prevention and mitigation, and support for promoting and formulating fundamental flood control projects to reduce flood risk.

1.3 Target Area

This advisory activity covers the flood control matters in the whole country of Pakistan.

1.4 Relevant Ministries and Agencies

The main ministries and agencies involved in this activity are as follows:

Responsible Ministry	:	Ministry of Water Resources (MoWR)
Implementing Agency	:	Federal Flood Commission (FFC)

1.5 Contents of the Advisory Activity

(1) Output Prospected

Output 1	:	Basic information on flood countermeasures will be collected and issues will be compiled.
Output 2	:	Support will be provided for confirming the progress of the 4th National Flood Protection Plan (NFPP-IV) and the implementation of flood control projects.

Output 3 : Fundamental flood control projects for flood risk reduction will be identified and formulated.

Output 4 : FFC's implementation capacity (capacity to: (1) formulate flood control MP; (2) formulate flood control projects; and (3) facility operation and maintenance, etc,, will be strengthened.

(2) Advisory Activities

1-1 : Understand the current state of regulations and organizational structure.

1-2 : Analyze the status of important policies, plans, and projects necessary to examine flood control projects

1-3 : Analyze the current state of hydrological observation, river survey, basin survey and hydrological analysis

1-4 : As to the formulation of flood control plan, understand the current situation and capabilities of FFC and analysis issues.

1-5 : Analyze the status of flood control and river crossing facilities and the situation of operation and maintenance of the facilities.

2-1 : Confirm the budget distribution status related to NFPP-IV and analyze the issues.

2-2 : Confirm the progress of each project related to NFPP-IV and analyze the issues.

2-3 : Analyze the factors that the implementation of NFPP-IV, and compile recommendations for promoting implementation.

3-1 : Advise on flood control measures of JICA-related projects.

3-2 : Examine fundamental flood control projects based on the identification of bottleneck issues to be solved for flood risk reduction in consideration of flood damage potential, utilizing outputs of ongoing JICA projects on flood control.

3-3 : Among the flood control projects examined in Activity 3-2, financial and/or technical cooperation projects (especially, focusing on structural measures) should be organized and prioritized by JICA.

3-4 : Explain the results of Activity 3-2 to the Pakistani government and other donors and obtain an agreement on the direction of flood control projects to be undertaken in the future.

3-5 : Based on activities 2 and 3-1 to 3-3, organize important philosophy when formulating future flood control plans, and share awareness with FFC staff.

4-1 : Based on the analysis results in Activity 1, examine contents that should be challenged for capacity enhancement of FCC staff.

4-2 : Based on the examination in 4-1, conduct capacity enhancement events (seminars, workshops, etc.) according to issues to be challenged for flood control planning.

1.6 Term of the Advisory Activity

The advisory activity is scheduled for a period of 25 months from September 15, 2021 to September 15, 2023.

1.7 Members of the JICA Advisory Team and Time Schedule

The JICA Advisory Team of six (6) Japanese advisors, one (1) assistant advisor from CTI Engineering International Co., Ltd. (CTII), and two (2) national staff. To present advisory activity progress and results, several reports will be submitted to related organizations.

Table 1.7.1 Members of the JICA Advisory Team

Title	Name	Designation or Field of Specialty
JICA Advisor	Mr. Toshihiro GOTO	Team Leader / Flood Control Plan
JICA Advisor	Mr. Tsuyoshi MATSUSHITA	Deputy Team Leader / Flood Control Facility Management
JICA Advisor	Mr. Kohei Takayama	River Channel Planning I / Structure Design
JICA Advisor	Mr. Takafumi Sueishi	Hydrometeorology / Hydraulic / Satelite Image Analysis

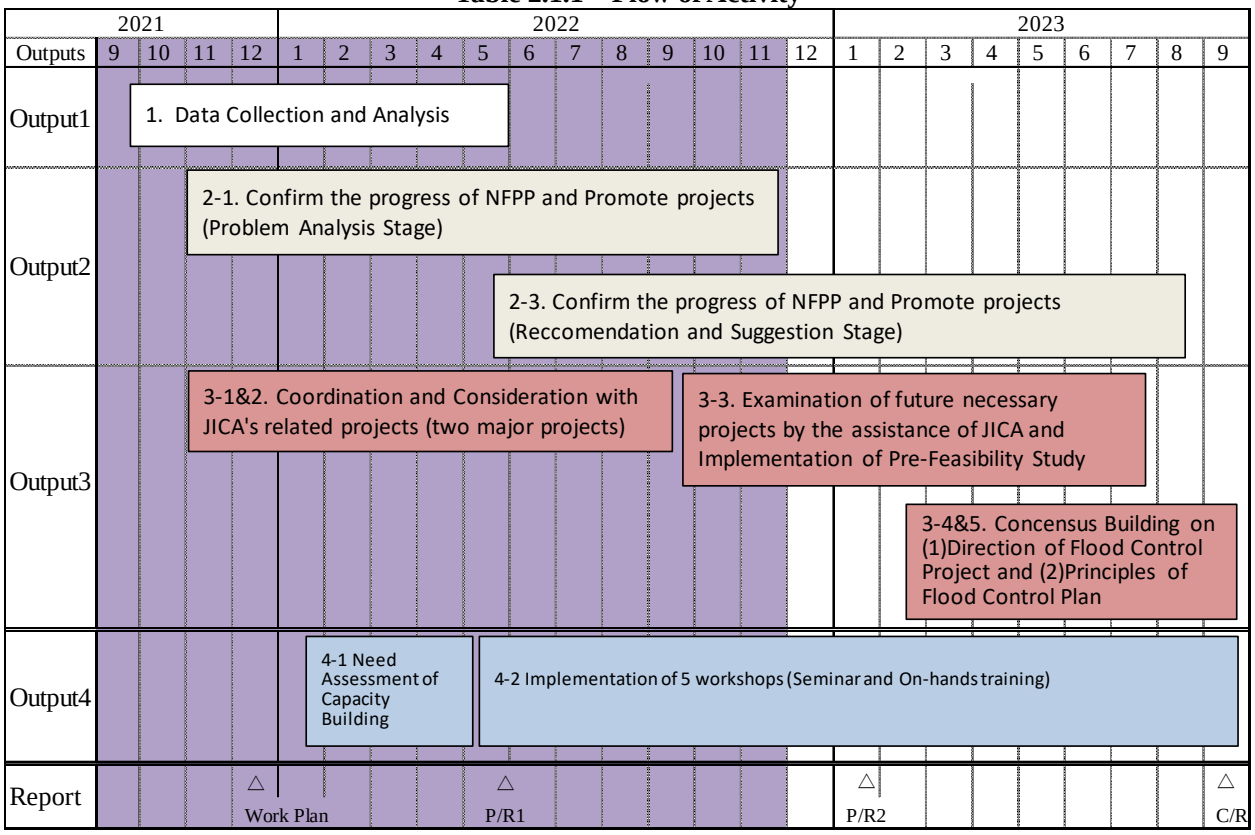
JICA Advisor	Mr. Takashi Ono	Construction Planning / Cost Estimation
JICA Advisor	Mr. Qasim Saeed	River Channel Planning II / Operation & Maintenance
Assistant Advisor (CTII)	Dr. Rahmat Ullah	Basic Survey for Flood Control
National Staff	(Two staffs)	Secretary and Technical Survey for Flood Control Plan

CHAPTER 2 ACTIVITIES

2.1 Main Activities

The flow of activity is shown in Table 2.1.1. The main activity consists of four activities, comprising a total of 15 sub-activities (refer to section 1.6)

Table 2.1.1 Flow of Activity



P/R: Progress Report, W/P: Work Plan Report, C/R: Completion Report

Source: Advisory Team

2.2 Activities Related to Output 1

Output 1: Basic information on flood countermeasures will be collected and issues will be organized

2.2.1 Understand the Current State of Regulations and Organizational Structure

2.2.1.1 Roles of Related Organizations and Regulations on Flood Control Measures

The roles and responsibilities of eight major organizations related to flood control measures listed in NFPP-IV are summarized in Table 2.2.1. These can be broadly divided into organizations involved in flood risk reduction, which implement structural and non-structural measures, and organizations involved in crisis management, such as flood response, rescue and rehabilitation. Flood risk reduction agencies play a major role in enhancing advance investment for disaster risk reduction (DRR), which is the goal of the advisor's work. In particular, the Federal Flood Commission (FFC), the executing agency for the advisory activity, plays a central role in formulating flood control measures plans.

Table 2.2.1 Role of FFC and Related Agencies in Flood Control Measures

Agency		Roles and Responsibilities of Flood Control Measures
Flood Risk Reduction Agency	Department of Water Resources, Federal Flood Commission (FFC)	● Preparation and implementation of the National Flood Protection Plan (NFPP) ● Review and approval of flood protection plans prepared by province governments or relevant federal agencies ● Review of damage status of flood control infrastructure and restoration and reconstruction plan after flood ● Improvement of Flood Forecasting and Warning System (FEWS) ● Standardization of design and specifications of flood control facilities ● Development of a research program on flood control and protection ● Development of standard operating procedures for reservoirs for flood control
	Water and Power Corporation (WAPDA)	● Development, maintenance, management and operation of water level observation networks for major rivers nationwide ● Flood warning through real-time observation and transmission system of river water level observation data ● Control of river flood discharge through operation and operation of major hydroelectric dam reservoirs
	Provincial Irrigation Department (PID)	● Observation of river water level and flow rate and implementation of river survey ● Operation of irrigation dams and weirs during floods and maintenance and management of rivers and irrigation channels ● Planning and implementation of irrigation and drainage projects
	Department of Defense; Pakistan Meteorological Department (PMD)	● Operation and maintenance of meteorological and seismic observation systems ● Provision of weather forecasts and flood and earthquake information warnings ● Operation and maintenance of flood early warning system
	Commissioner, Pakistan Indus Water Commission (PCIW)	● Resolution of disputes between Pakistan and India over the water resources of the rivers that run through them and promotion of cooperation in joint water resource development ● Receipt of water level and discharge data of transboundary rivers observed on the Indian side and provision of the data to the flood forecasting department of PMD
Crisis Management Organization	Ministry of Meteorological Change; National Disaster Management Agency (NDMA)	● Implementation, coordination, and monitoring of disaster management ● Preparation of national plans approved by national committees and monitoring of their implementation ● Technical assistance by agencies and provincial agencies to develop and develop guidelines for disaster management planning ● Relevant Ministries, Departments or Provincial Governments and Provincial Authorities Coordination and Direction of Disaster Response ● Promotion of disaster prevention education to raise awareness of disaster prevention
	Province/Disaster Management Agency (PDMA)	● Coordination and monitoring of the formulation and implementation of provincial disaster prevention management plans ● Study of vulnerability to various disasters and mitigation measures in the province ● Review disaster preparedness of provincial and non-governmental organizations ● Instructions to Provincial Government Agencies on Disaster Response ● Basic education and community training in disaster management
	Pakistan Army	● Repair and reinforcement of river embankments, weirs, and other major river structures in collaboration with the Provincial Irrigation Department ● Implementation of flood prevention activities, such as protection against bank failures in the event of a flood, and relief activities for disaster-stricken residents ● Support for post-flood recovery and reconstruction activities

Source: NFPP-IV Survey Report

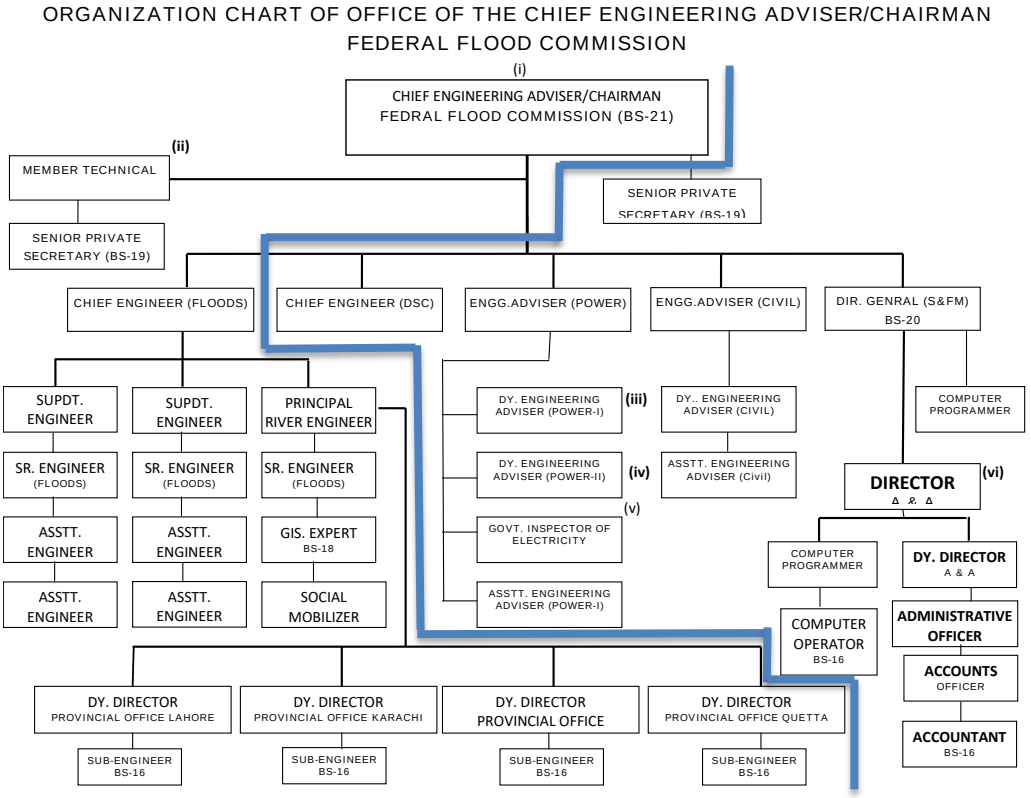
In general, individual flood control project plans are prepared by PID and related ministries. FFC reviews and approves these projects and organizes them into the National Flood Protection Plan (NFPP). Each project approved by the FFC will be implemented by the organization that prepared the plan under the FFC's financial and technical support if the budget is allocated by the federal government or development donors. FFC also plays a role in standardizing the design and specifications of flood control facilities to improve the quality of the project.

2.2.1.2 FFC Organizational Structure

(1) FFC Organization Structure

The current organizational structure of the Federal Flood Commission (FFC), the C/P (Counterpart) organization, is as shown in Figure 2.2.1. This organization chart was obtained as “Organization Chart of Office of the Chief Engineering Advisor (CEA) / Chairman of Federal Flood Commission (FFC)”. The organization and function of FFC were incorporated into the Office of CEA in 1977. Exactly, the left portion of the blue line in Figure 2.2.1 represents only the organization of FFC. Under CEA and FFC chairpersons, there are the Flood Management Wing (lower portion of Chief Engineer of Floods),

Dams & Barrages Safety Council Wing (lower portion of Chief Engineer of DSC), Power Wing (lower portion of Chief Engineer of Power), Civil Engineering Wing (lower portion of Chief Engineer of Civil), and Services & Financial Management (under the Chief Engineer of S&FM). The party of Chief Engineer (Floods) is the core of FFC (the Flood Management Wing).



Source: FFC

Figure 2.2.1 Organogram of CEA and FFC (as of April 2022)

(2) Functions and Roles of FFC

The history, functions and achievements of FFC are detailed in the Annual Report published by the Office of CEA/CFFC in March of each year. The roles and functions of the FFC are listed below. In particular, regarding the fifth function in the list, from the viewpoint of the preparation process of NFPP-IV, the planning of flood control measures (especially structural measures) seems to be collected and researched from/by each province and related agencies. In other words, the original plan was made by provinces and related organizations but not FFC. FFC has functions for planning, proposing and monitoring flood control measures; however, bidding and construction are not implemented.

1. Preparation of Flood Protection Plan for the country including management of the Plan.
2. Scrutiny of flood control/protection schemes funded by the federal government and prepared by Provincial Governments and Federal Agencies.
3. Review of damage of flood protection works and review of plans for restoration and reconstruction works.
4. Measures for improvement of Flood Forecasting & Warning System.
5. Preparation of a Research Program for flood control and protection.
6. Standardization of designs and specifications for flood protection works.
7. Recommendations regarding principles of regulation of reservoirs for flood control.
8. Evaluation and monitoring of the progress of implementation of the National Flood Protection

Plan.

9. The Federal Flood Commission may notify sub-committees as it deems appropriate.

(3) FFC Personnel Structure

FFC has a total of 153 posts, of which 37 are civil servants. At present, 16 of those 37 positions are vacant. These positions need to be staffed for FFC to function properly. According to the Planning Commission 1 report on the FFC strengthening project (called as PC1 Report: Report for each agency's budget application to the Federal Government), low salaries and benefits (such as secondary income from project implementation) are one of the causes. In addition, the chairman suggested that "Currently, MoWR personnel are holding office at the FFC building which is not large enough for all of MoWR and FFC personnel. According to FFC, the organizational improvement of FFC and establishment of new buildings should be made to ensure an appropriate working environment for employees."

Table 2.2.2 Number of CEA/FFC Posts, Tenures and Vacancies

	Number of Posts	Number of Tenures	Number of Vacant Seats
Public officials	37	21	16
Support staff	116	101	15
Total	153	122	31

Source: FFC(2022)

(4) FFC's Organizational Improvement Plan

FFC has applied to the Planning Commission of the Ministry of Planning, Development and Spatial Initiative (MoPS) for NFPP-IV with the total project budget (PKR 367 mil.) for the project "Strengthening and Capacity Building of OCEA/CFFC" approved by the Council of Common Interest (CCI) under the Inter-Provincial Coordination Division of the Federal Government. However, the budget for the project has not been approved by the federal government as of March 2022. Therefore, at the end of March 2022, FFC submitted an updated PC1 report.

The FFC Chairman asked for advice on organizational strengthening in revising the PC1 report on strengthening the office of FFC/CEA. The chairman said that he was considering adding a new Wing to the Office of CEA, and that he needed to put more effort into surveys, research, planning, flood monitoring and transmission, and if possible, to become a semi-public organization such as WAPDA. For the preparation of the revised PC1 report, the JICA Advisory Team and the chairman exchanged ideas on strengthening the organization with the Chairman for a month. The National Water Policy (2018) also promotes the strengthening of existing organizations in the water sector.

(5) Management of Flood Management Committee (FMC) Meetings

The activities of FFC are to convene meetings for consultation, prepare main materials and information, and carry out proceedings, advice, and arrangements at pre-monsoon-, post-monsoon- and during-monsoon-, project scrutiny- and annual meetings. As member of the Flood Management Committee (FMC), FFC has the role of managing the various meetings by inviting relevant organizations to such meetings. The Chairman of FFC/CEA chairs the meetings, and members from the 13 relevant organizations are listed in Table 2.2.2. Although the Ministry of Climate Change (MoCC) which promotes climate change and environmental policies necessary for considering flood countermeasures is not a member of FMC; however, it participated in the pre-monsoon meeting held by FMC. Planning Commission (MoPS-PC) is also not a member; however, MoPS-PC joins in the meetings specially to discuss funding feasibility of projects.

Table 2.2.3 Flood Management Committee (FMC) Meeting Members

Item No.	Participants and Organizations	Roles
1.	Chief Engineering Advisor, M/o Water Resources	Chairman
2	Secretary, Irrigation Department Government of the Punjab	Committee member
3	Secretary, Irrigation Department Government of Sindh	
4.	Secretary, Irrigation Department Government of Khyber Pakhtunkhawa	
5.	Secretary, Irrigation Department Government of Balochistan	
6.	Chairman, National Highway Authority	
7.	Chief Executive Officer, Pakistan Railways	
8.	Member (Infrastructure), Planning Commission of Pakistan	
9.	Member (Water), WAPDA	
10.	Member (DRR), NDMA	
11.	Pakistan Commissioner for Indus Water (PCIW)	
12.	Chairman, Indus River System Authority (IRSA)	
13.	Director General, PMD	

Source: FFC

(6) Role in Flood Monitoring

FFC receives flood information from the Flood Forecasting Department (FFD) under PMD and communicates and provides the information to senior agencies, the President, military headquarters, and relevant provinces and national councils. The information transmission seems to have been carried out by mainly printed paper and/or telephone during emergency period.

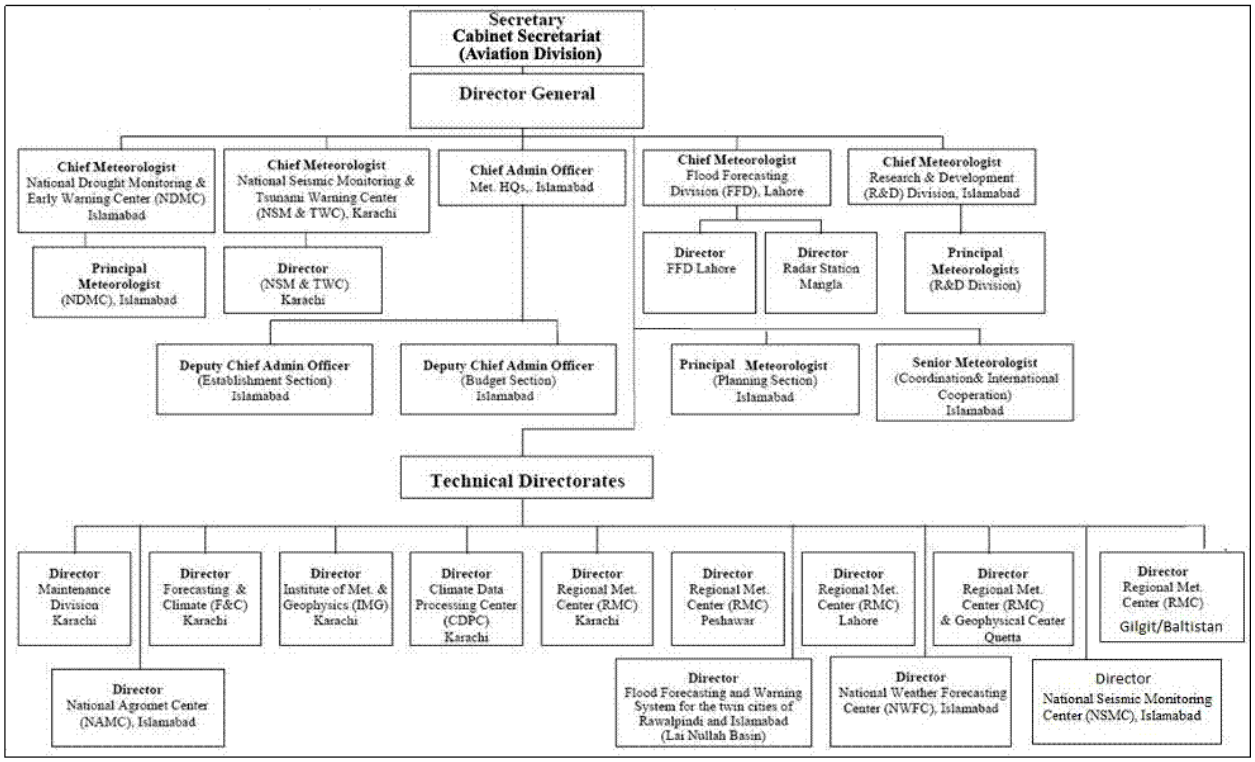
2.2.1.3 Organizational Structure of Pakistan Meteorological Department (PMD)

The Pakistan Meteorological Department (PMD) is a semi-government and semi-private government agency belonging to the Aviation Department of the Cabinet Secretariat. It has a total of approximately 2,430 employees (347 public employees and 2,083 other employees). Details of the organization are described in the JICA "Preparatory Research Report for Establishment of the Centre for Medium-Range Weather Forecasts and Strengthening of the Weather Forecasting System in the Islamic Republic of Pakistan (2016)". The organization chart shown in Figure 2.2.2 was obtained from the JICA Grant Aid Team. PMD has a headquarter in Islamabad and offices with research facilities in all four provinces. The Flood Forecasting Division (FFD) under PMD is located in Lahore and manages flood forecasting activities throughout Pakistan with the support of the Provincial Irrigation Department (PID) and Provincial Disaster Management Authority (PDMA). PMD also has local offices equivalent to the number of districts.

(1) Role in Flood Control

In addition to providing information on safety and protection against wind and flood disasters such as weather forecasts and public warnings, PMD conducts research and surveys in other fields (Research on meteorological phenomena, astronomical events, hydrology, astrophysics, climate change etc.; aeronautical engineering; and study on renewable energy resources etc.). The seismic detection system has also been introduced since 1974. According to PMD, the early warning system of PMD includes but are not limited to, the following:

- Numerical Weather Forecast System
- Heavy Rain Warning System
- Flood Early Warning System
- Earthquake & Tsunami Early Warning System
- Cyclone Early Warning System
- Heat Wave & Marine Early Warning System
- Glacial Lake Outburst Early Warning System
- Drought Monitoring & Early Warning System



Source: PMD

Figure 2.2.2 PMD Organization Chart

In particular, PMD is responsible for weather and flood forecasting/warnings, and its support to relevant agencies using the flood forecasting system and weather radar greatly contributes to flood control. The radar daily forecasts are provided through the media and the Flood Forecasting System (FFD uses software such as IFAS, RRI, and SOBEK for flood analysis) is used to predict the time of flood arrival from the reference point to the next reference point; however, the advisory team could not find the System. FFD receives data, not only from PMD regional offices, but also from WAPDA and PID, then displays the discharge volume in the schematic diagram monitors on the wall, and sent the numerical information to FFC every day during flood period.

(2) Weather and Flood Monitoring System

Flood monitoring is carried out 24 hours a day during the monsoon season at the Flood Warning Center in the headquarters building of PMD in Lahore, Punjab Province, which is formed temporarily during the flood period, and flood information is sent to relevant agencies every day. In addition, Punjab Flood Commission members consisting of PID, PMD, WAPDA, PDMA, etc. gather together in the same building and make decisions on issuing warnings. There are no Flood Warning Centers in other provinces, only in Punjab Province, which is the origin of the floods in Pakistan. According to the PMD Islamabad Director, there is also a plan to place offices in each district in the future. PMD has 100 manual observatories, 40 automatic weather stations (AWS), and 8 radar stations.

According to PMD-FFD, as of October 2022, there will be 97 manual observatories (http://www.pmd.gov.pk/Observatories/) and 45 automatic weather stations (Automatic Weather Station: AWS) and eight radar stations. On the other hand, according to the DRR team of the Post Disaster Needs Assessment (PDNA) in 2022, the above 45 were installed around Hill Trent with JICA funds, but a total of 85 AMDs has been installed so far.

Strictly speaking, consolidated information about all observatories is not organized in PMD. One possible reason is that some observatories are currently managed on a project basis. According to various materials and information from PMD, PMD as a whole will have more than 200 observatories as of October 2022, including observatories temporarily installed in rural areas (actually these observations' data have been obtained as the last two years' time series daily data). For example, 31

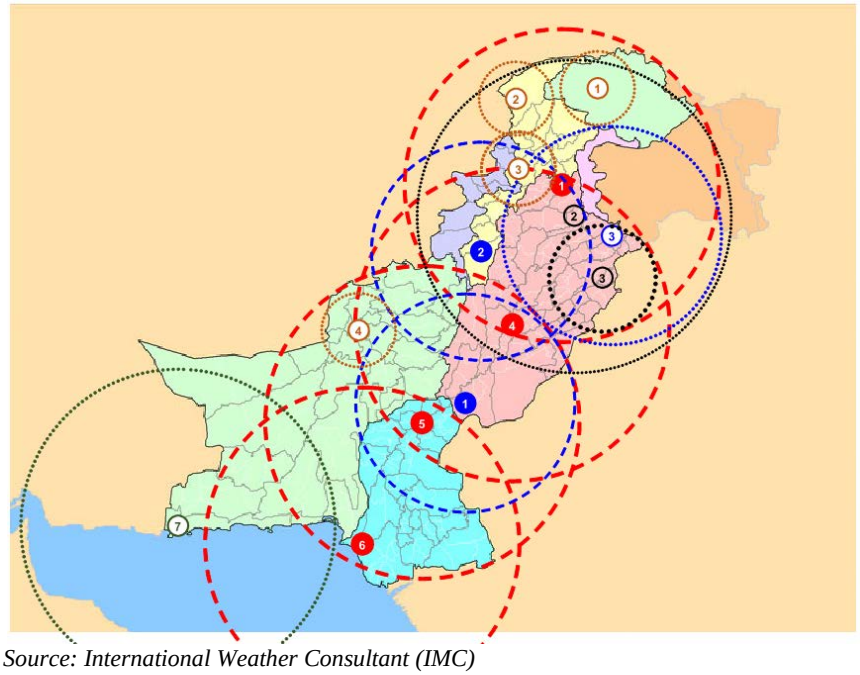
AWS observation stations are listed on the PMD website (http://www.pmd.gov.pk/aws/index.html); however, for Flood Automatic Weather Stations (FAWS) indicates that archive data is available to download from 52 stations (http://202.83.174.35/faws/archive/stations.php).

In any case, centralized management of observatories is required.

(3) Future Challenges for PMD

According to PMD, there are several subjects to be challenged by PMD as follows:

- Inappropriate information sharing to Pakistan from India regarding four (4) Indus tributaries originating in India.
- Restoration of Sialkot and Lahore radar stations in a meteorological strategic location (originally built by ADB but looking for a source to finance the restoration), leading to a better understanding of the monsoon meteorological phenomena that cause flooding.
- Establishment of FFD offices in each province.
- PID-Punjab also plans to install radars in Lahore and Sialkot.
- Suggestions to FFC to prepare improvement of the current system; understanding of quantitative rainfall; revision of flood arrival time, construction of reservoirs on Chenab and Ravi rivers vulnerable to flooding; and revision of low, medium and high water flow at the reference point.
- Promotion of combined use of commercial power sources and solar cells for power supply to observatories
- Installing Automatic Weather Station (AWS) in 636 Subdistricts.
- Visualization of flood forecasting system results in Islamabad (MIKE 11 was introduced by JICA project in the past, but it is not used now because of maintenance cost.)
- Consolidation of inventory maps table and location maps for all stations



Source: International Weather Consultant (IMC)

Figure 2.2.3 Radar Layout in Pakistan

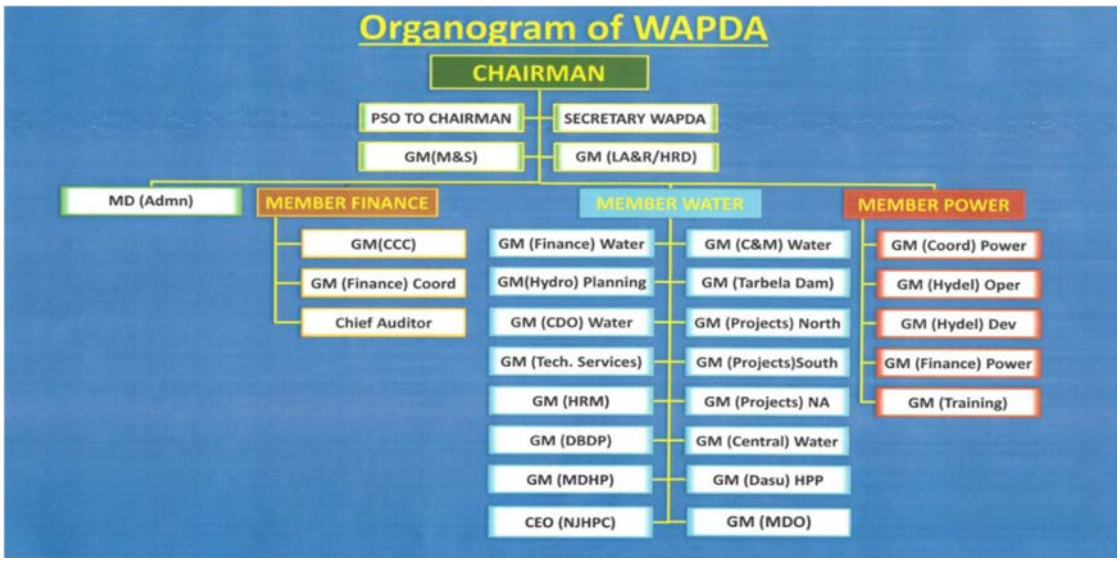
2.2.1.4 Water and Power Development Authority (WAPDA)

(1) Organizational Structure and Role of WAPDA

WAPDA was established in 1958 as a semi-public organization to coordinate and unify the direction of the water and power sector. WAPDA is primarily responsible for research, planning and project implementation in the following areas:

- Power generation, transmission and distribution
- Irrigation, water supply and drainage
- Flood prevention and reclamation of flooded and salt-affected areas
- Flood management
- Inland navigation

The organization of WAPDA consists of three major departments, Water, Power and Finance, as shown in Figure 2.2.4. Each department can independently carry out processes such as planning, designing, bidding and implementation. The sub-offices of WAPDA will be responsible for the execution of the construction and subsequent O&M, and the head office of WAPDA Lahore will direct and control these offices. However, after the construction of irrigation canals, weirs, and other dams, the operation and management of these facilities is handed over to provincial governments (except for large dams). There are several sub-offices in each province, some of which also manage hydrometeorological observations and observation facilities.



Source: WAPDA

Figure 2.2.4 Organizational Chart of WAPDA Headquarters

(2) Role in Flood Control

As part of flood and water utilization management, WAPDA has been providing hydrological data, and its role is to maintain hydro-met stations and to transmit real-time data for flood warnings. In particular, data from manual stations have been provided to PMDs, NDMA, PIDs, and PDMAs so far. In addition, the operation and maintenance of major dams effective for flood mitigation such as the Tarbela and Mangla dams is being carried out by WAPDA, and the implementation of flood mitigation by dam operation is planned to be done in the future.

In order to transmit the real-time data mentioned above, MoWR-FFC & WAPDA held a stakeholder meeting on March 31, 2022 to explain and answer questions on “Pakistan National Master Plan for Flood Telemetry Network” and is currently revising this master plan (M/P) based on comments from relevant parties. This M/P is to update WAPDA hydrological and meteorological (Hydro-met)

stations nationwide, introduce a telemetry system, manage real-time information by WAPDA, and transmit it to related agencies. There are about 679 manual stations in total, and it is expected that the modern hydro-met stations will be set up at the same points as these or monitoring equipment will be updated. Since the hydro-met station is installed in the position where the observation station originally existed, the examination on the optimization of the distribution is not examined so much. Although WAPDA and FCC are set as the observation HOST and the observation Co-HOST, the systems, equipment, and roles to be deployed in these HOST and Co-HOST are unclear. In addition, since the whole project schedule is not described, a schedule for the installation of stations and telemetry systems including the construction of HOST and observation stations with adjustment to the stations are considered and made clear. The telemetry project of the stations is divided into Phases 1 and 2, and it will be ordered separately in several places. Therefore, it is necessary to confirm if the respective sensor and communication equipment to be installed in the different works can be harmonized. The above questions were also asked to FFC from this project.

Table 2.2.4 Observatories Owned by WAPDA

Items	Manual Observatory (Water Level)	Independent Observatory (Hydrology and Meteorological Conditions)	Independent Observatory (Hydrology and Meteorological Conditions)	Total
Number of stations	679	59	24	762

Source: WAPDA

2.2.1.5 Relevant Legal Systems

The NFPP-IV survey report mentioned that there are relevant legal regimes referred by Pakistan Governments for river and basin management. The contents are summarized in Table 2.2.5.

Table 2.2.5 Other Relevant River and Basin Management Legislations

Document Name	Year of Publication	Main Contents
Water Sector Strategy	2002	Pakistan's policy of water resource development (utilization) to meet future water demand.
National Water Policy	2018	See 2.2.3.1
Canal & Drainage Act 1873, Forest Act	1873	An ordinance regulating the use of irrigation canals and the navigation and drainage of canals in northern India. The responsible organization, burden of expenses, etc. are stipulated.
Bengal Embankment Act	1882	Ordinance on Bunds in the States of West Bengal and Bihar, India. The responsible organization, burden of expenses, etc. are stipulated.
Andhra Pradesh Rivers Conservancy Act	1884	An ordinance on river conservation and land use in the Andhra region of Andhra Pradesh, India.
Orissa Public Embankment Construction and Improvement Act	1951	The legal rules governing the construction or improvement of flood control facilities by the government of Orissa, India.
Assam Embankment and Drainage Act	1954	Ordinance on embankment (embankment, dam) and drainage (Tunnels, culverts, ditches, channels, canals, siphons, and floodgates) in Assam district. Responsible organizations, cost sharing, land expropriation, etc. are stipulated.
Andhra Pradesh Irrigation (Levy of Betterment Contribution) Act	1955	Ordinance on Irrigation Facilities in the State of Andhra Pradesh, India. The responsible organization, burden of expenses, etc. are stipulated.
Bihar Irrigation & Flood Protection (Betterment Contribution) Act	1959	The Ordinance on the Construction, Improvement and Maintenance of Irrigation and Flood Protection Facilities (Canal, channel, reservoir, embankment, dam), State of Bihar, India. Responsible organizations, cost sharing, land expropriation, etc. are stipulated.
The Orissa Hydro-ElectricProjects and Flood Control Works (survey) Act	1961	An ordinance providing rules for the investigation of hydroelectric projects and flood control facilities in Orissa, India.
The Kerala Protection of Riverbanks and Regulation of Removal of Sand Act	2001	Ordinance to regulate the protection of riverbanks and sand extraction from rivers in Kerala, India, as sand extraction from rivers is a cause of riverbank collapse and biological environment destruction.

Source: Advisory Team

The Water Sector Strategy (2002) proposes a policy for medium- and long-term water resource development in Pakistan, but there is no mention of flood management. The rest are domestic laws of India, and similar laws are being developed in Pakistan based on these laws.

2.2.2 Activity 1-2: Analyze the Status of Important Policies, Plans, and Projects Necessary to Examine Flood Control Projects

In particular, it can be said that important policies related to flood control measures in Pakistan include the National Water Policy 2018 and the National Climate Change Policy 2021. As for the situation toward the implementation of flood control measures, priority projects were extracted from NFPP-IV and organized as FPSP-III, and FFC is searching for funds for these projects for the FPSP-III.

2.2.2.1 National Water Policy 2018

The National Water Policy 2018 was issued by MoWR in April 2018. It aims to: (1) recognize the emergence of new water disasters; and (2) provide an overall water policy framework and comprehensive action plan guidelines against the background of the shortage of drinking water and industrial water due to rapid population growth and the worsening of drought in the north and south due to the effects of climate change, while 95% of water resources are used for agriculture which is the cornerstone of the national economy. In addition, under the 18th amendment of the Constitution, the policy is positioned as a national framework for Provinces to develop sustainable M/Ps for water resource development and management, with sufficient Province autonomy. In particular, water-related sectors such as irrigation, agriculture, urban and rural water supply, and the environment are stated to be challenges for Provinces. The Water Policy lists 15 water concerns that need to be addressed, including the concentration and prominence of climate change impact on meteorological phenomena. To respond to these water crises, FFC recommends the implementation of four (4) key measures, including the establishment of an institutional framework that can address these issues. FFC has therefore proposed an organizational improvement plan. The policy was formulated in 2018 and approved by the federal government in 2022. National Water Policy states 11 items in Table 2.2.6 for nationwide flood control policies. Regarding zoning, etc., it is consistent with the policy of National Disaster Risk Management (2010) and NFNP-IV

Table 2.2.6 Provisions of National Water Policy 2018 on Flood Management

Provisions	Contents	Summary
Flood Management		
20.1.1	The Flood Protection Plans (National as well as Local) shall be updated periodically using integrated and innovative approaches, removing technical shortcomings and learning lessons from past major flood events	Update through an integrated approach
20.1.2	Flood zoning shall be established and appropriate land use would be enforced by avoiding the growth of such developments in flood hazard areas that would make the flood protection facilities vulnerable to failure. Where feasible, land use shall be adjusted to ensure compatibility with the frequency and duration of flooding	Zoning and Land Use Management
20.1.3	Flood Plain Mapping and Zoning shall be carried out along River Indus and its tributaries (Kabul, Swat, Jhelum, Chenab, Ravi & Sutlej) and a River Act shall be prepared for restricting/ prohibiting permanent settlements in high and medium flood risk areas	Formulation of the River Act
20.1.4	Reservoir Operational Rules shall be reviewed and optimized to ensure efficient and prudent decisions to control floods provided, however, that the safety of the dam, embankments, spillways, dam abutments, foundations and all other hydraulic structures is to be placed at no risk under any condition;	Operation of dam
20.1.5	Effective use shall be made of non-structural measures like flood forecasting and early warning systems to minimize flood losses through better forecasts and warning, through additional forecasting facilities, e.g. radars, and other monitoring equipment and flood forecasting computer software incorporating rainfall-runoff and hydrodynamic models;	Early warning system
20.1.6	The construction of additional flood protection facilities and improvement of existing infrastructure shall continue where needed, concurrently with the development of other measures specified here. Greater emphasis shall be laid on proper maintenance of the existing infrastructure and strengthening of vulnerable reaches of flood protection embankments	Improvement of river facility and enhancement of bunds

Provisions	Contents	Summary
20.1.7	The design and maintenance standards of existing barrages and flood protection structures shall be reviewed and changes made where necessary to bring them to the level of functional capability, reliability and safety	Maintain safety levels of the river facility
20.1.8	Hill torrent management for conservation and mitigation of floods shall be given due priority	Prioritization in hill-torrent management
20.1.9	Community-based flood disaster management initiatives shall be encouraged for effective mitigation of flood hazards	Encouragement of community-based flood disaster management
20.1.10	River flood classification shall be reviewed and enforced as per priority – main rivers, secondary rivers, tertiary rivers, nullahs, streams etc.	Flood classification
20.1.11	Level of Arboriculture shall be increased to work as water storages for reducing run-off and flood peaks	Implementation of arboriculture
Urban Storm Management		
20.2.1	The drainage system of major cities shall be rehabilitated/ upgraded keeping in view the damages/ inconveniences caused to increased population and due to the likely increase in short-duration intense rainfall events attributed to climate change	
20.2.2	Delineation of flood plains will be carried out and legislation would be recommended to impose a ban on all types of construction in those plains except that aimed at flood management.	
20.2.3	The capacity of WASAs and other municipal-level organizations will be built to deal with the planning, execution and management of schemes aimed at the prevention of urban flooding.	
20.2.4	In the cities prone to urban flooding, dedicated warning systems will be installed to make accurate forecasts in the wake of extreme events induced by climate change.	
20.2.5	Steps will be taken to promote bio-engineering measures against urban flooding along with structural and non-structural measures.	

Source: National Water Policy 2018

2.2.2.2 Current Status of NFPP-IV

(1) NFPP-IV and FPSP-III

As of January 2023, the government budget for NFPP-IV (362 bil. PKR), which was formulated in 2015, has not been allocated and the project has not started. As a result, FFC has selected significant projects and rearranged it as the FPSP-III. It has applied for implementation funds through the EDA to several donors including ADB and JICA; however, has not secured a budget on March 2022. As of March 2022, ADB was expected to be the most likely source of funding (ADB responded that it would consider it positively), and it was working to secure it. As of November 2022, ADB sent a consultant team to FFC to formulate FPSP-III, and the results will be received in March 2023 by FFC.

As shown in Table 2.2.7, about 80% of FPSP-III projects are occupied by Flood Protection Works in terms of budget. According to the Bund (bund or dike) manual, the Flood Protection Works mainly refers to the improvement and construction of river bunds and spur dikes, and this indicates that these restoration and construction projects are major projects for flood control measures.

Table 2.2.7 Share of Bund Improvement Projects among FPSP-III Projects

Item No.	Particulars	Project Cost (1 million PKR)	Percentage of Total (%)
1	Construction of new bund (Flood Protection Work)	11,787.50	12.3
2	Reinforcement and repair of bund and construction of river facilities such as spur dike (Flood Protection Work)	64,264.98	67.0
3	Nonstructural measures (Telemetry Systems, etc.)	19,927.00	20.7
Total	Total operating costs of FPSP III	95,980.00	100.0

Source: Advisory Team

(2) Past Fundings by FPSP

FFC has formulated three (3) 10-year National Flood Control Plan (NFPP-I-III) for the period 1978-2007. Under the plan, 874 large and small flood control projects have been implemented in Pakistan's major and minor river basins. NFPPs form the basis of Pakistan's flood control projects, and ADB

provided loan assistance for the implementation of NFPPs from NFPP-II as a Flood Protection Sector Project (FPSP) from 1989 to 2007. Most of the ADB loan was used for flood control measures (improvement of flood control facilities such as embankments); however, the progress of the project was significantly delayed, and the FPSP ended before the planned loan amount could be used.

ADB's loan for the flood control project plan of NFPP-IV (2015-2025) was not planned when NFPP-IV was formulated. Looking at the track record of ADB's cooperation since 2010, it has shifted from cooperation in NFPP flood control projects focused on structural measures to disaster recovery and reconstruction support, such as the restoration of facilities damaged by floods and the development of flood disaster risk funds. It is speculated that ADB would shift to a cooperation style and reach the present.

Table 2.2.8 Implementation Progress for Past NFPPs and FPSPs

Cost Million Rupees

No.	Plan/Project	Period	Proposed Schemes		Executed Schemes		Remarks
			No.	Estimated Cost	No.	Estimated Cost	
1	NFPP-I	1978-1988	840	9,500	311	1,730	100% by GoP
2	NFPP-II	1988-1998	735	8,500	180	1,419	100% by GoP
2A	FPSP-I	1989-1997	256	4,556	256	4,735	80% by ADB & 20% by GoP
3	NFPP-III	1998-2008	439	11,703	383	4,292	100% by GoP
3A	FPSP-II	1998-2007	391	13,877	101	4,165	80% by ADB & 20% by GoP
3B	Lai Nullah Flood Forecasting & Warning System		1	348	1	348	97% by Japanese Grant & 3% by GoP
NFPP-I, II, III			2,014	29,703	874	7,441	
ADB: Asian Development Bank IDA: International Development Agency GoP: Government of Pakistan							

Source: Development of National Flood Protection Plan-IV

(3) Past Fundings by FPSP

In June 2023, FPSP-III was approved by MoPS-PC and became operational. Multiple development donors have offered funding, probably due to the trend of assistance for recovery and reconstruction from the 2023 flood damage. The total cost of the FPSP-III project is about 194bil. PKR, and the proportion of measures is 159bil. PKR for structural measures (151 projects) and 35bil. PKR (13 projects) for non-structural measures. The resource share of the FPSP-III is planned to be 155 bil. PKR (80%) from development donors and 19 bil. PKR (10%) each from the government of Pakistan and provincial governments.

On the other hand, the total amount of funds offered by all development donors is 316 bil. PKR, which exceeds the total estimation cost of FPSP-III projects. Each donor does not link the investment funds to individual projects, and the funds will be managed and utilized by the PIDs.

In addition, each development donor is implementing rehabilitation and reconstruction projects separately from FPSP-III (for example, “Improvement Water Management and Irrigation Systems in Punjab (IWWISP, funded by the World Bank)” and “Sindh Flood Emergency Rehabilitation Project funded by the World Bank)” etc. In case the project content overlaps with FPSP-III, the list of FPSP-III projects will rearranged as appropriate through FFC-PID and MoPS-PC.

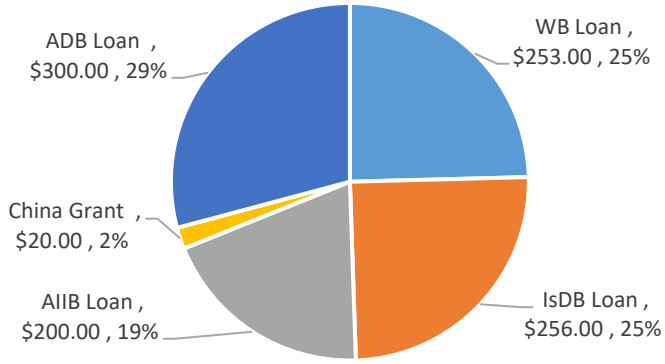


Figure 2.2.5 Status of Funding Application from Various Development Donors for FPSP-III

2.2.2.3 Climate Change Policy (NCCP)

Ministry of Climate Change (MoCC), in collaboration with UNDP and relevant government agencies, updated the National Climate Change Policy (NCCP) 2012, a framework for adaptation and mitigation of climate change, in accordance with the Paris Agreement (COP 21, 2015), including mitigation of greenhouse gas emissions, which was approved by the Office of the President of Pakistan in October 2021.

NCCP 2021 specifies policy measures for climate change adaptation in water resources, agriculture and livestock, health, forests, biodiversity, other ecosystems, disaster preparedness, socioeconomic sectors, and climate change mitigation in energy generation, energy efficiency and conservation, transportation, urban planning and waste management, industry, agriculture and livestock, and carbon sequestration and forests.

In particular, in the area of disaster preparedness, the report recognizes that "Climate change has the potential to increase climate-related natural disasters such as floods, droughts, cyclones, landslides caused by heavy rains, urban flooding caused by storms, and drainage; Pakistan is particularly affected by climate change, although there are uncertainties" and provinces that the impact can be minimized through adaptation measures and preparedness. The policy does not mention the climate change analysis presented by MoCC at FFC monsoon conference; however, MoCC official said that the results of the analysis were analyzed by region and season throughout Pakistan, and the impact on precipitation were also analyzed. As NFPP-IV states that response to adaptation measures for climate change impacts is one of the issues, it will be necessary to propose and implement adaptation measures based on this policy in the future.

2.2.3 Activity 1-3: Analyze the Current State of Hydrological Observation, River Survey, Basin Survey and Hydrological Analysis

2.2.3.1 Status of Hydrological and Meteorological Station Network

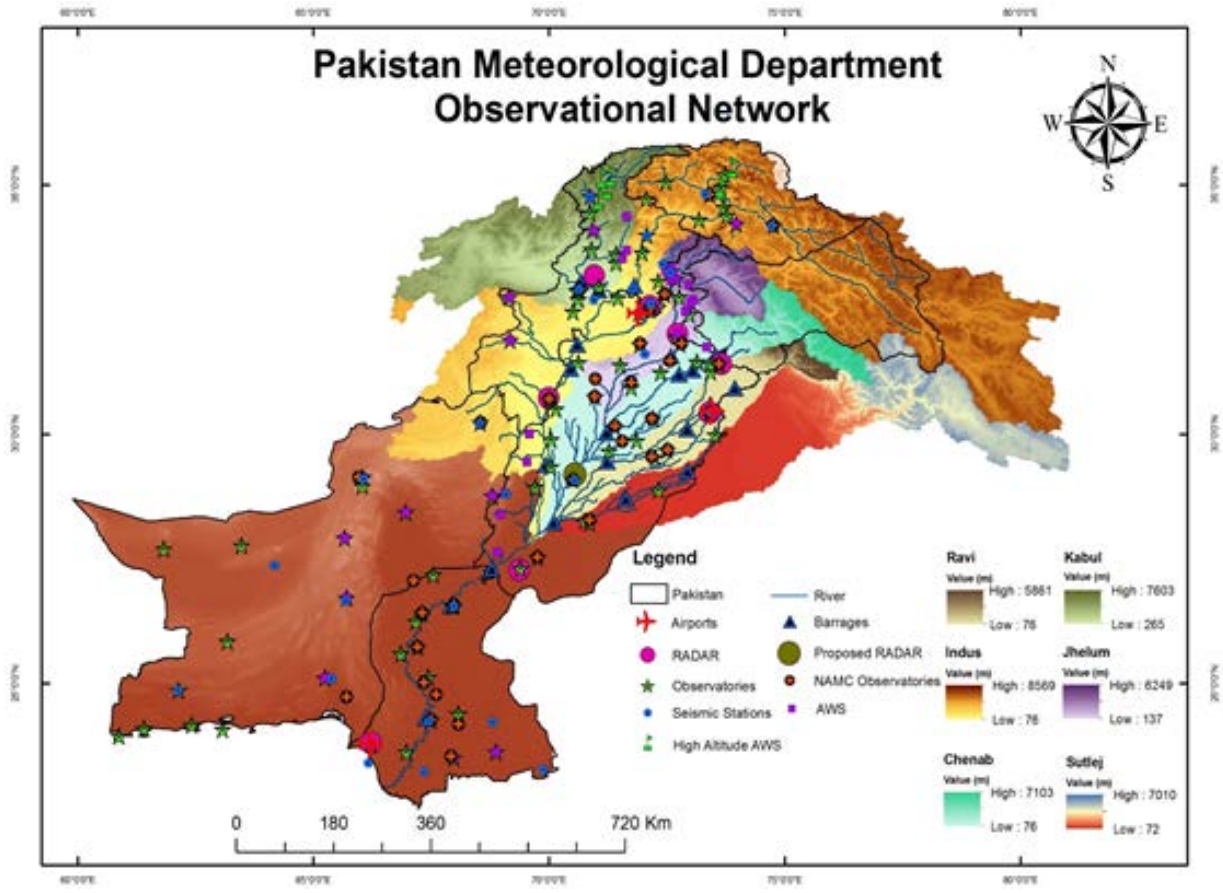
In Pakistan, hydrological and meteorological stations are installed and maintained by WAPDA, PMD and PIDs. In addition, hydrological observation stations have been set up in the basins of major rivers and tributaries to observe the river discharge in the weirs of major rivers.

WAPDA has established hydrological observatories in the basins of major rivers and tributaries for the purpose of managing river facilities such as dams with associated protection works, barrages, and canals on major rivers, and also conducts discharge flow measurement/observation at major barrages. PIDs also set up hydrological observatories near irrigation facilities and their controlled basins, and mainly manually observe water levels, discharges, and rainfall. The observation data is utilized for planning, design, and operational management of waterways and river facilities under the direct control of each provincial agency. PMD mainly establishes meteorological observatories, analyzes and forecasts weather, and attempts to forecast and warn of floods based on flood arrival time such as WAPDA and other meteorological disasters. Unfortunately, flood predictions do not use runoff analysis models, but are based on comparisons between observed flow discharges (calculated from water level and discharge rating curves in each barrage) and planned values, as well as pre-calculated flood arrival times (between barrages) and contacted FFC.

(1) PMD Surface Hydrological and Meteorological Stations

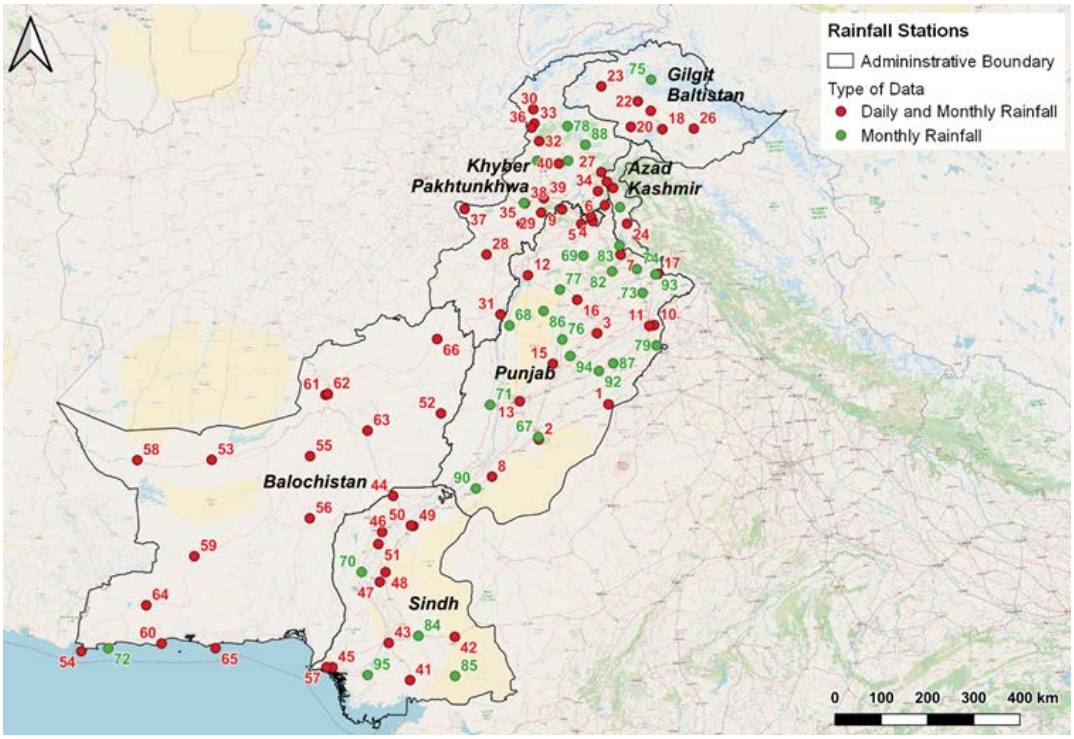
PMD has about 100 manual observatories (confirmed 93 stations on the PMD Map), around 40 automatic weather stations (AWS), other non-disclosed stations (more than 60), and 8 radar stations.

The location map covering all existing observation stations is shown in Figure 2.2.6(according to PMD, some names are omitted). Of these, manual precipitation observation stations are shown in Figure 2.2.7; and existing and planned radar stations are shown in Figure 2.2.8.



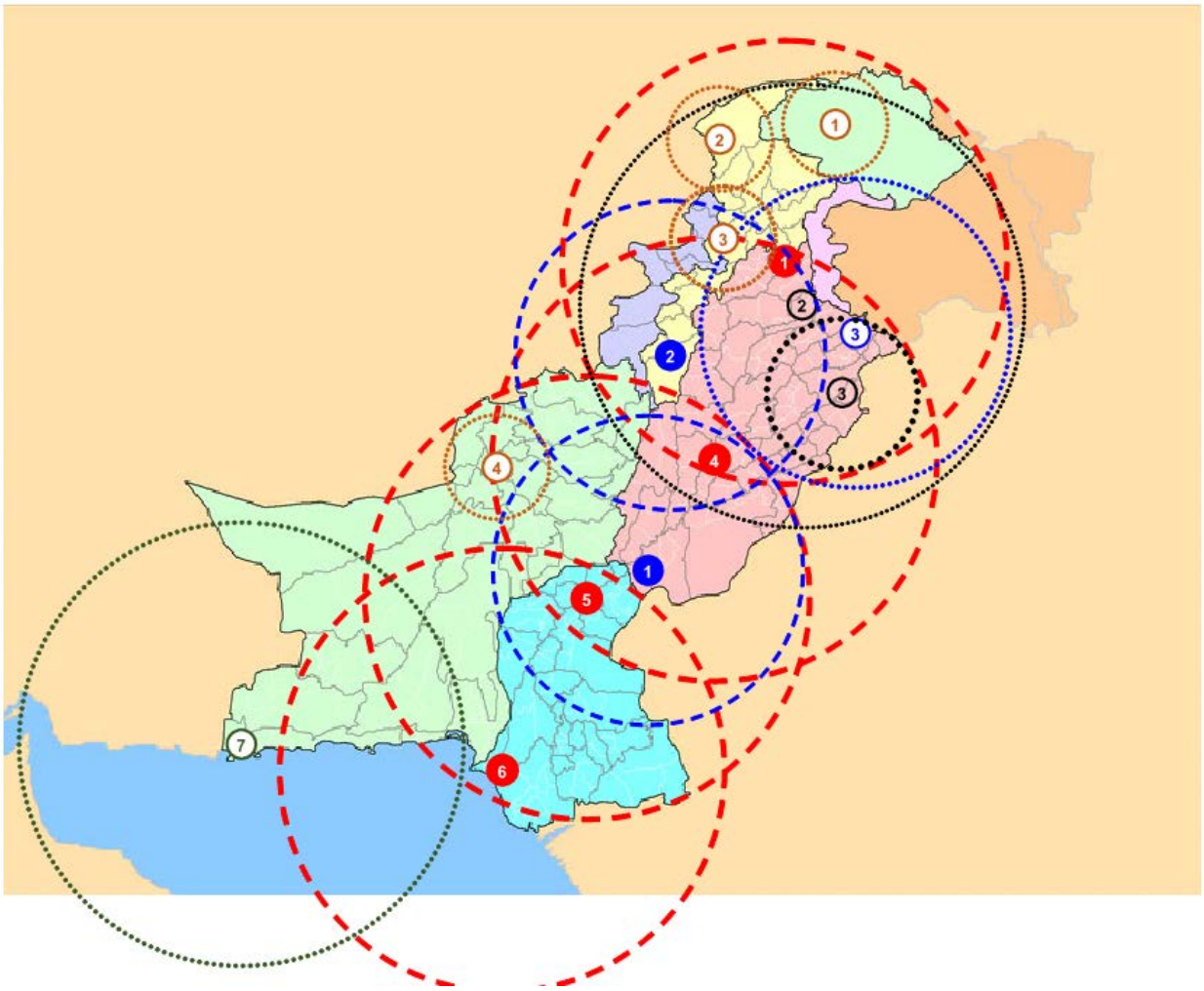
Source: PMD

Figure 2.2.6 Location of PMD Stations



Source: PMD

Figure 2.2.7 Location of Manual Rainfall Stations



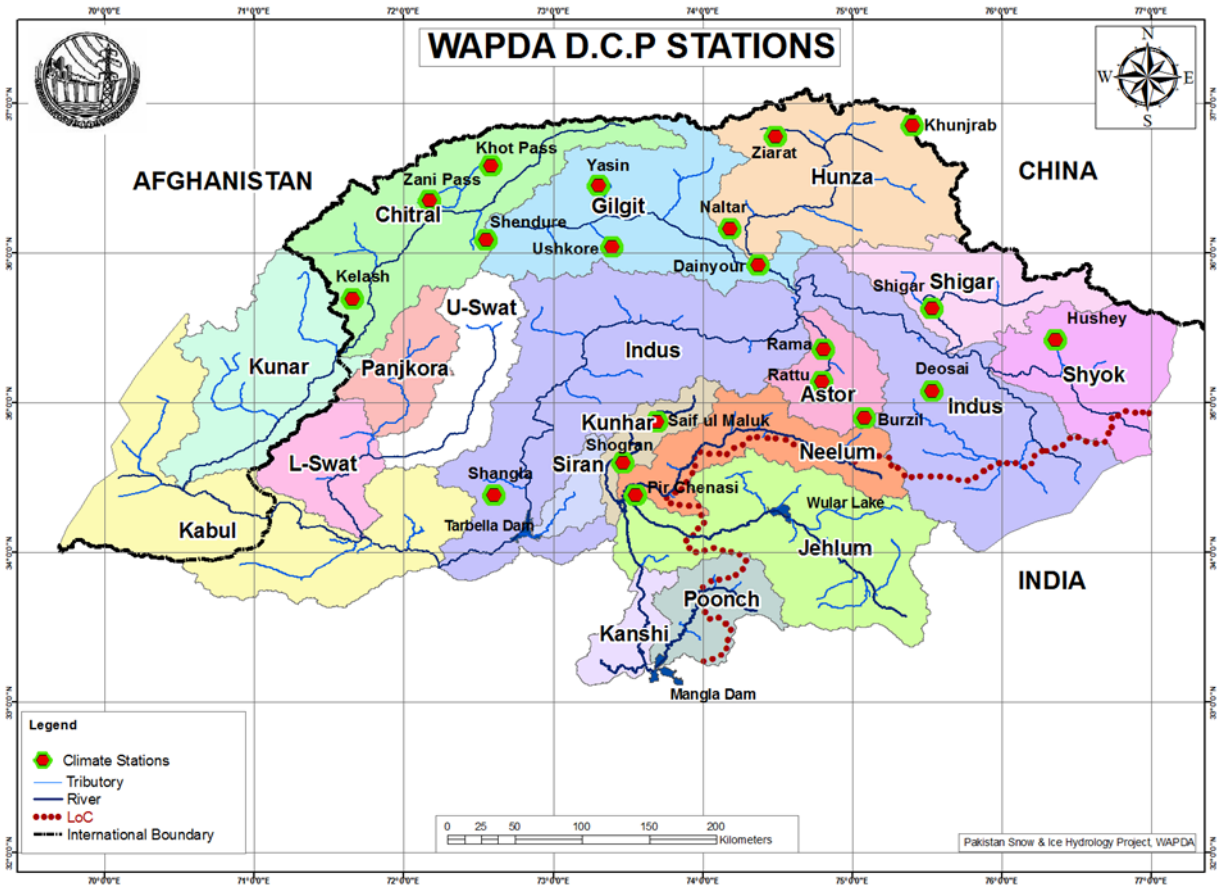
Source: PMD

Figure 2.2.8 Location and of Existing and Planned Radar Stations(Fill-Colored: Existing, Others: Planned. Red: S band, Blue: C band, Brown: X band)

(2) Ground Hydrological and Meteorological Observatory of WAPDA

WAPDA's network of ground-based observatories currently includes 679 manual observatories and 59 automated observatories (AWS). Most of stations will be upgraded and automatized in accordance with the National Master Plan for telemetry network system funded by ADB. The JICA Advisors are currently requesting the submission of comprehensive location maps and metadata of all these stations.

WAPDA has installed observatories near glacial lakes and is monitoring the movement of glacial lakes at 21 locations.



Source: WAPDA

Figure 2.2.9 GLOF Monitoring Stations by WAPDA

2.2.3.2 Status of River Surveys

(1) Longitudinal and Quality Data of Bund

According to the FFC staff, the longitudinal diagram of bunds and water level in case of flood have been prepared in each province and are not consolidated in FFC. Both FFC and PIDs were requested to provide the information through ZOOM and "face to face" meetings, field visits, seminars, etc., but unfortunately the consolidated data could not be detected even in each PID. According to one of the former senior chief engineers of Punjab-PID (the highest position among PID technical staff), who is a member of JICA advisory team, such information on embankment specifications has never been consolidated and organized even in PIDs.

After the 2010 floods, ADB and Public Sector Development Program (PSDP) funds to raise bunds to levels that could withstand the 2010 floods. But PID said that the bund level data are not available to gain at this time. NFPP-IV (2018) included the current bund level at the time of formulation; however, there is no information to distinguish whether it is before or after raising the bund. In addition, the current bund level in NFPP-IV was only the information of the bund around the barrages. In the future, FFC and PIDs need to clearly indicate and manage the current bund height across the rivers and improve the quality of the bunds to efficiently protect living people and their assets in the back of bunds.

At the 2nd Workshop (Bund O&M), PID-Sindh province informed the river mainline (streamline) using satellite images, etc., and discussed how to strengthen the bund in the water colliding area. In addition, Sindh is conducting a survey on the vulnerable bunds of the Indus River channel, as shown in Figure 2.2.10. These specific locations were organized in the Sindh Contingency Plan (2023), which is believed to have been the basis of the FPSPIII request.

Regarding the river cross section, we have obtained information that there is one near the barrage (for creating the HQ curve); however, it cannot be seen at other points. Since it is a vast river, it is difficult to imagine that periodical measurement of the cross-sections is made at points other than barrages, as in Japan.

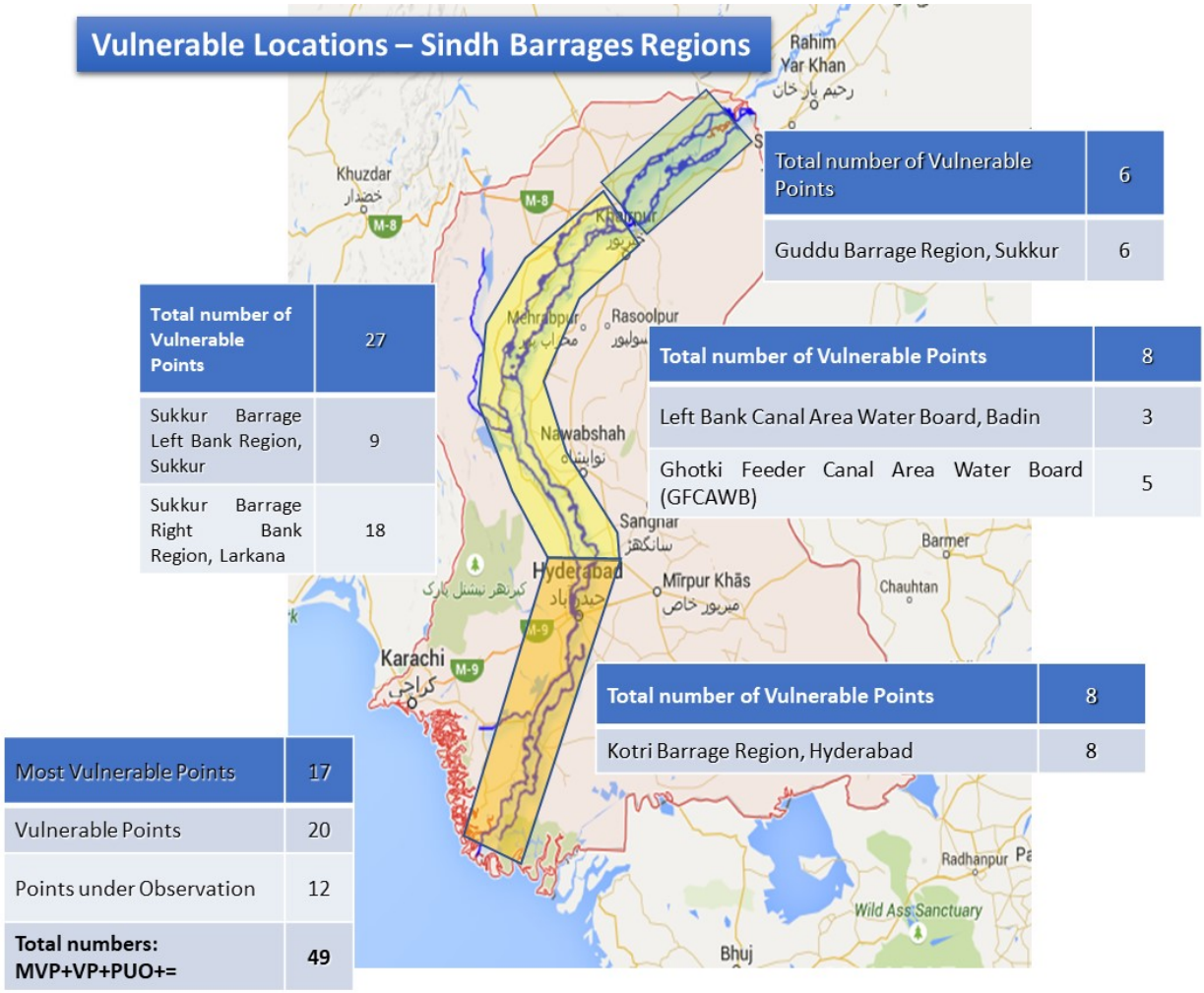
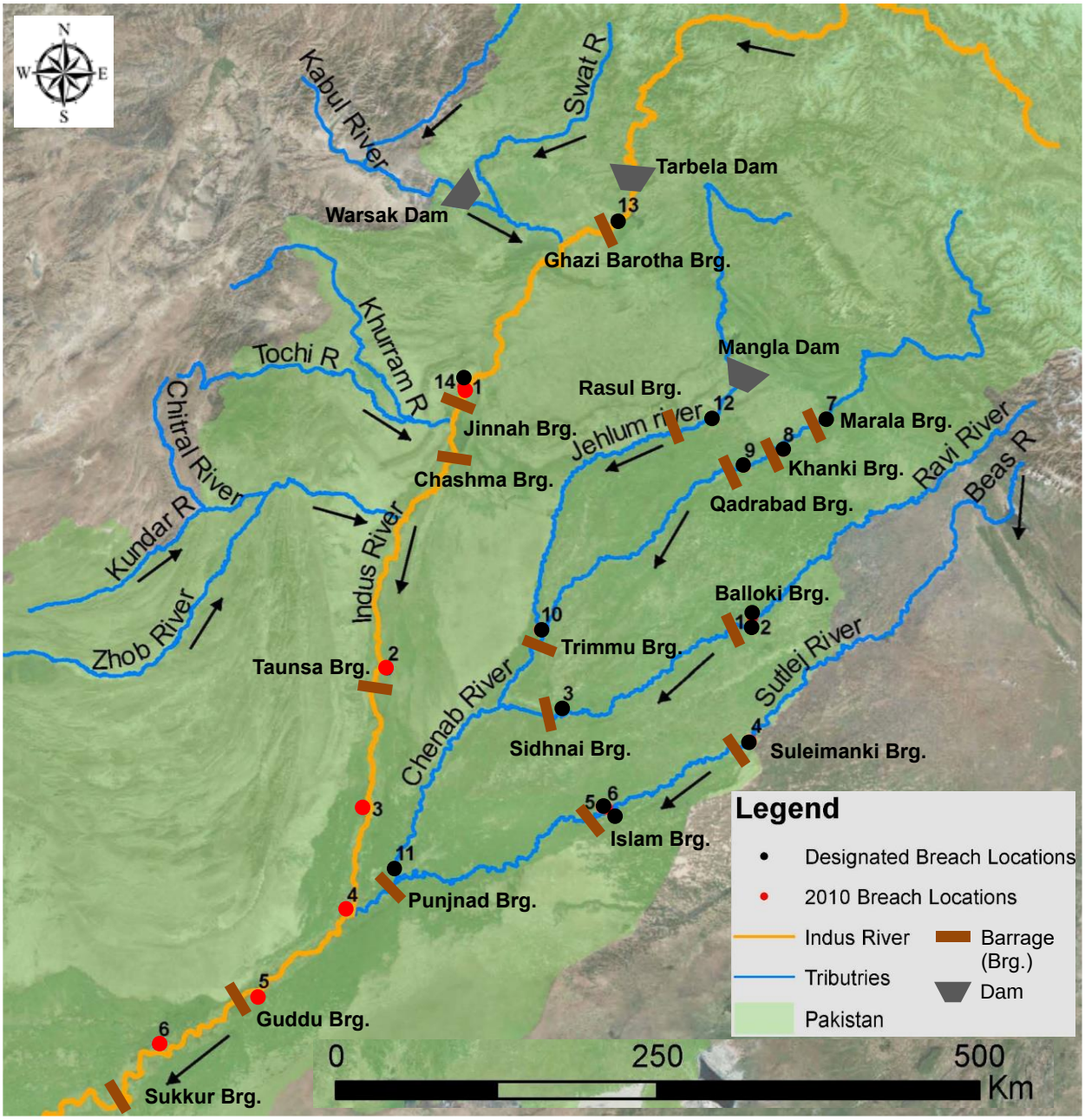


Figure 2.2.10 Vulnerable Points in the Bunds of Indus River

(2) Designated Sites of Artificial Breach and Sites of Natural Breach Caused by the Flood in 2010

In the main river of the Indus River and its main tributary rivers, planned flow rates (water levels) are set at major intake weirs, and when a flood of a scale exceeding this level occurs, some of the flood flow is discharged outside the flow channel of the river by artificially cutting off the bunds in the upstream of the weir or embankment of approach road (called Breach) to prevent fatal damage of barrages and bridges. According to NFPP-IV, there are 14 designated Breach sites, which are located upstream of the Barrage. The following figure shows the 14 designated Breach points, and the following table shows the list of weirs with designated Breach points upstream of the weir.

The decision on whether to breach the embankment is made by the Coordination Committee (PID, District Administration, Army, Provincial Highway Department etc.). FFC established the above committee and approved the SOP for artificial notches. Breach (by explosion, etc.) is carried out by the Army.



Source: NFPP-IV

Figure 2.2.11 Locations of the Breach Designation Upstream of the Barrage and the Breach Site during the 2010 Flood

Table 2.2.9 Barrage with Breach Designation Upstream of the Barrage

Serial No.	River Name	Barrage Name	Barrage's Planned Flow Rate	
			[cu.ft/sec (cfs)]	[m^3/s]
●1	Ravi	Balloki	225,000	6,368
●2	Ravi	Balloki	225,000	6,368
●3	Ravi	Sidhnai	175,000	4,953
●4	Sutlej	Suleimanki	325,000	9,198
●5	Sutlej	Islam	300,000	8,490
●6	Sutlej	Islam	300,000	8,490
●7	Chenab	Marala	1,100,000	31,130
●8	Chenab	Khanki	800,000	22,640
●9	Chenab	Qadirabad	900,000	25,470

●10	Chenab	Trimmu	645,000	18,254
●11	Chenab	Panjnad	700,000	19,810
●12	Jhelum	Rasul	850,000	24,055
●13	Indus	Ghazi Barotha	660,000	18,678
●14	Indus	Jinnah	950,000	26,885

Source: NFPP-IV

On the other hand, when the flood occurred in 2010, as shown in the following table, in the main river of the Indus River, in addition to the breach operation carried out at the designated breach location on the upper right bank of the Jinnah Barrage, the breach occurred naturally at 5 locations.

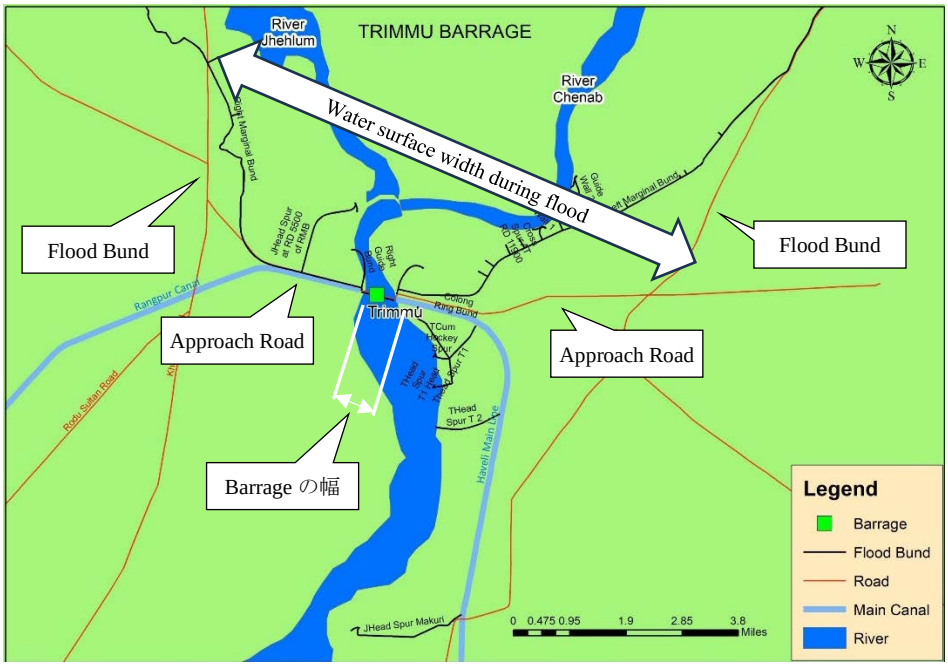
Table 2.2.10 Breach Locations During the 2010 Flood

Point No.	River Name	Location	Breach Length		Breach flow rate		Cause
			[ft]	[m]	[cu.ft/sec]	[m^3/sec]	
●1	Indus	upper right bank of the Jinnah Barrage	1,340	408	151,393	4,284	Artificial, normal operation
●2	Indus	Upper left bank of the Taunsa Barrage	7,410	2,259	125,000	3,538	Spontaneous occurrence: Foundation collapse
●3	Indus	Jampur Flood Bund and Allied Structures	2,354 696	717 212	7,300 3,200	207 91	Spontaneous: Piping (Penetrating Failure)
●4	Indus	Fakhar Flood Bund Fakhar Road Bund	565 2,467	172 752	7,540 52,700	213 1,491	Spontaneous occurrence: Overtopping
●5	Indus	Upper left side of Guddu Barrage	880	268	Unknown	-	Spontaneous occurrence: Cracks in bund body
●6	Indus	Tori Bund	7,874	2,400	Unknown	-	Spontaneous occurrence: Overtopping

Source: NFPP-IV

(3) Relationship between Barrage and the Bridge and Surrounding Embankments, Planned Breach Designated Locations

Barrages and bridges are constructed with facility widths and bridge lengths that match the width of the water surface during non-flooding. In contrast, the distance between the Flood Bund on the left and right banks is several kilometres, so the distance between the barrage or bridge and the Flood Bund is connected by an approach road. The top elevation of the Flood Bund and the approach road is the same, so that approach road does not overflow during flooding.



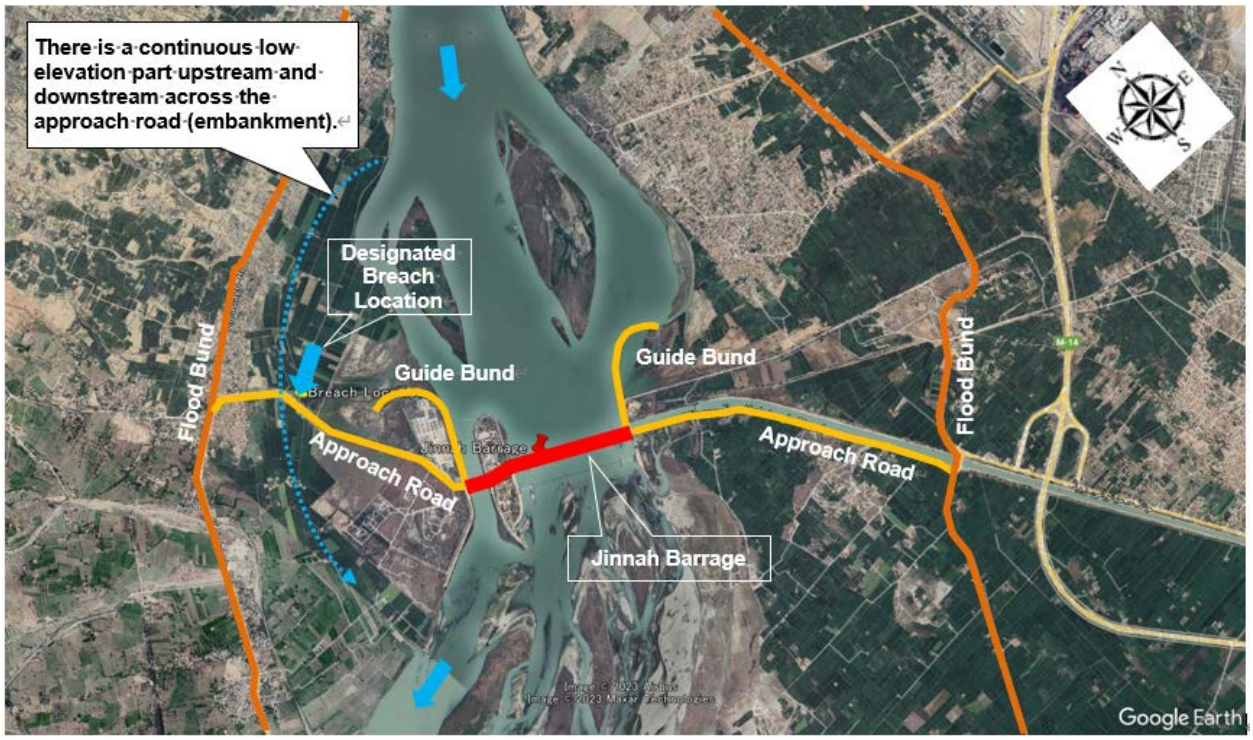
Source：Punjab Irrigation Dept.

Figure 2.2.12 Relationship between Barrage, Flood Bund and Approach Road (Exp. Trimmu Barrage)

The width at which river water can flow down is limited to barrage and bridge portions. Therefore, during a flood, these areas become constrictions, and as the flow rate increases, the water level rises, and the width of the flowing water extends to Flood Bund. After that, Breach may be required to ensure the safety of barrages and bridges when the river flow rate increases further and safety of strucrues are threatened, such as the risk of overflow in the barrage and major bridges.

When performing artificial and planned breach on barrages and major bridges, the location of Breach is predetermined. Artificial breach is designated as a place where there are traces of old river channels or where low elevations are continuous in the upstream and downstream directions of embankments, such as those that have been damaged by previously occurring spontaneous breach. Breach's determination of bunds is made by the Coordination Committee (PID, District Administration, Army, Provincial Highway Department). The FFC has approved the establishment of the above committee and the artificial cutout SOP. The execution of Breach (by blowing up, etc.) is carried out by the military.

The figure below shows the Breach designated location in Jinnah Barrage and the occurrence of Breach during the 2010 flood.



Source: Research Team, using Google Maps

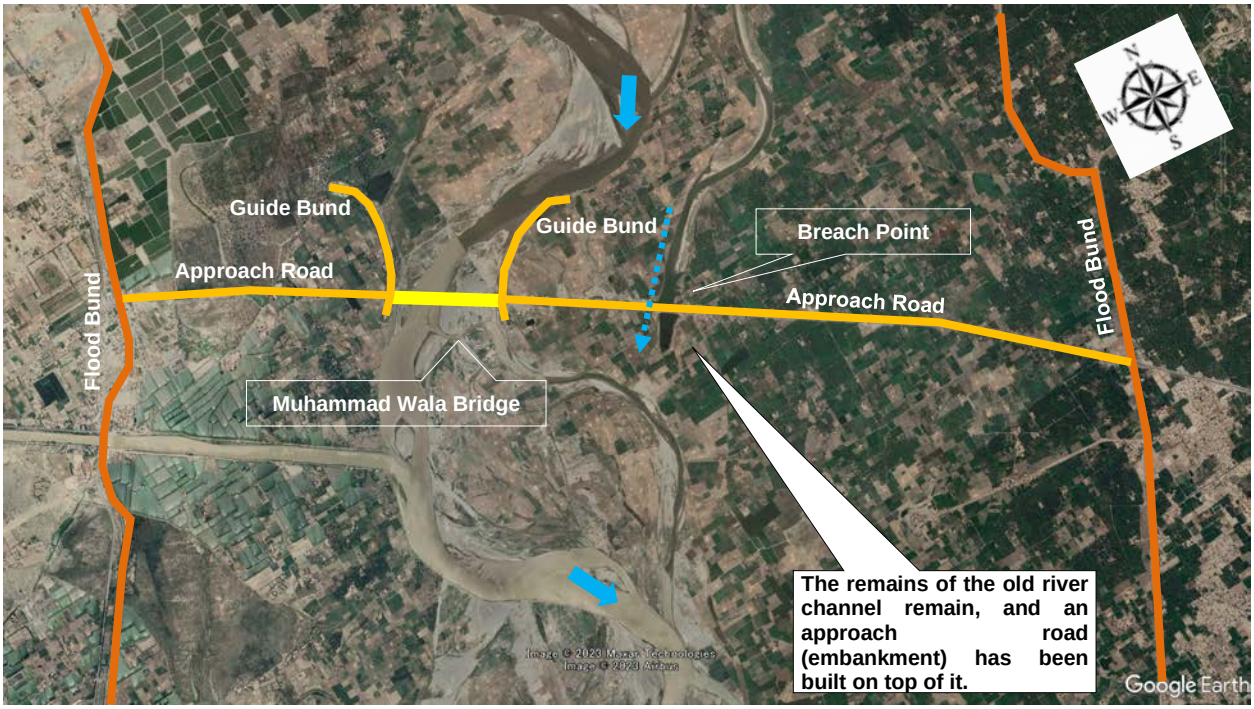
Figure 2.2.13 Designated Breach Location at Jinnah Barrage

Left: Approach Road Condition before Breah, June 2009 Right: After Rehabilitation of Breach Location , April 2011

Source: Research Team, using Google Maps

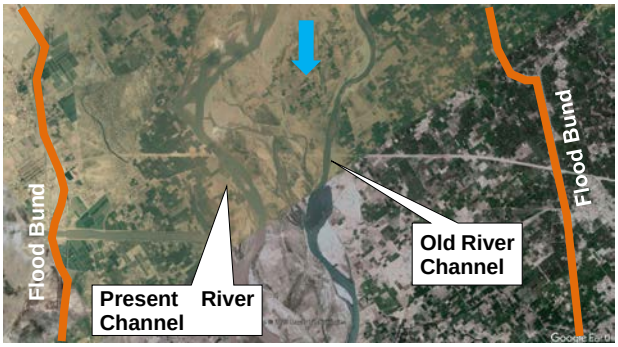
Figure 2.2.14 Conditions before and after the 2010 flood at the Breach site in Jinnah Barrage

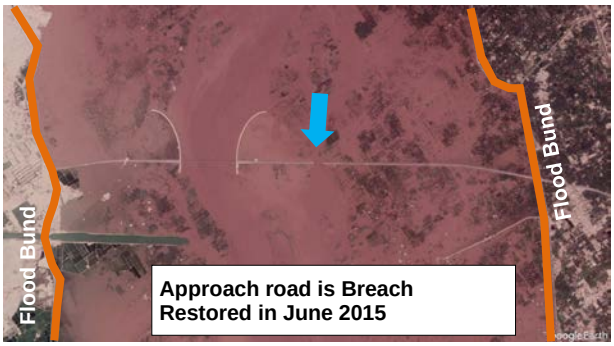
Examples of Breach on major bridges other than Barrage include the Breach designation of the Muhammad Wala Bridge over the Chenab River northwest of the city of Multan, and the occurrence of Breach at that point during the 2014 flood season.



Source: Research Team, using Google Maps

Figure 2.2.15 Relationship between the Breach designation of the Muhammad Wala Bridge and the embankment





Left: Situation before bridge R construction November 2009 Right: Breach situation during September 2014
Source: Research Team, using Google Maps

Figure 2.2.16 Breach outbreak at Muhammad Wala Bridge

2.2.3.3 Climate Change Research

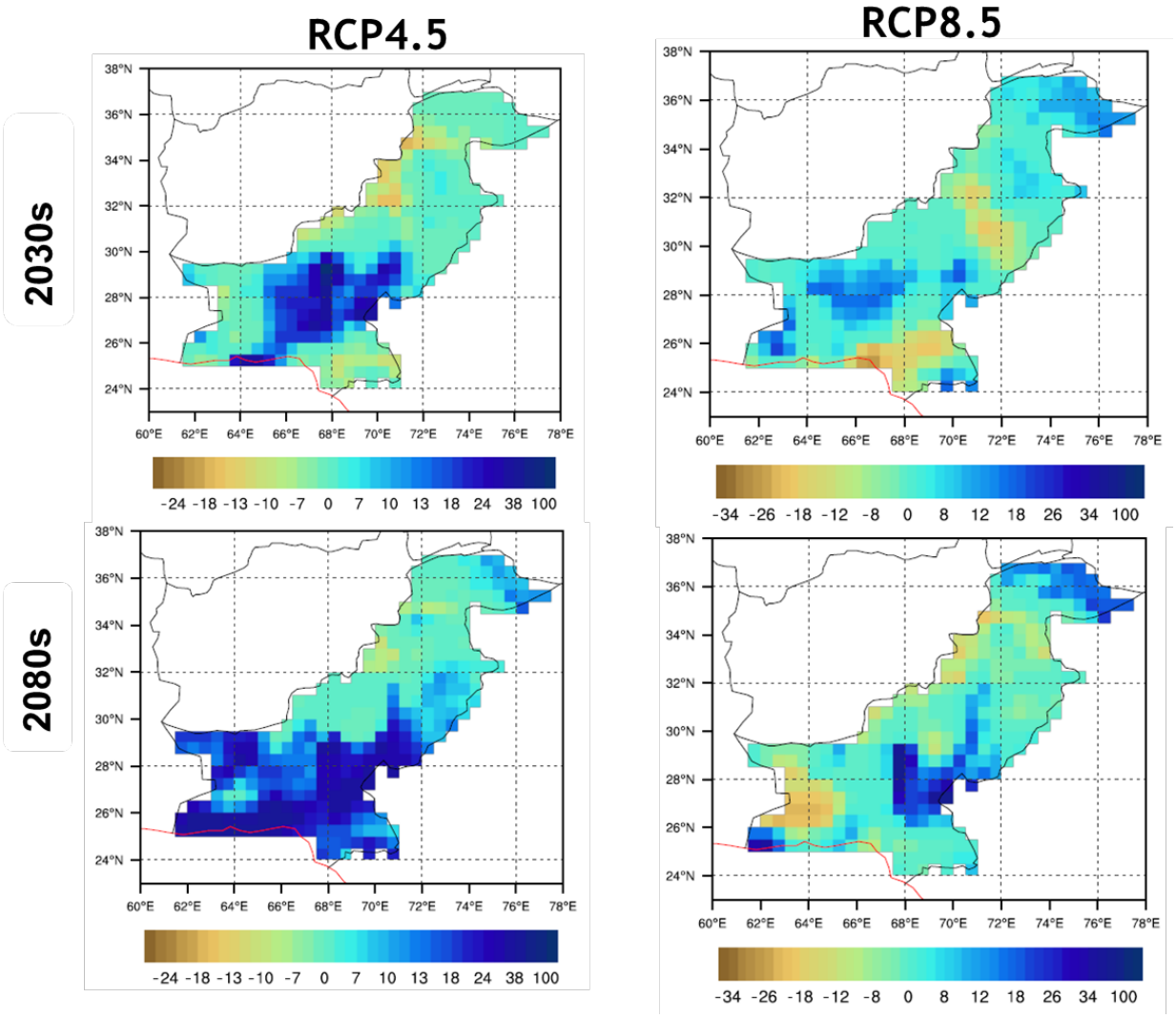
According to MoCC in the post-monsoon meeting (December 8th), the climate change impact analysis related to precipitation has been conducted for 2030 and 2080 year in major scenarios (see Figure 2.2.17). The seasonal analysis was also performed, as shown in Box 1.

Specific numerical analyses are mainly conducted by the Global Climate Impact Studies Center (GCISC). At present, there is no organized method for utilizing these analysis results in flood protection planning.

Box-1. Seasonal climate change impact on precipitation (excerpt from MoCC presentation)

- The precipitation has increased in all provinces for both seasons except AJK in summer, where it has decreased. The greatest increase in the monsoon season is observed in the GB region followed by Baluchistan province.

- The increment is higher in summer as compared to winter with September and June showing the greatest increase.



Source: MoCC

Figure 2.2.17 Changes in Future Precipitation in Pakistan

2.2.4 Activity 1-4: As to the Formulation of Flood Control Plan, Understand the Current Situation and Capabilities of FFC and Analysis Issues

For each national level flood control project, a basic plan is first proposed by PIDs and related organizations. Then, FFC conducts a technical review before incorporating the basic plan into NFPP. Based on this process, issues related to flood control project formulation were extracted from three aspects: (1) Policies, strategies, and systems surrounding project planning and management, (2) Technical content of NFPP-IV, and (3) organizational capability of FFC.

2.2.4.1 Policy/strategic/Institutional Issues Surrounding Project Planning and Management

(1) Difficulties in Overall Planning based on High-Level Policies

At the time of formulation in NFPP-IV (2018), there were no policies and strategies that would serve as higher level plans for national flood control plans such as the National Water Policy (2018). The National Water Strategy (2002) just describes a strategy for water use. Currently, the National Water Policy (2018) is the upper plan that indicates the policy of flood control. The flood control policy described in the National Water Policy is linked to NDMP-I (2010).

Therefore, at present, it is difficult to say that the concept of integrated flood management, which is particularly advocated in the National Water Policy, is properly mounted for the national-level flood control plan of NFPP-IV. In the future, FFC will need to formulate and revise the NFPP and flood control projects based on the National Water Policy, which outlines general flood control policies.

(2) Constraints in the Budgetary System

Even though FFC gave technical advice to the PIDs, if the project was implemented through the province's own budget or a contract between the province and the donor, the province is not obliged to report to FFC regarding the start and completion of the project. Therefore, it is difficult for FFC to grasp the development status of all flood control measures. If the NFPP-IV projects, which should be implemented with the province-federal joint budget, is implemented only with the province budget, it is possible that FFC will be not completely unpredictable for such projects.

So far, through hearings, workshops, and small meetings, PIDs have not disclosed the progress of NFPP-IV project, and FFC does not own it. PIDs may not be managing NFPP-IV projects properly. Under the circumstance that new projects will be proposed after the flood, in case ad-hoc management is implemented using PIDs' information system instead of returning to NFPP-IV, FFC will not be able to grasp the overall status of flood control measures.

(3) Lack of Opportunities to Understand and Update Flood Control Development Status

The vulnerability of the river channel may change even after a small or medium-sized flood; nevertheless, the construction/rehabilitation plan for river structures such as bunds and spur dikes (Flood Protection Works: FPW) will remain unchanged until December 2022. Since FFC does not have organized information on understanding river channel conditions after several floods, there may be already unnecessary or low-priority FPWs. Although the FFC is conducting inspections of individual projects through FMC meetings, etc., it has not been able to discuss and organize the progress and updates of the NFPP-IV project as a whole. Based on the history so far, it seems that the PIDs' follow-up to NFPP-IV or its project list has not been established.

2.2.4.2 Issues in the Technical Content of NFPP-IV

(1) Gap between Philosophy and Technical Content

The structure of the main report of NFPP-IV consists of an explanation of the need for integrated flood management in the first part and a list and summary of projects in the second part. It is becoming difficult to understand which region's safety should be secured by what kind of project combination. In other words, the relationship between protected areas and flood control facilities cannot be identified; and even if the proposed (non-) structural measures are listed, the extent of their effectiveness and roles is not clear. It is becoming difficult to find an integrated flood control management policy in the contents of the plan.

(2) The long-term perspective principle and its method are not shown

NFPP-IV is a 10-year plan, but the concept and methods of “how to proceed and approach to reach long-term target level for nationwide flood control” have not been organized. Until now, bunds have been constructed and raised whenever floods that exceed the past have occurred. An artificial bund breach is taking place. If these flood management methods are to be used in the future, the long-term flood management costs of flood management and damage compensation will also be adversely affected if the planning relationship between the two methods (bund constructions and artificial breaches) remains unclear.

(3) No Bund Information Necessary for Future Improvement of River Facilities.

NFPP-IV does not organize information on the current and planned bund levels, which are one of the most important flood control facilities on the Indus River. According to interviews with Punjab and Sindh PIDs, the only verbal explanation was that the level had already been developed with ADB funds after the 2010 flood, and there are no documents such as longitudinal and cross-sectional maps of the entire Indus River in the provinces that show this situation. Also, it is said that the flood level

in 2010 is the planned water level, but the Advisory Team is apprehensive that the flood water level in 2010 was due to the artificial bund breach upstream.

Although appeals were made to PIDs at every opportunity, they were never presented or made explicit. According to FFC officials and former Punjab PID Chief Senior Engineer (the highest position as an engineer) Mr. Qasim and others, the level and quality of bunds are not comprehensively organized, and it is difficult to submit them. If the Advisory Team visits to the local PID, it may be able to understand the situation in the archival rooms and with certain staff. In addition, since the bunds reinforcement project and its location are unclear in NFPP-IV documents, it is difficult for FFC to grasp the overall situation.

2.2.4.3 FFC Organizational Issues

(1) Insufficient number of personnel and limited capacity of the building

As mentioned above, half the number of the FFC technical staff are vacant. In addition, there are about four engineers who can respond to substantial discussions and questions with the Advisory Team as to flood management. The other Wing leaders also work almost alone during the busy season, so it can be a big deal to complete their work.

In addition, even if the vacancies were to be filled, there are almost no empty rooms at present, and even the office of the Advisors for this activity cannot be secured satisfactorily. The current building was originally occupied by FFC; however, it seems that the member of Ministry of Water Resources moved in and pressed the FFC members.

(2) No Visualization Information for Flood Management Communication during Monsoon Season

For flood monitoring and its information transmission, paper information from WAPDA, PMD, etc. is sent to about 20 line ministries through fax, telephone, letter, email, and committee. Instead of visual information, PMD and WAPDA mainly disclose and communicate information based on numerical values and standards.

(3) Information necessary for flood control planning is not managed properly within FFC.

FFC does not store electronic data (other than reports) used in formulating NFPP-IV, and the consultant who handled the formulation work discarded all the electronic data after storing it for five years. For future flood control planning activities, it is necessary to improve the data management method to be used in NFPP and various reports. As for FFC database, which seems to have been constructed in NFPP-IV survey, FFC does not possess and use it completely at the present time.

(4) Weak awareness of national project management

According to interviews with FFC staff, young executives are aware that they are not obliged to keep track of projects implemented by PIDS and others, even if they are NFPP-IV projects. In addition, the Advisory Team have participated in various FMC meetings so far; however, it seems that discussions focused on the progress of NFPP-IV itself have not been carried out. Although it is difficult to secure the budget, it is necessary to hold discussions in order to appeal to the executives of PIDs and FFC about the importance of project progress management for proper flood control in Pakistan.

2.2.5 Activity 1-5: Analyze the Status of Flood Control and River Crossing Facilities and the Situation of Operation and Maintenance of the Facilities

2.2.5.1 Standards Applied in Design, Construction and Maintenance of River Facilities

The officially recognized design standards for river facilities in Pakistan are the Manual of Irrigation Practice (revised in 2017) issued by the Punjab Irrigation Department and the Bund Manual (Version 4, 2008) issued by the Irrigation Department of Sindh.

In addition, other design criteria were created by FFC in the Second Flood Protection Sector Project - Package B: Capacity Building for Integrated River Management and Subprojects Implementation in 2001. and Methodology", and the design standards are currently (August 2023) in the process of being updated.

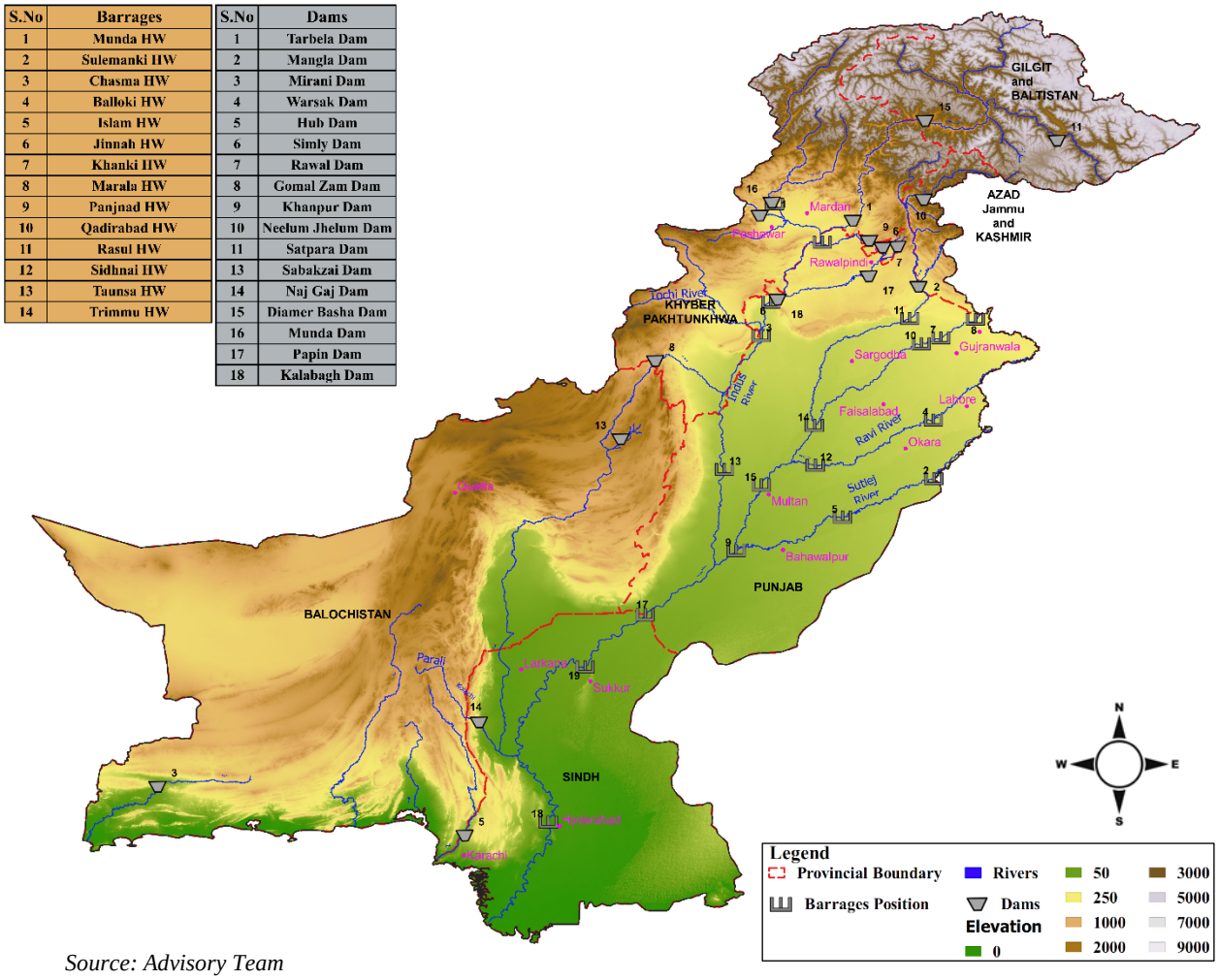
The design, construction, and maintenance of bunds in Sindh and Balochistan are conducted in accordance with the design standards of the Bund Manual, and the Manual of Irrigation Practice is the standard in Punjab and KPK.

As a countermeasure which is not described in the standard, since most of the construction materials of the embankment collected at the site are silty to sandy materials, a core made of cohesive soil is made in the center of the embankment to improve water sealing of the embankment.

Raw GIS or CAD data of the maps, which are attached to the NFPP-IV survey report, were not able to be obtained from FFC or NESPAK. Therefore, the Advisory Team is making GIS data base, which consists of the locations of dikes, water systems, weirs, dams, etc., by tracing the maps.

S.No	Barrages
1	Munda HW
2	Sulemanki HW
3	Chasma HW
4	Balloki HW
5	Islam HW
6	Jinnah HW
7	Khanki HW
8	Marala HW
9	Panjnad HW
10	Qadirabad HW
11	Rasul HW
12	Sidhnai HW
13	Taunsa HW
14	Trimmu HW

S.No	Dams
1	Tarbela Dam
2	Mangla Dam
3	Mirani Dam
4	Warsak Dam
5	Hub Dam
6	Simly Dam
7	Rawal Dam
8	Gomal Zam Dam
9	Khanpur Dam
10	Neelum Jhelum Dam
11	Satpara Dam
13	Sabakzai Dam
14	Naj Gaj Dam
15	Diamer Basha Dam
16	Munda Dam
17	Papin Dam
18	Kalabagh Dam



Source: Advisory Team

Figure 2.2.18 GIS Map Showing Topography and Locations of Facilities

With regard to the present state of bunds and water systems, the survey will be started after the data is consolidated and arranged by GIS or CAD and information on past river surveys is mounted. Regarding important river facilities such as dams and weirs, the status of their operation and maintenance will be investigated through hearings and documents.

As for FFC database, which is believed to have been constructed in the NPFF-IV survey, it is known that FFC does not possess it at this point. The JICA Advisors are waiting for a definite answer as to why FFC does not possess it.

(1) Overview of dams in Pakistan

In 2018, the Pakistan Committee of Large Dams (PANCOLD) obtained basic information on the dams from the provincial PID and WAPDA, which are the managers of each dam, and prepared a register of all dams in Pakistan and distributed them to the relevant parties. Since then, in line with the National Water Policy, several dam construction projects have been initiated, so an updated version of the dam registry was prepared in 2022 to include not only completed dams, but also dams in progress and planning.

Table 2.2.11 Overview of Provinces (Regions) and WAPDA Dams in Pakistan

Administrator	Completed (in operation)		Under Construction	Planning
	Dam	Water Storage Capacity	Dam	Dam
Punjab	74	0.667 MAF（823 MCM）	9	2
Sindh	80	0.291 MAF（359 MCM）	39	8
KPK (Including the former FATA)	51	0.413 MAF（509 MCM）	14	20
Balochistan	596	1.599 MAF（1,972 MCM）	56	397
AJ&K	-	-	-	34
WAPDA (Mega Dams)	9	14.360 MAF（17,712 MCM）	3	12
合計	810	17.324 MAF（21,369 MCM）	121	473

Note: MAF: Million Acre Feet, MCM: Million Cubic Meter, 1AF = 1,233.48m^3 (approx..200m x 20m x 0.3m)
Source: Pakistan National Register of Dams, PANCOLD/FFC, 2022

The above number of dams includes the number of weirs, check dams (sabo dams), and groundwater recharge dams (Delay Action Dams). Balochistan has a large number of dams, the majority of which are check dams and groundwater recharge dams with a storage capacity of several hundred AF or less. In terms of the scale of water storage capacity, the nine dams managed by WAPDA alone account for 83% of the country's total water storage capacity.

Table 2.2.12 Overview of WAPDA's 9 Major Dams

Dam	Bund Height	Water Storage Capacity	River	Location (Prefecture, Province)	Year
Tarbela	148 ft	7,614,000 AF	Indus	Haripur, KPK	1974
Mangla	147 ft	9,127,765 AF	Jhelum	Mirpur, AJ&K	1970
Warsak	76 ft	164,000 AF	Kabul (tributary of Indus)	Peshawar, KPK	1960
Gomal Zam	436 ft	898,270 AF	Gomal (tributary of Indus)	D. I. Khan, KPK	2012
Khanpur	120 ft	9,300 AF	Haro (tributary of Indus)	Haripur, KPK	1985
Darawat	118 ft	12,161 AF	Nai Baran	Hyderabad, Sindh	2013
Mirani	127 ft	369,690 AF	Dasht	Turbat, Balochistan	2008
Hub	154 ft	657,000 AF	Hub	Hub, Sindh/Balochistan	1979
Satpara	128 ft	93,081 AF	Satpara (tributary of Indus)	Skardu, GB	2013
Total	-	18,945,267 AF	-	-	-

Source: Pakistan National Register of Dams, PANCOLD/FFC, 2022

Of the nine dams under WAPDA-managed management, Tarbela and Mangla are the two largest in size, accounting for 88% of the WAPDA-controlled dams' storage capacity.

The Tarbela and Mangla dams do not have flood control capacity, but pre-discharge from the dam when flooding is expected during the flood season. It may lower the water storage level and can be considered to contribute to flood control. As part of WAPDA's Tarbela Dam Project, the Flood Management Manual was created in 2020.

(2) Tarbela Dam Flood Management Manual

In 2010, the flood flow of the Indus River exceeded all floods ever recorded, causing enormous damage to Pakistan. This event necessitated a review of existing reservoir operations to reduce the risk of possible future flooding, and WAPDA established the Tarbela Dam Flood Control Manual in 2020.

- Until then, reservoir operation methods were purely aimed at ensuring the safety of dams, and although it was confirmed that the water level of the reservoir rose within the range from the lowest to the full water level during floods, thereby attenuating the flood peak, it did not include specific provisions to intentionally control flood discharge in order to mitigate downstream flooding.
- If the discharge from the Tarbela Dam exceeds 600,000 cfs (16,980 m^3/s), villages located on the left and right banks about 40 km downstream of the Tarbela Dam will be flooded. For this reason, this manual proposes a routine for floods with inflows exceeding 600,000 cfs.
- Approximately 90% of the annual river inflow into the Tarbela dam reservoir is snowmelt, and the remaining 10% is due to rainfall in the catchment area upstream of the dam site (about 4,000 km^2), which is the most important flooding factor in the basin.
- The effective storage capacity of the Tarbela Dam (irrigation, hydropower) is 5.98 million AF (7.38 billion m^3), which is 9.3% of the annual inflow of 64 million AF (79 billion m^3) into the Tarbela Dam reservoir. The reservoir has a minimum water level of 1,392 ft and a high water level of 1,550 ft.
- According to hydraulic analysis, the reservoir inflow at PMF was 1,773,000 cfs (50,176 m3/s), which would result in a storage level of 1,552.2 ft. In the event of a simultaneous PMF and upstream natural lake failure, the reservoir inflow would reach 2,127,000 cfs (60,194 m3/s), with an estimated water level of 1,556.5 ft.
- The Tarbela Flood Management Committee makes decisions on reservoir operations during floods at the Tarbela Dam, which is responsible for developing flood maps, evacuation procedures, evacuation routes, and evacuation plans, as well as requesting assistance from the Army and other agencies.
- Ultra-high flooding is expected if the flow rate at the Bunji station located about 30 km upstream of the Tarbela Dam exceeds 300,000 cfs, or if rainfall of 4 inch (100 mm) per hour or more continues for 6 hours at the observation point near the Tarbela Dam. The Talbela Flood Control Commission will decide whether to discharge more than 520,000 cfs from the dam.

- **Table 2.2.13 Tarbela Dam Allowable Water Release**

Flood Scale	Discharge (cfs: cubic feet per second)
Low	250,000
Medium	375,000
High	500,000
Very High	650,000
Super High	800,000

Source: WAPDA, Tarbela Dam Project, Flood Management Manual 2020
1 cfs=0.0283cu.m/sec

After the Tarbela Dam began operations (1976), the maximum annual reservoir inflow exceeded 500,000 cfs only three times: in 1989 (510,000 cfs), 1992 (520,000 cfs), and 2010 (835,000 cfs). When the inflow into the Tarbela dam reservoir reached 835,000 cfs on July 30, 2010, the discharge from the dam was 604,000 cfs.

Reservoir Operation Rules

Water is stored while ensuring safety against overflow of the dam body.

Table 2.2.14 Operating Rules when the Water Level Rises / Falls

Storage Level	Normal	Drought	Memo
1500-1510	5 ft/day	5 ft/day	Allowed up to 10 ft/day depending on the situation
1510-1530	3 ft/day	5 ft/day	
1530-1540	2 ft/day	2 ft/day	
1540-1550	1 ft/day	2 ft/day	
When the water storage level drops	5 ft/day	5 ft/day	

Source: WAPDA, Tarbela Dam Project, Flood Management Manual 2020

Reservoir Operation Rules during a Very High Flood

In order to temporarily keep the flood peak flow of the Indus River in the reservoir and to prevent synchronization with the peak flow rate at the confluence with each downstream tributary, a controlled discharge with a permissible storage level according to the amount of inflow into the reservoir has been considered.

Table 2.2.15 Reservoir Inflow and Water Limit

Reservoir Inflow	Reservoir Water Level	Memo
Less than 1,000,000 cfs (28,300 m^3/s)	1551.50 ft	
1,000,000～1,400,000 cfs (28,300~39,620 m^3/s)	1552.00 ft	
1,400,000～1,773,000 cfs (39,620~50,176 m^3/s)	1553.50 ft	
2,127,000 cfs (60,194 m^3/s)	1556.50 ft	

Source: WAPDA, Tarbela Dam Project, Flood Management Manual 2020

At water levels below 1505 ft, the water is released only through irrigation tunnels, and when the water level is 1505 ft or higher, it is released through the spillway. Flow regulation is carried out by gate operation. By defining how to operate the reservoir at a storage level of 1550 ft or more, it can be considered possible to mitigate sudden flood peaks. In addition, based on the upstream flood warning information, it is possible to lower the reservoir and mitigate downstream flooding before the flood reaches the dam.

2.2.5.2 Design Flood Discharge and Maintenance Status of the Bund

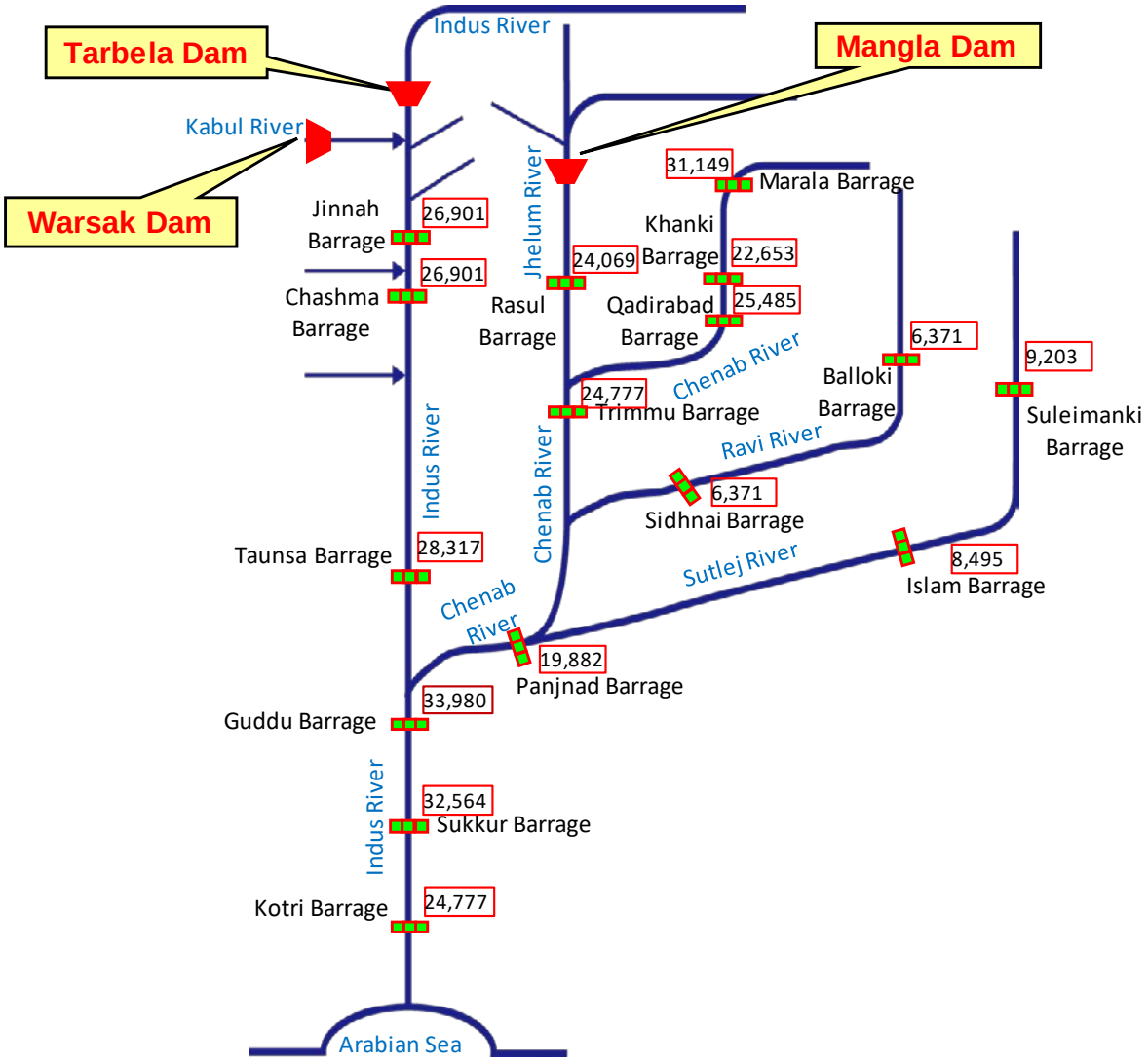
For the main river and tributaries of the Indus River, the designed-water level and maximum discharge amount (the maximum flow that can be discharged from a barrage) are set in the upstream of the barrages, but not at other point. These values are used to determine the operation of the barrages and the judgement of breaches. The conversion from water level to flow discharge can be easily calculated by discharge rating curves, and the discharge amount flowing downstream is always checked in all phases. It is very important to grasp the amount of flood runoff considering that the designed discharge in the upstream and downstream barrages is reversed in some areas.

Generally speaking, there is a primary bund directly connected to the barrage, and a secondary bund (embankment for roads and irrigation canals) outside of the primary one, so the plan probably relies on the reservation ability of water to flow the flood within the secondary bund. However, in the 2010 flood, flooding occurred in the hinterland over the secondary bund from near the Guddu barrage.

The design discharge of the Indus River should be designed in the condition of no overflow from river, considering the arrival of unexpected scale of flood water guided by raised bunds in the downstream in case of no breaches.

2.2.5.3 Designed Release Discharge of Barrages to Examine River Design Flood Discharge

In Pakistan, barrages have been designed with a focus on water utilization in accordance with the surrounding environment of rivers and the flow rate required for irrigation. Therefore, for example, the design flow is reversed upstream and downstream at Kotori (1955), which was built after the upstream Sukkur (1932) was completed. In 1955, the level of flood flow at the Kotori might be not so large due to flood overflows from the bund upstream.



Source: Advisory Team

Figure 2.2.19 Planned Maximum Discharge of a Weir in the Indus River System

Table 2.2.16 Design Flood Discharge and Water Level at the Barrages

Item No.	Name of Barrage/Syphon	River Name	Completion Year	Length		Design Discharge		Design Water Level	
				(feet)	(m)	(mil. CFs)	(mil. CMs)	(feet)	(m)
1	Jinnah	Indus	1939	3,780	1,152	0.950	26,901	N.A	N.A
2	Chashma	Indus	1971	3,556	1,084	0.950	26,901	N.A	N.A
3	Taunsa	Indus	1958	4,346	1,325	1.000	28,317	N.A	N.A
4	Guddu	Indus	1962	4,450	1,356	1.200	33,980	N.A	N.A
5	Sukkur	Indus	1932	5,280	1,609	1.150	32,564	N.A	N.A
6	Kotri	Indus	1955	3,000	914	0.875	24,777	N.A	N.A
7	Rasul	Jehlum	1967	3,209	978	0.850	24,069	N.A	N.A
8	Marala	Chenab	1968	4,475	1,364	1.100	31,149	N.A	N.A
9	Khanki	Chenab	1892	N.A	N.A	0.800	22,653	N.A	N.A
10	Qadirabad	Chenab	1967	3,373	1,028	0.900	25,485	N.A	N.A
11	Trimmu	Chenab/Jehlum	1965	3,025	922	0.875	24,777	N.A	N.A
12	Punjnad	Chenab/Jehlum/Ravi	1925	N.A	N.A	0.700	19,822	N.A	N.A
13	Ravi Syphon	Ravi	1965	N.A	N.A	N.A	N.A	N.A	N.A
14	Balloki	Ravi	1965	1,646	502	0.225	6,371	N.A	N.A

Item No.	Name of Barrage/Syphon	River Name	Completion Year	Length		Design Discharge		Design Water Level	
				(feet)	(m)	(mil. CFs)	(mil. CMs)	(feet)	(m)
15	Sidhnai	Ravi	1965	712	217	0.150	4,248	N.A	N.A
16	Suleimanki	Sutlej	1921	1921	586	0.325	9,203	N.A	N.A
17	Mailsi Syphon	Sutlej	N.A	1,601	488	0.343	9,713	N.A	N.A
18	Islam	Sutlej	1927	1,650	503	0.300	8,495	N.A	N.A

Source: Punjab Irrigation Department

2.2.5.4 Status of Bund Maintenance related to the Indus Main Tributary

(1) Previous Bund Design Standards

Past national plans, flood control projects, and design standards created by the Province indicate the design standards for bunds. Although uniform, compared to the design criteria in Japan, the values are generally appropriate.

Table 2.2.17 Previous Bund Design Standards

Document	Year	Height of Bund	Freeboard (above HFL)	Top Width	Side Slope (V:H)		Hydraulic Gradient	Back Berm (Pushta)	Stone Pitching
					River-**side**	Land-**side**			
NFPP-I	1978	HFL+FB	6.0 ft	20-25 ft	1:3	1:2	1:6 (assumed)	Min. 2 ft cover above HGL	For Severe wave wash damage
NFPP-II	1988	HFL+FB	USBR Approach	N.A	1:3	1:2	1:6 (assumed)	Min. 2 ft cover above HGL	For Severe wave wash damage
FPSP-I	1989	HFL+FB	6 ft (Indus/ Chenab) 5 ft (Ravi)	25 ft (Ravi/ Chenab) 30ft (Indus)	1:3	1:2	1:6 (assumed)	Min. 2 ft cover above HGL	For Severe wave wash damage
FPSP-II	2001	HFL+FB	6.0 ft	25 ft	1:3	1:2	1:6 (assumed)	Min. 2 ft cover above HGL	For Severe wave wash damage
Manual of Irrigation Practice, Punjab		HFL+FB	5.0 ft	16 ft	1:3	1 :2	N.A	Min. 2 ft cover above HGL	For Severe wave wash damage
Bund Manual, Sindh	2008	HFL+FB	4.0 ft	20 ft	1:3	1:2	1:6 (assumed)	Min. 2 ft cover above HGL	For Severe wave wash damage
NFPP – National Flood Protection Plan, HFL – Highest Flood Level, HGL – Hydraulic Grade Line, FPSP – Flood Protection Sector Project, FB – Freeboard, N.A – Not Available									

Source： Task-A Development of NFPP-IV and PC-1、Annex 3 Design Criteria

(2) NFPP-IV Bund Design Standards

NFPP-IV describes the following considerations for bund design. It is stated that specification decisions and technical studies will be made on scientific grounds.

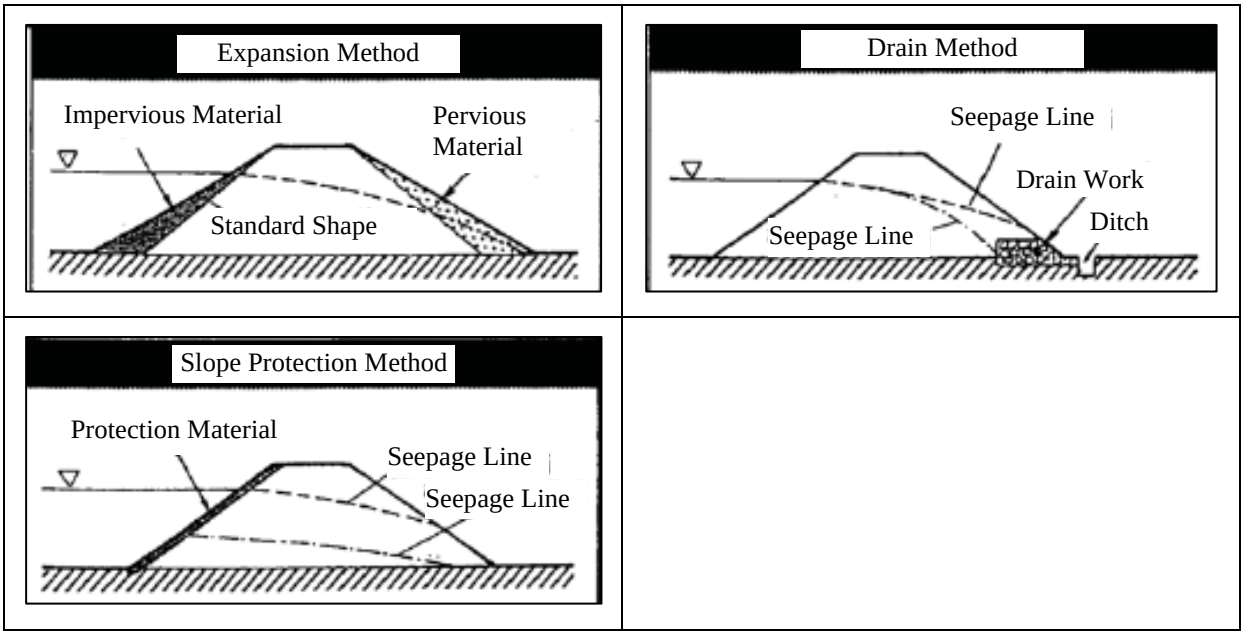
- Hydraulic studies
- Examination of embankment specifications (margin height, top width, slope slope, internal dynamic water gradient, etc.)
- Water control design
- Consideration of riverbank erosion and washing
- Consideration of seawall construction (Masonry)
- Geotechnical studies (soil surveys (on-site and indoor), earthquake studies, osmotic flow analysis, stability calculations (arc slip calculations), etc.)

1) Riverside Erosion

Although there are standards for water control work, there is still room for improvement in riverbank erosion countermeasures, such as the fact that revetment work specializes in stone cladding and there are few types of work, there is no mention of preventing the suction of the embankment, and there is little information on root consolidation work.

2) Destruction by Penetration (Slip Fracture)

There is a description of osmotic flow analysis and stability calculation (arc slip calculation), but there is no clear mention of countermeasures. The following countermeasure methods established in the Japan can also be procured in Pakistan and can be applied.



Source：Guideline of Structural Study of River Dikes, Japan

Figure 2.2.20 Countermeasures for Bund Infiltration Countermeasures for Bund Infiltration Destruction

3) Embankment materials and construction management standards

The Bund Manual, Sindh (2008) provides specific figures for desirable embankment materials, but limits the general description of construction management standards. NFPP-IV does not provide specific figures for embankment materials and construction management standards, but clearly states the frequency of compaction tests. In addition, both standards state that soil materials are used differently inside and outside the embankment (inside: sandy soil, outside: viscous soil).

According to information obtained locally (PID Punjab), although compaction is performed by bulldozers at the time of embankment embankment, sufficient compaction by rollers is usually not performed.

There is no control value set and it is left to the discretion of the designer or contractor. In addition, by using the embankment material internally and externally, construction may become complicated.

Table 2.2.18 Embankment Materials and Construction Management Standards

Item	Bund Manual, Sindh (2008)	NFPP-IV	Criteria for Japan (River Earthwork Manual)
Desirable embankment material	・It was recommended that sandy soils having 30% to 40% clay	・Sand cores are sometimes provided in bunds and embankments when constructed of clay soils.	・Maximum dimensions are 10~15cm or less (due to

Item	Bund Manual, Sindh (2008)	NFPP-IV	Criteria for Japan (River Earthwork Manual)
	content may be used for construction of bunds and embankments. ・Sandy material should be placed inside and clayey material at the outer side of bund.	・In Pakistan bunds constructed with sandy soils are covered with a six inch to one feet thick layer of clay.	restrictions on the thickness of the sowing at the time of construction) ・Fine particle content (0.075 mm or less) is 15% or more of soil material (to ensure impermeability) ・ Fine particle content 50% or less (because there is a risk of cracking when drying)
Construction Management Standards	・Proper compaction must be done carefully. Each layer must be consolidated thoroughly using rammers and rollers.	・The fill materials are spreaded at the location of structure in layers of specified thickness. Water is added and mixed thoroughly up to optimum moisture content. ・Compaction tests are performed to ensure the compaction of the fill. At least one test per layer per 500 ft length or as specified will be required.	・Average compaction degree: Dc = 90% or more ・Lower compaction quality limit: Dc=80%

Source：As described in the table

4) Maintenance and Management

NFPP-IV describes the following inspection items for existing bunds.

- Preparation for field survey (equipment necessary for survey, safety management)
- Periodic Inspection
- Annual inspection
- Non-flood season inspection
- Special Inspection
- Flood Inspection
- Post-flood inspection
- Post-earthquake inspection
- Details of inspection methods
- Inspection checklists and survey report sheet templates

Regarding the inspection method, the problem, points of interest, cause of the problem, future impact of the problem, etc. are carefully described, but an engineering perspective is necessary, and training of inspectors is necessary to conduct inspections appropriately. In addition, there is no description of the emergency recovery method, and the response after the inspection is entrusted to the on-site engineer. According to Indus Basin Floods Mechanisms, Impacts, and Management, 2013, ADB, "Province Irrigation Engineers maintain Barrage and Embankment, but they are not adequately skilled and do not manage them properly."

2.3 Activities Related to Output 2

Output 2: Support will be provided for confirming the progress of the 4th National Flood Protection Plan (NFPP-IV) and the implementation of flood control projects

2.3.1 Activity 2-1: Confirm the Budget Distribution Status Related to NFPP-IV and Analyze the Issues

As of January 2022, the federal budget has not been disbursed for NFPP-IV. Since the federal government was unable to provide funding, FFC identified priority projects as FPSP-III and approached development

donors for the funding. Around July 2022, ADB began to consider it positively. Since around November of 2022, consultants have been deployed and are conducting activities for the formation of FPSP-III. It was subsequently approved by MoSP-PC in June 2023. Information on this budget allocation is described in 2.2.2.2(3).

2.3.1.1 Situation of Budget Allocation

(1) Initial Budget Application Status and Results

The history of the budget application from FFC to the Federal Government at the beginning of the formulation of NFPP-IV is summarized in items i to iv below and Table 2.3.1.

i. NFPP-IV was approved by the Council of Common Interests (CCI), the highest interprovincial coordination body under the Prime Minister, on May 2, 2017 for a total cost of PKR 332.2 billion (Agreed to split the total amount of 332.2 billion PKR equally between the federal and state governments.)

ii. Various public sectors have applied to the Public Sector Development Program (PSDP) under MoPS for a total budget of PKR 70,000 billion for ongoing and medium- to long-term planned projects. The annual national budget is about PKR 8.5 Tri, and the annual average public investment is less than PKR 700 billion/year. However, this program no longer includes the NFPP-IV project.

iii. In 2019, FFC submitted a budget request to MoPS-Planning Commission (PC) for PKR 332 billion for all NFPP-IV projects, but the request was not accepted. According to FFC officials, the reason is not only that many projects have already been booked, but also that "flood control projects do not directly generate profits."

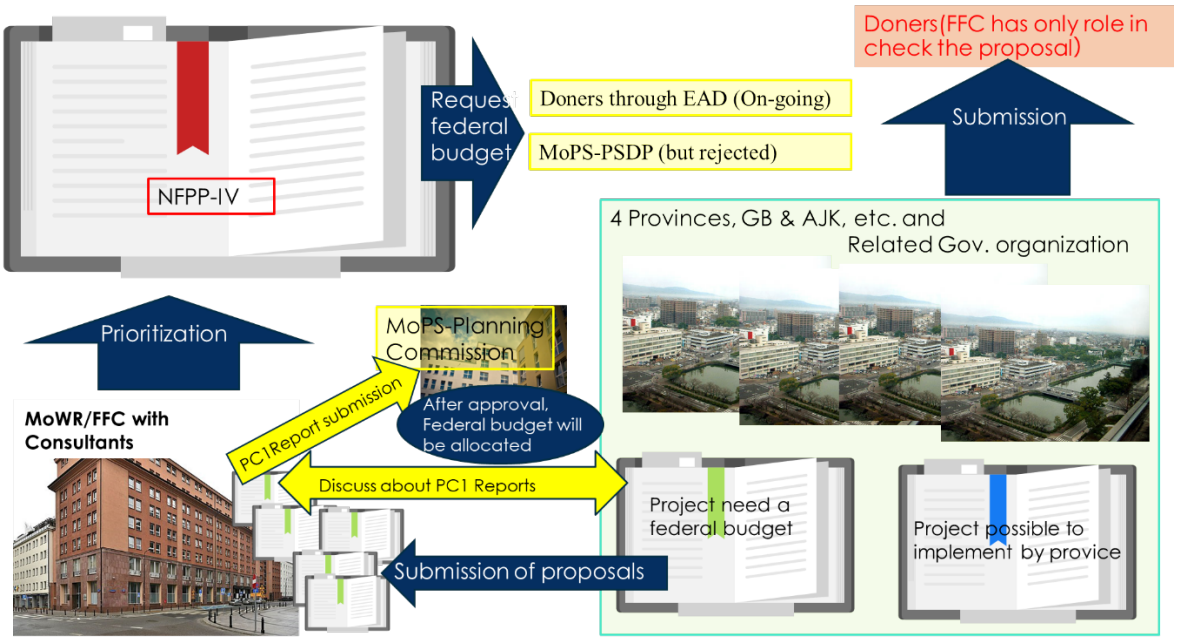
iv. As a result, the FFC narrowed its scope of projects down to a total PKR 95 billion (as a FSFP-III project) and applied to the Central Development Working Party (CDWP) under MoPS in 2020, which was also not accepted. After this, the Ministry of Economic Affairs (MoEA), when contacted by CDWP or FFC, has sent a letter to each donor section of Economic Affairs Division (EAD) in the Ministry asking about the possibility of securing funding sources. FFC also sent a letter directly to the EAD's Paris Club & ADB department.

The following table shows recent letter communications concerning the FPSPIII budget application.

Table 2.3.1 Letter on Securing Funding Sources for the FPSP-III Project

No	Date	Contents
1	July 16, 2020	Request Letter from EAD-MoEA to JICA
2	December 28, 2020	MoEA Internal Letter: Letter to all EAD development partner personnel. It is also well known that the CDWP has concluded that MoEA should seek funding
3	November 4, 2021	Request Letter from FFC - MoWR to EAD Department for Paris Club & ADB - MoEA
4	January 4, 2021	Request Letter from EAD-MoEA to USAID
5	January 28, 2021	Request from EAD-MoEA to Saudi Fund

Source: Advisory Team



Source: Advisory Team

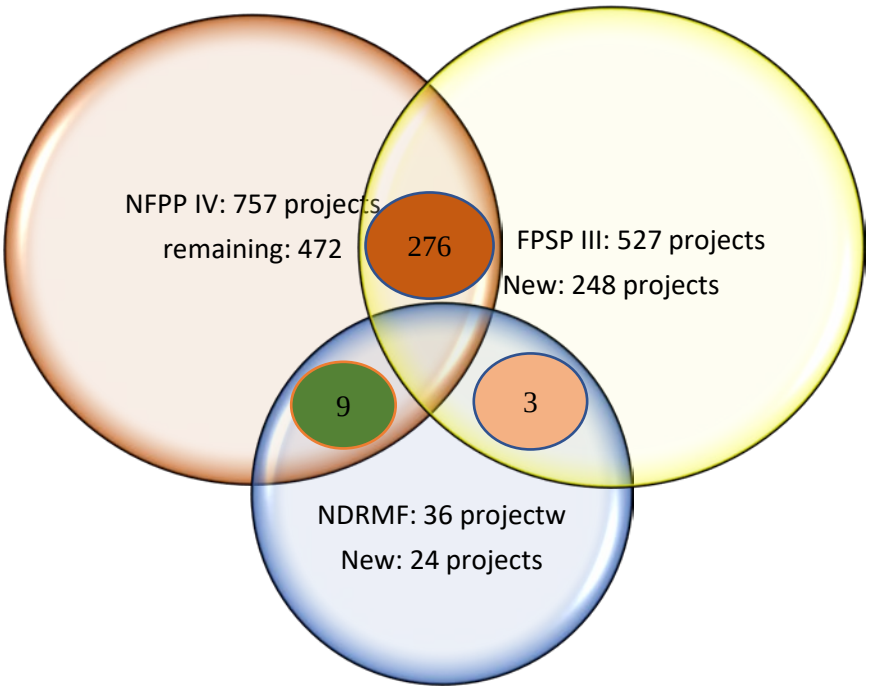
Figure 2.3.1 Flow of Business Application and Approval to the Federal Government (Planning Commission)

(2) Situation of FPSP-III until December 2022

At the beginning of 2021, the budget allocation was approved by the NDMA to be implemented through the National Disaster Risk Management Fund (NDRMF) with ADB funding. There have been twists and turns between ADB and FFC regarding the amount of budget for the FPSP-III. Therefore, a consultant has been dispatched from November to March 2022 to form FPSP-III with ADB funds, with an expectation of about PKR194bil.

Before the consultant was dispatched from ADB, the Advisory Team asked the issue, "Since the proposed projects for FPSP-III include projects other than NFPP-IV, FFC needs to confirm the implementation status of NFPP-IV again to confirm adequacy of the proposed project. The ADB consultant team has set the working TOR in consultation with FFC based on these indications.

The relationship between (a) NFPP-IV projects, (b) FPSP-III candidate projects, and (c) FPSP-III candidate project through NDRMF (referred to as the NDRMF projects) is shown in the figure below. FPSP-III includes about half of the projects (248) proposed in NFPP-IV (527), but the other half is new. More than half of the NDRMF projects are new projects. The situation is remarkable in Punjab, Balochistan, KPK, GB, and other (Merged Area). On the other hands, the Sindh PID respects the NFPP-IV plan. Some of the NDRMF projects were directly submitted to NDRMF without revisions by each PID based on the recommendations of FFC. In response to this, FFC expressed its concerns by calling each PID and request PIDs to submit proposed projects to FFC after the revision.



Source: Advisory Team

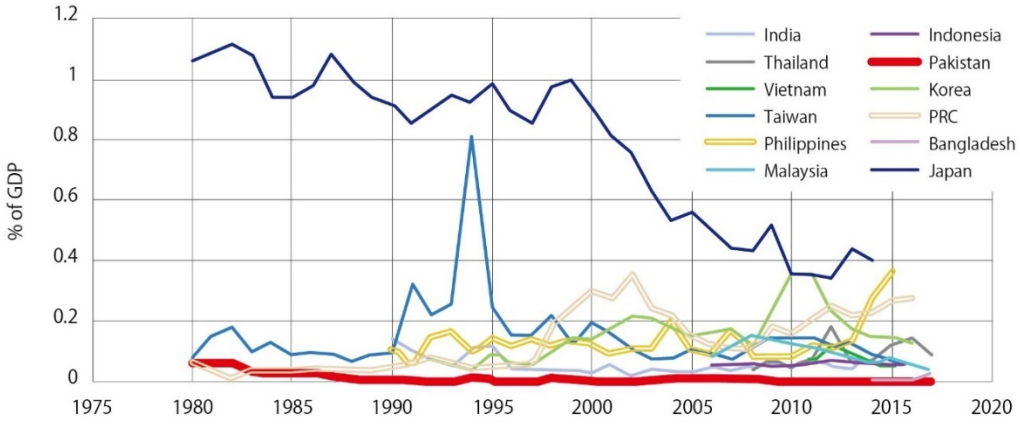
Figure 2.3.2 The Relationships between NFPP-IV, FPSP-III and NDRMF

(3) Factors Hampering Budget Allocation

Based on discussions and consultations with the FFC chairman and staff, the following are considered to be obstacles to budget allocation.

1) Flood countermeasures may not be recognized as a development issue

The ratio of flood control investment to GDP in Pakistan (0.004%) is the lowest ratio compared to other Asian countries. It is possible that the federal government's recognition of Sendai Framework for Disaster Risk Reduction (SFDRR2015), which states that "pre-investment in disaster risk reduction including flood control is a development issue," is diluted.



Sourse:Bridging the Gaps in Infrastructure Investment for Flood Protection in Asia-JICA-RI Working Paper, Mikio Ishiwatari and Daisuke Saka

Figure 2.3.3 Comparison of the Ratio of Flood Control Investment to GDP in Asian Countries

2) Possibility that the NFPP-IV budget was not appropriate

The NFPP budget amount may not have been appropriate for the federal government's PSDP budget. As shown in Table 2.2.8, NFPP-IV (360bil. PKR) has a budget more than ten times that of NFPP-III (26bil. PKR). NFPP-III project cost achievement rate was 34%, of which more than half was funded by ADB and other donors. As such, NFPP-IV may request quite challenging budget. Incidentally, according to the National Disaster Management Plan (NDMP2010), the total project cost of NFPP-IV was estimated at 500bil. PKR.

Table 2.3.2 Achievement of NFPPs

Plan	Category	Financing Source	Period	Plan (1)		Completed (2)		Completion Rate = (2)/(1) %	
				Number of Projects	Cost of Projects (mil. PKR)	Number of Projects	Cost of Projects (mil. PKR)	Number of Projects	Cost of Projects
NFPP-I	GOP Program	GOP	1978-1988	840	9,500	311	1,730	37%	18%
NFPP-II	GOP Program	GOP	1988-1998	479	3,944	180	1,418	38%-	36%-
	FPSP-I	ADB+GOP		256	4,556	256	4,735	100%	104%
	Total	-		735	8,500	436	6,153	72%	59%
NFPP-III	GOP Program	GOP	1998-2008	438	11,775	383	4,284	87%	36%
	FPSP-II	ADB+GOP		391	13,877	101	4,165	26%	30%
	Lai Nullah Project	JICA Grant		1	348	1	348	100%	100%
	Total	-		830	26,000	485	8,797	58%	34%
Grand Total		-	-	2,405	44,000	1,232	16,680	**51%**	**38%**

Source: FFC

3) Provincial and Federal Budget Reserve Ratios do not Reflect Projects' Characteristics

In Pakistan, many rivers flow through several provinces. Concerning such provincial cross-border rivers, consensus building between provincial governments as well as the federal and provincial governments is required to decide budget allocation. In NFPP-IV, the budget allocation was adjusted so that the federal government and the provincial governments could divide the budget evenly. However, in the NFPP-IV organization method (listing of projects by province), the projects are difficult to be regarded as investments in the cross-border or the inter-provincial rivers.

2.3.2 Activity 2-2: Confirm the Progress of Each Project Related to NFPP-IV and Analyze the Issues

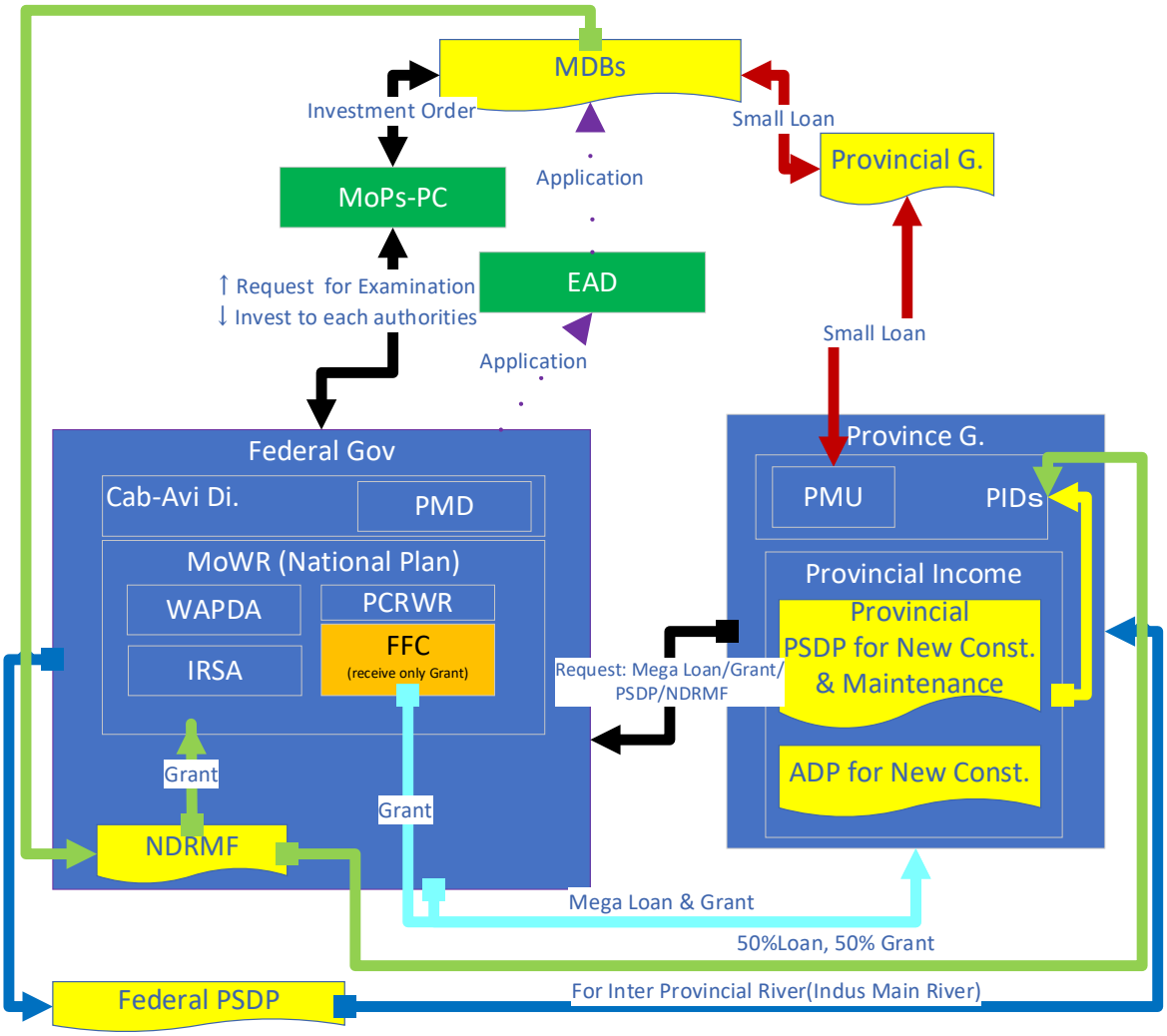
2.3.2.1 Progress Situation

According to FFC supervision, there have been no projects funded by the federal government so far, and there have been no reports from project implementing bodies regarding the implementation of projects planned under NFPP-IV (as of June 2023). FFC reviews national flood control projects all the time; however, the reviews is done only until the project entity submits PC1 reports to MoPS-PC (to secure the project budget). After that, FFC basically does not notice the progress and completion of the projects. In addition, it was confirmed at the information collection stage that PIDs also do not have a clear understanding of the progress of NFPP-IV projects.

2.3.2.2 Problematic Administrative (budget allocation) System for the IFM

Although the management (technical deliberations and monitoring) of national-level flood protection projects normally should be carried out by the FFC, there are many flood protection projects that are not

managed by the FFC (especially progress and confirmation of completion). In particular, for (1) MDB-funded projects directly to provinces/ministries/agencies, and (2) NDRMF projects in which FFC is not involved in the funding, the current administrative system makes it impossible for FFC to monitor the start, progress and completion of projects.



Source: Advisory Team

Figure 2.3.4 Comparison of the Ratio of Flood Control Investment to GDP in Asian Countries

On the other hand, there are also problems on PIDs side. Despite the advisory team's frequent requests to confirm the progress of NFPP-IV projects at ZOOM meetings and workshops held through FFC, as well as FMC meetings, the advisory team was unable to collect the information. The reason was speculated on the difference between latest PID's priority projects and NFPP-IV projects due to changes in the conditions of bunds and river channel conditions, or project implementation using the state budget. In other words, since the situation has changed from the time when NFPP-IV was formulated, it seems that PIDs are promoting their prioritized project implementation including national projects while no updating status of NFPP-IV projects.

As if to prove the mentioned situation above, many projects newly proposed by PIDs were mixed into FPSP-III project, which was originally intended to promote the NFPP-IV project. Despite this situation, PIDs have so far not requested FFC to give feedback on the NFPP-IV project list with its contents and to reconsider the priority projects. Therefore, it appears that FFC was unable to properly manage the progress of even national flood control projects.

2.3.2.3 Subjects to be Solved

As mentioned above, it is not suitable for IFM in the Indus River system that FFC is not notified of the completion information of flood control works. For example, in the case of FPSP-III projects, The fund is procedurally distributed to related organizations through discussions between FFC and MoPS-PC, so the FFC can naturally detect when projects will start. In the case of direct financing, even for projects listed in NFPP-IV as national projects, a series of accurate information regarding their progress and completion cannot be recorded or accumulated in FFC.

In such a situation, the following issues may arise when proposing flood management projects during normal phase and after a disaster occurs.

- If the progress and completion of projects in the target area cannot be properly confirmed by FFC, it will be difficult for FFC to make proper adjustments for project proposing and implementing agencies. As a result, the level of flood control in the Inter Provincial River basins such as the Inter Indus River and Hill Torrent cannot be improved, and appropriate business policies cannot be formulated from a bird's-eye perspective.
- There is a possibility of duplication of target projects by multiple development donors and surplus from borrowings with unclear use of funds.

2.3.3 Activity 2-3: Analyze the Factors that Promote / Hinder the Implementation of NFPP-IV, and Compile Recommendations for Promoting Implementation

In the Indus River and its main tributaries, artificial bund breaches are provided to cater a situation where flood endangers the safety of hydraulic structures, such as barrages, headworks or bridges. In the event of a flood exceeding the design high water level (or design flow discharge), breach activities which is to cut the bund upstream of the barrages, are carried out to protect the barrages and to control the excessive flow downstream.

On the other hand, FFC's annual report and NFPP-IV states that current conventional flood management is based on “Ad-hoc measures consisting of hard and soft measures without consideration of holistic problems from upstream to downstream”. Conventional flood control measures include individual measurements such as runoff control, flood storage, capacity improvement of weirs and headworks, separation of rivers and people, emergency measures during floods, and post-flood rehabilitation.

FFC are aware of the necessity of integrated flood management and also the importance of watershed flood management for proper flood risk reduction. Integration of conventional flood management methods and adequate management by FFC will lead to reasonable integrated flood management in the future. Based on the hearings of FFC and other organizations so far, issues to be solved in implementing integrated flood management are described in the following subsections.

So far, the factors that promote and hinder the implementation of NFPP-IV was analyzed in 2.2.4 and 2.3.1. The recommendations to settle these issues are as follows.

Table 2.3.3 Recommendations on Implementation Facilitation of NFPP

No	Aspects	Recommendation
1	Budget Allocation	➢ Involve the federal government such as MoPS and MoEA from the formulation stage to raise awareness of changes in global trends in flood control measures based on SFDRR and the low investment scale for flood DRR in Pakistan. ➢ Regarding budget distribution rules for federal and provincial governments, clearly describe them in higher-level plans such as National Water Policy in accordance with the basic policy between the federal and provincial governments. ➢ Before formulating the NFPP, analyze in advance the ratio of support from donors and the country's own funds, etc., taking into consideration past performance and the national budget.

No	Aspects	Recommendation
2	Policy/strategy/ institutional	➢ Add descriptions in the flood management of the National Water Policy - Describe allocation policies for federal and provincial budgets - Prepare and/or update NFPP based on the National Water Policy - Review River Act based on clear flood management methods in Pakistan ➢ Strengthening cooperation in the management of flood control projects - Reestablish concrete linkages and systems between FFC and other organizations in flood control management through legislation. ➢ Construction of NFPP evaluation and update system - Introduce management technology from other countries in FFC and PIDs - Establish an NFPP evaluation and update working groups in FFC and PIDs. - Hold meetings to share project progress information for the entire NFPP by FMC. - Introduce an electric management system for project information.
3	Technical contents of NFPP	➢ Prepare basic principles for the investment in flood control facilities and establishment of flood management system from the perspective of river basins. ➢ Consideration of a long-term view on national flood control management -Setting the design scale for the development of flood control facilities for major river basins -Analysis of the flood risk after the artificial breach and consideration of mitigation/compensation possibility for floodplain damages -Formulate climate change adaptation policy (how to respond to changes in external forces such as rainfall and river discharge) - Clarification of long-term flood control facility deployment plan ➢ Develop bunds information sharing system between FFC and PIDs - Survey nationwide situation of bunds -Organize river channel characteristics by scientific analysis -Investigate information sharing method that allows FFC and PIDs to mutually check the bunds' status ➢ Ensure flexibility in national flood protection plans - Consideration and implementation in a system for projects' improvement and update in timely response to changes in river vulnerability areas/points. ➢ Clarify the project characteristics for the demarcation of budget allocation -State the conditions for budget allocation from the federal government -Arrange project components for each river basin in addition to each province
4	Organization of FFC	➢ Strengthen incentives and motivation for FFC engineer staff -Activation by increasing projects managed/managed by FFC -FFC relocation to hire enough number of staff ➢ Introduction of convenient communication functions - Introduction of a visual information collection system that allows FFC to directly check the flood situation from the engineering viewpoints ➢ Promote processing, accumulation and management of flood control information. -Clarify the department in charge of information and introduce an electronic information-sharing system with related organizations -Secure tools and databases for digital processing ➢ Develop an appropriate project management environment. -Awareness of flood control planning and a comprehensive monitoring of projects -Increased staff, introduction of project management system such as a database

Source: Advisory Team

Other Issues

According to the interviews with check sheets, there are the following problems in future flood management in addition to the above. FFC needs to deal with the problems as well.

- The reference of the River Act applied to each province was formulated with NFPP-IV. FFC submits the reference document to each province to contribute to provincial river acts' renewal. The contents of each provincial river law are inconsistent with the reference. Provincial governments have begun to revise their laws, starting with Punjab's recent revision. However, as of September 2023, the acts are not revised
- NFPP-IV survey has issues to be solved in the next NFPP as follows:
  - Considerations and examinations for design discharge and flood control operations of river facility are not mentioned in detail in the NFPP-IV, although the importance of comprehensible flood management is described.

- Although the NFPP-IV shows a long list of priority projects assembled from each province and agency, the processes in determining of superiority of projects were not explained in detail.
- There are no drawings and documents organized, analyzed and examined in NFPP-IV are not attached in NFPP-IV and not possessed by FFC. Documents of project proposals submitted by each province are not attached and FFC does not store them.
- The data of hydrological run-off model used in the NFPP-IV is to be useful for planning flood countermeasure for the future review; however, FFC do not possess the input data and simulation model. The flood inundation analysis was carried out by a simple method to extend the water level horizontally to the bund, so it is difficult to infer the actual flood situation in the floodplain area from the results. The consultants in charge of the NFPP-IV compilation destroyed the data after 5 years from the formulation.

➢ FFC thinks some of the project proposals from the province and relevant organizations do not technically reach satisfactory level for FFC in scrutinizing meetings. Sometimes inappropriate participants who cannot explain the proposed projects join the scrutinizing meetings. On the other hand, the participants believe that the project cannot be accepted because of the lack of budget.

➢ The guidelines and manuals for flood control measures currently prepared in only a few provinces. The documents can be referred to in the other provinces, while if needed it is better to prepare the document according to the characteristics of each province, such as the condition of watersheds, the scale of rivers, and implementation projects.

In addition, in NFPP-IV, issues in flood control planning are organized as shown in Table 2.3.4. In particular, "policies and plans" and "financial resources" include problems that cannot be directly solved technically. Pakistan's governments and agencies related to flood control must also consider how to deal with them.

Table 2.3.4 Shortcomings, Limitations and Deficiencies in Flood Management

Items	Contents
Policies and Plans	• Lack of will of the Pakistan government to respond to and implement flood control measures • Overemphasis on easily-implemented and visible structural measures • Inappropriate non-structural measures • Illegal occupation of flood-prone area • Disposal of raw sewage into municipal drainage facilities • Clogged drainage channels due to poor maintenance and solid waste dumping
Excess Flood and Design Criteria	• Flooding beyond design limits due to climate change • The need for a review of changes in flood patterns and channel behavior • The need to review design standards for major river structures and urban and rural structures
Bottleneck at Barrage or Bridge	• Overflow upstream of barrages and bridges due to a shortage of discharge capacity • Necessity of considering the plan of artificial breaching upstream of barrages and bridges • If artificial breach is not possible, the need to consider alternatives
Flood Early Warning System	• Flood early warning systems are effective but underutilized. • Need to extend system coverage to the upper Indus and Chenab river basins
Financial Resources	• Poor financial resources (insufficient budget allocations for flood control measures) • More investment needed to improve flood control safety • Increase in irrigation water rates to cover the costs of irrigation operation and maintenance and infrastructure for flood control measures

Items	Contents
Others	• Institutional Issues (Close coordination between federal and provincial agencies, data sharing among agencies, expertise in flood management agencies, and definition of roles and responsibilities in flood source management) • Management challenges (regular inspection/monitoring of flood control facilities, expertise in the operation of water control structures, information and real-time instructions for water control structures) • Technical Issues (real-time data, low hydrological station density, spatial and temporal forecasting of monsoon events, response time to flash flooding, inconsistent dike and weir design criteria, storage facilities for flood peak attenuation, dike maintenance, monitoring and repair) • Financial Challenges (to implement projects in NFPP-IV, capacity development to enforce allocated funds, reliance on donor loans due to lack of government funds)

Source: NFPP-IV Survey Report

2.4 Activities Related to Output 3

Output 3: Fundamental flood control projects for flood risk reduction will be identified and formulated

2.4.1 Activity 3-1: Advise on Flood Control Measures of JICA-Related Projects

The ``Technical Assistance Project for Updating Pakistan's National Disaster Management Plan (NDMP2)" began in late August 2022. The FFC advisory team aims to resolve the above-mentioned issues of NFPP-IV based on, the current NDMP, as well as the issues analyzed in this advisory work, by updating the NDMP. In some cases, the activities of the FFC in charge listed in the NDMP are not carried out appropriately. This has resulted in inconveniences such as difficulty in understanding flood risks at NDMA. In light of this situation, the NDMP2 project team will hold a series of meetings with FFC after this advisory activity (September 2023) to discuss how to resolve issues associated with strengthening FFC's capacity for the achievements through the NDMA project. Furthermore, the advisory team was providing support that will lead to more efficient information gathering in the Grant-aid preparation Survey on “River Management Enhancement Project in Pakistan". In addition, the advisory team provided and examined new several JICA DRR projects as mentioned below.

2.4.2 Activity 3-2: Examine Fundamental Flood Control Projects Based on the Identification of Bottleneck Issues to be Solved for Flood Risk Reduction in Consideration of Flood Damage Potential, Utilizing Outputs of On-Going JICA Projects on Flood Control

Based on past activities, bottlenecks necessary for flood risk reduction are listed in 2.3.4.5 to 2.4.3.9 below. Bottlenecks are organized from the following five points of view. In particular, the advisory team pays particular attention to points 1 to 3 when formulating projects that JICA should implement. Regarding points 4 and 5, we made recommendations to the FFC at each consultation meeting with the FFC chairman, and some of them have begun to be implemented (described in section 4.5).

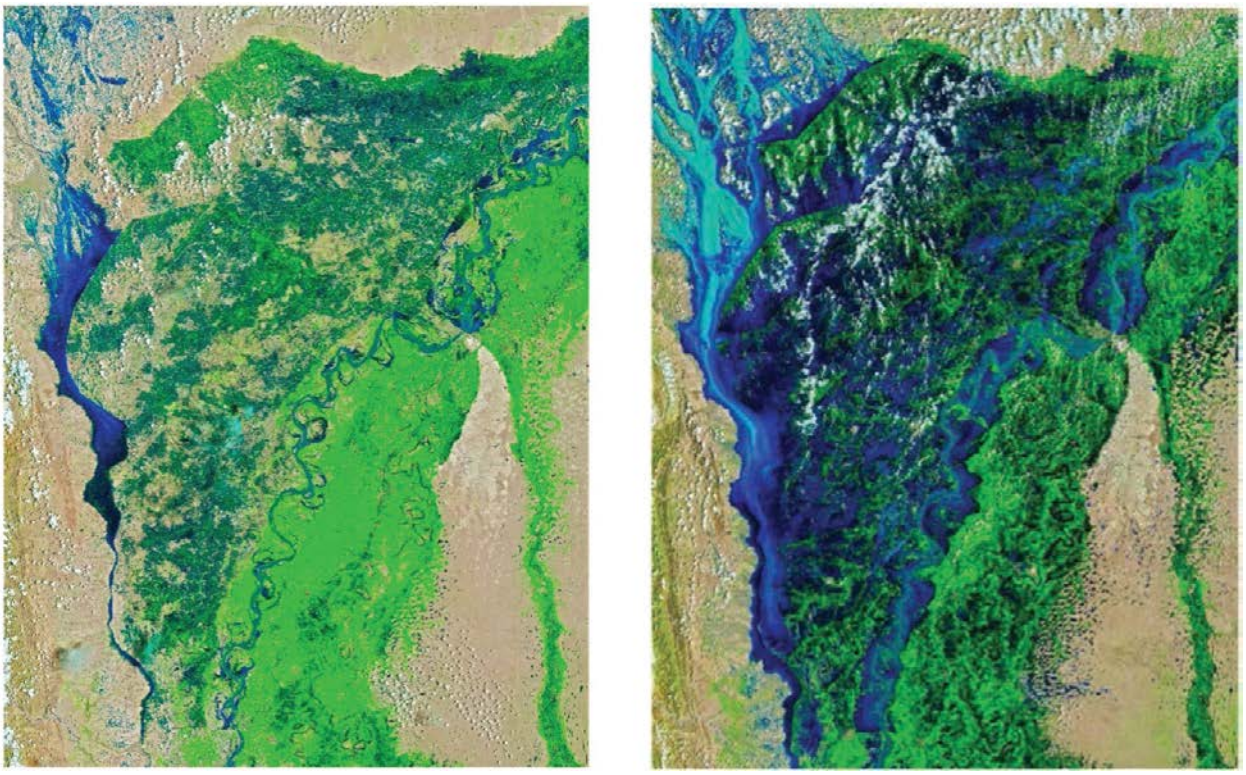
1. Flood damage situation and potential of damage occurrence (Section 2.3.4.5)
2. Necessity of flood control policy considering Pakistan's economic development effects (Section 2.4.3.6)
3. Flood protection from the perspective of natural and social conditions (Section 2.4.3.7)
4. Weakness of financial investment system in terms of IFM (Section 2.4.3.8)
5. Laws, guidelines and information preparation for formulation and update of NFPP (Section 2.4.3.9)
6. Fundamental flood DRR direction for Pakistan

2.4.3 Activity 3-2 Analysis on Bottleneck of IFM

2.4.3.1 Results of Post Disaster Needs Assessment (PDNA)

In the summer of 2022, the country experienced its wettest August since 1961. Sindh and Balochistan provinces were subject to unprecedented rainfall, surpassing average monthly totals by six and seven times,

respectively. The floods came on the heels of a severe heatwave (previously a 1-in-1,000-year event) and drought emergency during which temperatures continuously remained above 45°C, resulting in crop losses, power outages, and forest fires.



Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Main Report"

Figure 2.4.1 Extent of Flooding Comparison between August 4 and 28, 2022

Table 2.4.1 Damage, Loss, and Needs by Region

	Damage		Loss		Needs	
Region	(Billion PKR)	(Million US$)	(Billion PKR)	(Million US$)	(Billion PKR)	(Million US$)
Balochistan	349	1,625	541	2,516	491	2,286
Khyber Pakhtunkhwa	201	935	141	658	168	780
Punjab	111	515	122	566	160	746
Sindh	1,948	9,068	2,444	11,376	1,688	7,860
Cross-Provincial[12]	587	2,731	14	67	975	4,540
Special Regions[13]	7	32	11	49	10	48
Grand Total	**3,202**	**14,906**	**3,272**	**15,233**	**3,493**	**16,261**

Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Main Report"

- The sectors that suffered the most damage are housing at PKR 1.2 trillion (US$5.6 billion); agriculture, food, livestock, and fisheries at PKR 800 billion (US$3.7 billion); and transport and communications at PKR 701 billion (US$3.3 billion).
- In terms of reconstruction and recovery needs, transport and communications sector has the highest needs at PKR 1.1 trillion (US$5.0 billion); followed by agriculture, food, livestock, and fisheries at PKR 854 billion (US$4.0 billion), and housing at PKR 592 billion (US$2.8 billion).
- The provinces of Sindh and Balochistan account for approximately 50 percent and 15 percent of recovery and reconstruction needs, respectively.

- The "Water Resources and Irrigation" sector, which includes river facilities such as bunds and canals, was the fourth largest in terms of damage, at PKR 153 billion (US$ 711 million), with rehabilitation and reconstruction needs exceeding the amount of damage at PKR 168 billion (US$ 782 million).

Table 2.4.2 Damage, Loss, and Needs by Sector Group and Sector

	Damage		Loss		Needs	
Sectors	**(Billion PKR)**	**(Million US$)**	**(Billion PKR)**	**(Million US$)**	**(Billion PKR)**	**(Million US$)**
Social Sectors	**1,345**	**6,261**	**193**	**896**	**832**	**3,872**
Housing	1,200	5,586	137	636	592	2,757
Health	23	109	7	34	40	188
Education	120	559	47	219	197	918
Culture and Heritage	1	6	1	7	2	9
Infrastructure Sectors	**843**	**3,927**	**85**	**396**	**1,168**	**5,437**
Transport and Communications	701	3,264	60	281	1,073	4,994
Energy	19	88	1	3	25	117
WASH, Municipal Services, and Community Infrastructure	123	575	24	112	70	327
Productive Sectors	**996**	**4,635**	**2,853**	**13,281**	**1,022**	**4,760**
Agriculture, Food, Livestock, and Fisheries	800	3,725	1,986	9,244	854	3,976
Water Resources and Irrigation	153	711	-	-	168	782
Commerce and Industries	40	186	758	3,527	-	-
Finance and Markets	1	3	90	417	-	-
Tourism	2	10	20	93	0.4	2
Cross-Cutting Sectors	**18**	**83**	**142**	**660**	**471**	**2,192**
Governance	13	60	5	23	19	88
Social Sustainability, Inclusion and Gender	0.004	0.02	-	-	21	96
Social Protection, Livelihoods, and Jobs	-	-	130	607	361	1,683
Environment and Climate Change	4	18	6	30	35	164
Disaster Risk Reduction and Resilience	1	5	-	-	35	161
Grand Total	**3,202**	**14,906**	**3,272**	**15,233**	**3,493**	**16,261**

Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Main Report"

The vision of Pakistan's recovery framework is to achieve an inclusive and resilient recovery through a "Whole of Pakistan" approach, leading to sustainable development for the people and country. This vision

rests on three key pillars and an underlying foundation. The strategic recovery objectives of the framework and guiding principles of the vision, articulated below, will be critical.

Table 2.4.1 Disaster Recovery Framework

Underlying Foundation	Pillar
Build Back Better;	Restoration of Jobs and Livelihoods
People-centered Socioeconomic Recovery	Recovery and Reconstruction of Critical Assets, Services, and Infrastructure
Developing Systemic Resilience against Natural Hazards and Climate Change Impacts	Strengthening Governance and Stakeholder Capacity for Reconstruction, especially Communities.

Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Main Report"

The strategic recovery pillars noted above will be supported by five strategic recovery objectives:

Table 2.4.2 Recovery and Reconstruction Objectives

Recovery and Reconstruction Objectives
Enhancing governance and capacities of the state to restore lives and livelihoods of the affected people, especially the most vulnerable.
Restoring livelihoods and economic opportunities.
Ensuring social inclusion and participation in all aspects of recovery and related development.
Restoring and improving basic services and physical infrastructure in a resilient and sustainable manner.
Developing an enabling environment and facilitating private sector participation and financing.

Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Main Report"

The following guiding principles will be critical to ensure recovery and reconstruction efforts take a consistent approach:

Table 2.4.3 Guiding Principles to Support the Vision

Guiding Principles to Support the Vision
Participatory, inclusive, and green recovery for long-term resilience.
Pro-poor, pro-vulnerable, and gender sensitive, targeting the most affected.
Coordination of government tiers through centralized policy, planning, and coordination; and decentralized implementation.
Invest in nature-based solutions and ecosystem-based adaptation measures.
Conflict-sensitive implementation.
Prioritize institutional and regulatory reforms to ensure sustainability.
Use of local materials, knowledge, skills, and labor.
Avoid relocation as much as possible.
Balance between public and private sector recovery.
Emphasis of synergies between humanitarian effort and recovery.

Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Main Report"

(1) Damages in Water Resources and Irrigation Sector

The total damages to the Water Resources and Irrigation sector by the 2022 floods was estimated at PKR 152.6 billion (US$710.6million). The damage to public sector assets accounted for 98.5% of the total damage, while private sector assets accounted for 1.5%.

Of the damage, flood protection-related facilities and irrigation canals suffered the most damage, with these two items accounting for about 70% of the total damage in the water resources and irrigation sector.

In terms of damage to irrigation systems (canals: 32%, dams: 9%, etc.), which account for 41% of the total damage, crop production is expected to be adversely affected. In particular, delays in the rehabilitation of drainage systems in Sindh province are expected to further reduce crop production. In Balochistan province, irrigation and water storage infrastructure in arid areas has been damaged, resulting in inadequate irrigation supply.

Table 2.4.3 Damage to the Water Resources and Irrigation Sector by 2022 Flood by Facility

Facility	Damage		Share
	Billion PKR	Million USD	%
Flood Protection Infrastructure	55.5	259	36.4%
Irrigation Channel	49.4	230	32.4%
Drainage System	20.7	97	13.6%
Dam, Headwork, Weirs	14.3	66	9.4%
Supporting Infrastructure	12.7	59	8.3%
Total	152.6	711	-

Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Supplemental Report"

In terms of damage by region in the water resources and irrigation sector, damage to public assets is prominent, with the amount of damage in Sindh province (62% of the total water resources and irrigation sector) being the most prominent.

Table 2.4.4 Damage to the Water Resources and Irrigation Sector by 2022 Flood by Region

Province /Region/ Administrator	Damage		Needs		Major Damaged Facilities
	Public Million PKR	Private Million PKR	Million PKR	Million USD	
Balochistan	19,943.1	-	22,849.0	106.4	Canals, storage structures, weirs, drainage network, and flood protection works by flash flood of Hill Torrent
KPK	19,712.5	2,279.5	21,791.0	101.4	Lower Swat Canal, Chashma Right Bank Canal system (D. I. Khan (Dera Ismail Khan) district), and flood protection works in Swat and Kabul rivers
Punjab	5,216.0	-	5,807.9	27.0	Chashma Right Bank Canal (D.G. Khan (Dera Ghazi Khan) and Rajan Pur districts), Kacchi Canal system
Sindh	94,901.8	-	105,622.0	491.7	Heavy rains, standing water, and flash flows from Kirthar hills
特別地域	458.1	-	498.0	2.3	Irrigation channels and flood protection structures
WAPDA	10,132.4	-	11,436.5	53.2	On-going works of large irrigation and drainage systems
Total Million PKR	150,364.0	2,279.5	168,005.0	-	
Total Million USD	700.0	10.6	-	782.1	

Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Supplemental Report"

(2) Recovery Needs and Strategy in Water Resources and Irrigation Sector

Building long-term resilience requires (1) identification and prioritization of immediate interventions to be implemented in the short to medium term, and (2) development of a strategic master plan for building resilience in sensitive areas.

Short-term (within one year) rehabilitation strategy is to rehabilitate irrigation supply facilities and repair critical damage of agricultural water supply canals, drainage channels, and flood protection bunds by June 2023, accounting for 15% of the total needs.

Medium-term (within 3 years) rehabilitation, accounting for 30% of total needs, includes strengthening of agricultural water supply canals, drainage channels, dams, and accessory structures, construction of new structures, and strengthening of flood protection bunds through structural and non-structural measures.

Long-term (within 5 years) rehabilitation accounts for the remaining 55% of the total assessed needs and includes full operation of drainage channel, drainage systems and agricultural water supply systems, enhanced safety and stability of flood protection bunds, hydraulic structures, and flood channels.

Table 2.4.5 Damage Recovery Strategy in Water Resources and Irrigation Sector

Intervention/Activity	Short (Up to 1 Year)	Intermediate (Up to 3 Years)	Long (Up to 5 Years)	Priority (Rank 1–5)	Cost in PKR Million (US$ Million)
All the temporary works to make the structures operational, closing of all the breaches in canals, dams, and flood protection embankments	8,400.0			1	8,400.0 (39.1)
Full recovery of canal operation, repairing of canal regulating structures, strengthening the canal embankment, operationalizing galleries and *Karezes*, rehabilitating tubewells and water courses, repairing the guide and marginal bund and spurs	16,800.0			2	16,800.0 (78.2)
Strengthening of canals, dikes, dams, and appurtenant structures, construction of new structures (when needed), strengthening of flood protection embankment, repairing critical parts of drains, removing blockade		50,401.0		3	50,401.0 (234.6)
Complete operation of drains, drainage systems, canals, and canal systems, enhanced safety and stability of flood protection embankments, hydraulic structures, and flood channels			92,403	4	92,403.0 (430.2)
Total	**25,201.0 (117.3)**	**50,401.0 (234.6)**	**92,403.0 (430.2)**		**168,005.0 (782.1)**

Source: "Pakistan Floods 2022, Post Disaster Needs Assessment, Supplemental Report"

2.4.3.2 Survey Results on 2022 Flood by Advisory Team (for the Indus River Basin)

A survey on large-scale flood damage during the monsoon season in 2022 was conducted.

(1) Damage of Dike along Indus River

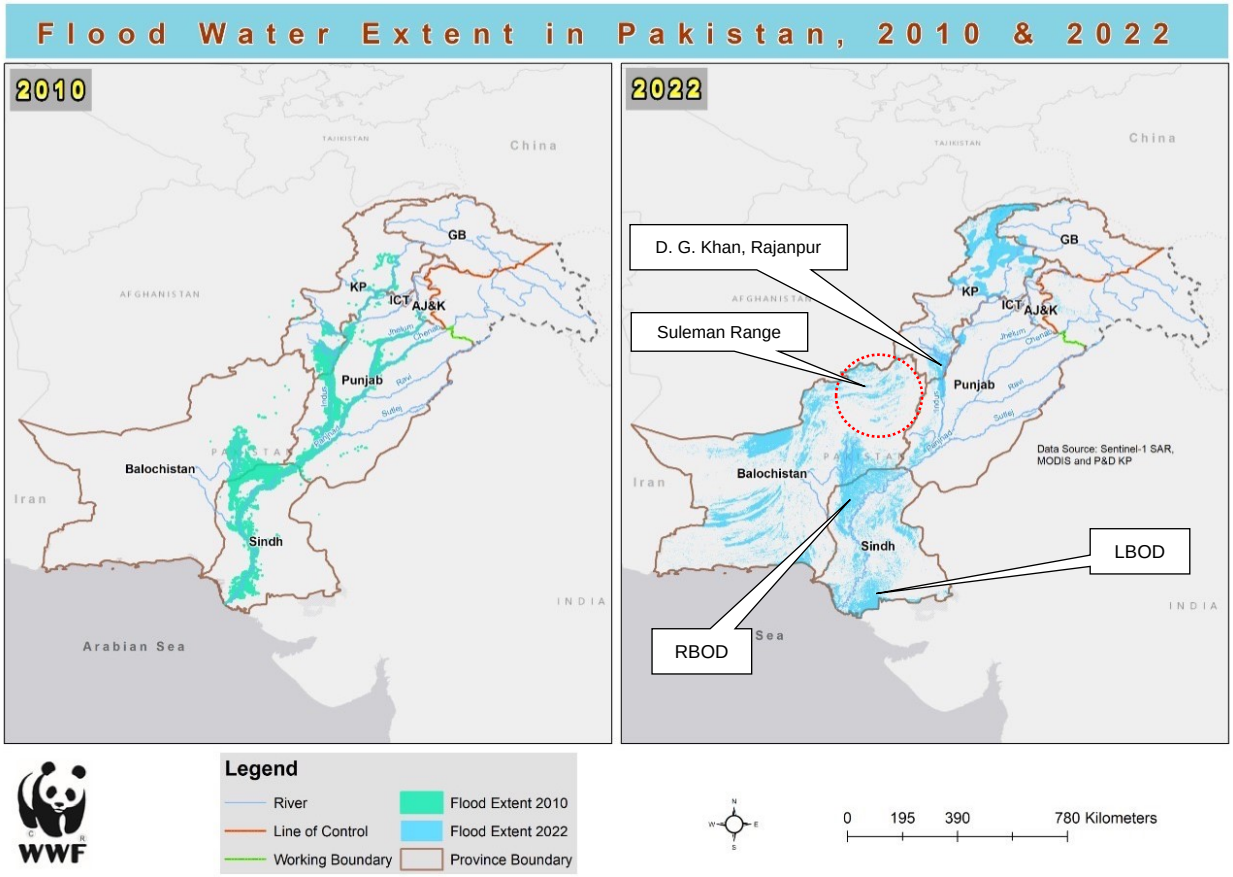
Among Indus River and four major tributary river basins (namely, Jhelum, Chenab, Ravi and Sutlej rivers) of Indus River, the area adjacent to the mainstream of Indus River was the most damaged. While the 2010 floods were mainly caused by overflows from the mainstream of Indus River, the 2022 floods were not caused by overflows from the mainstream of Indus River but by torrential rains in the provinces of KPK, Balochistan and Sindh.

According to the damage reports of each Provincial Irrigation Department (PID) obtained through the FFC, the damage along the main river included the collapse of the spurs, guide bund, partial collapse of the slope of dikes, but no fatal collapse of dikes along main river streams.

(2) Damage to River Structures and Irrigation Facilities

According to the damage reports of each PID, most of the damaged river structures, including irrigation facilities, were damage caused by flooding from hill torrents and riverbank collapse caused by flooding from irrigation facilities.

The main affected areas were mountainous areas in the northern part (KPK) and western part (Balochistan) of Pakistan, D.G. Khan (Dera Ghazi Khan) and Rajanpur districts in Punjab and Right Bank Outfall Drain (RBOD) area and Left Bank Outfall Drain (LBOD) area in Sindh.

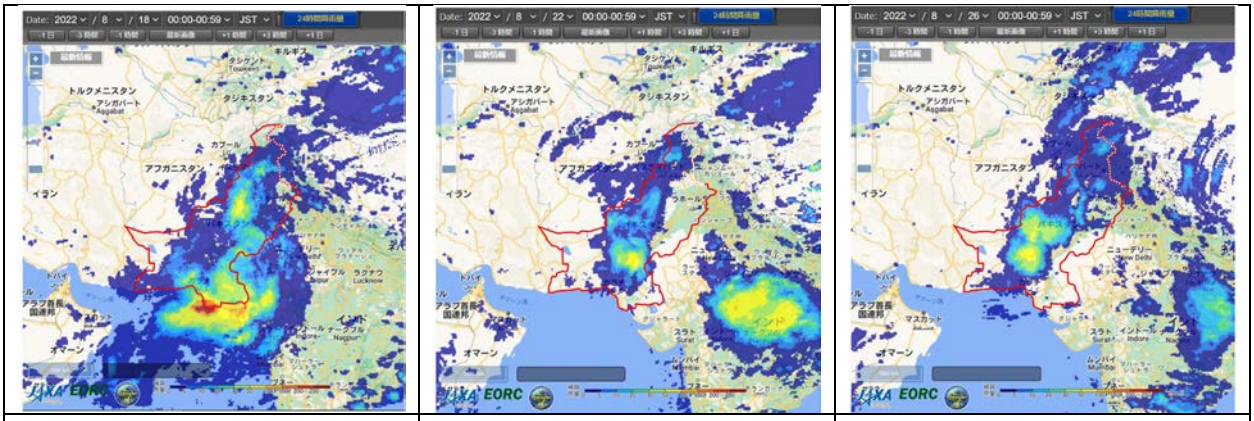


Note: colored are of "Flood Extent" in the mountain area in 2022 shown above does not correspond to actual flooded area.

Figure 2.4.2 WWF Comparison of 2010 and 2022 Flood Extents

(3) Heavy Rain Condition by Satellite Rainfall Data and Causes of Flood

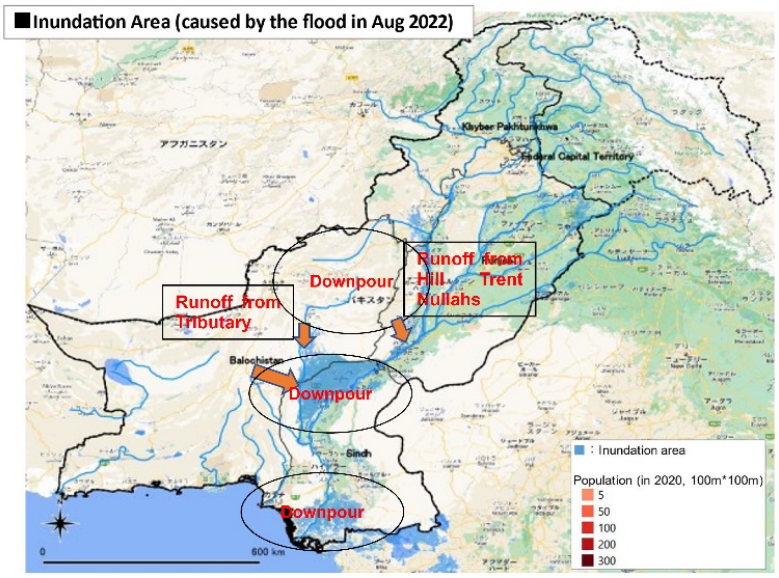
Satellite rainfall distribution around Pakistan from August 18 to 26 in 2022 by JAXA's satellite rainfall data indicates that more intense rainfall occurred in Sindh, Balochistan and KPK than in Punjab.



8 August 2022	22 August 2022	26 August 2022

Figure 2.4.3 Movement of Rainfall Distribution in 2022 (Source: JAXA)

According to interview survey with PIDs in Sindh and Punjab, floods in the RBOD area and D.G. Khan and Rajanpur Districts were caused by the Hill torrent flood from the Suleman Range and Balochistan, and the floods in the LBOD area, Balochistan and KPK Provinces were caused by the torrential rain at those places, which is related to the high intensity rainfall above.

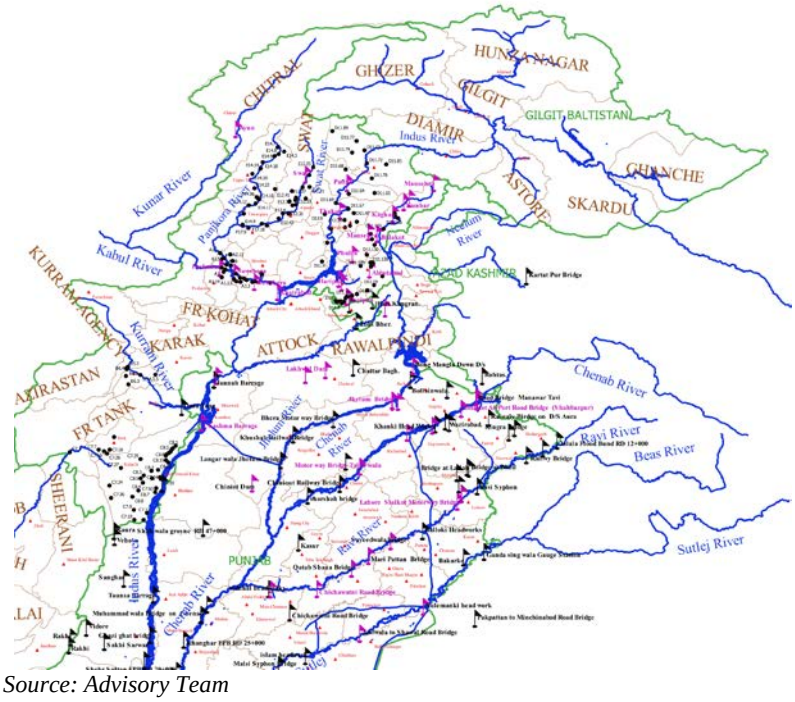


Source: Advisory Team (using Google Maps)

Figure 2.4.4 Consideration of Flood Causes

(4) Work to Identify Damaged Areas

Based on damage reports by each PID, the Advisory Team marked locations of damaged areas on the map. As an example, damaged areas (black circles) in KPK province and D. G. Khan area are shown in the following figure.



Source: Advisory Team

Figure 2.4.5 Consideration of Flood Causes

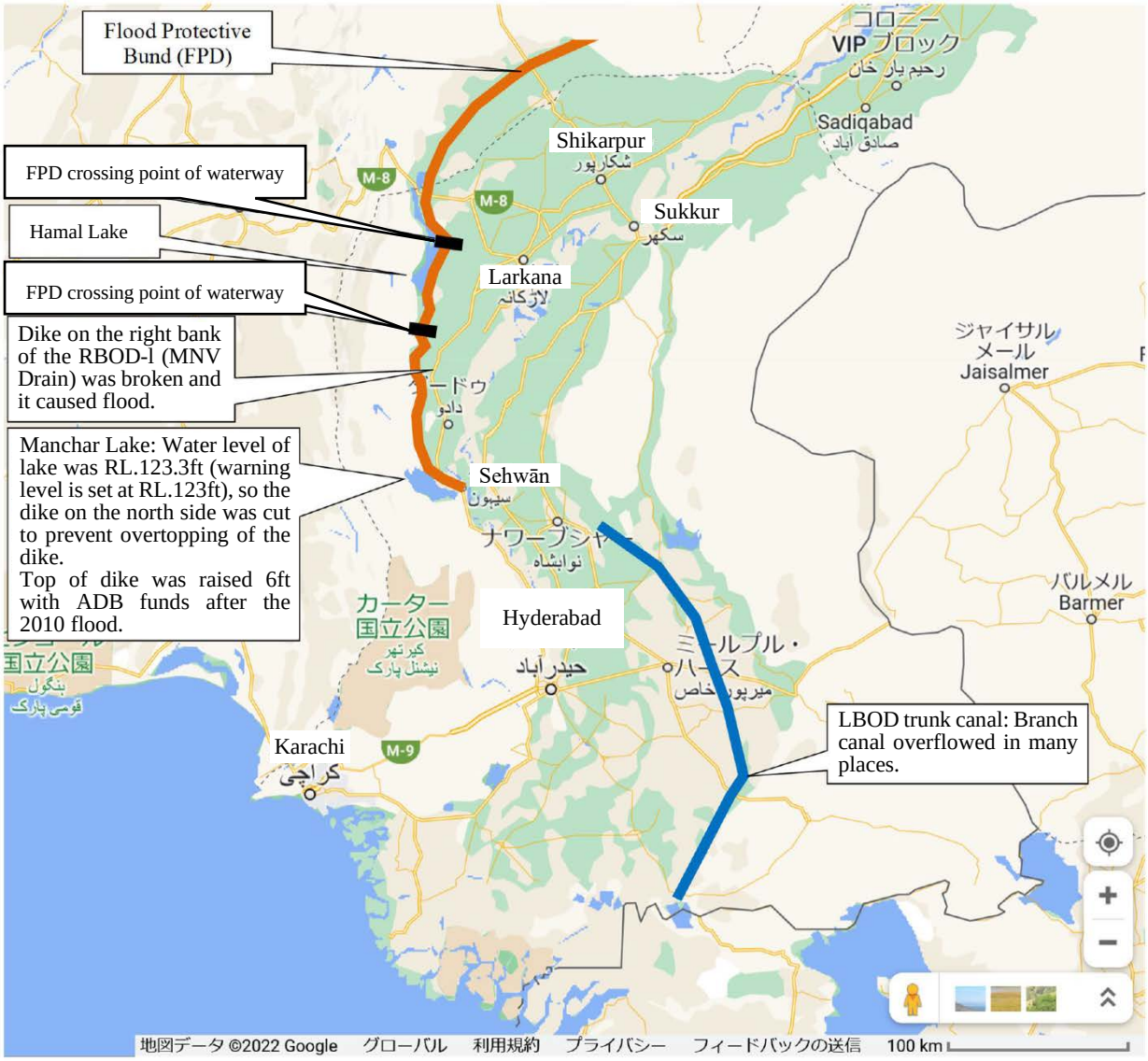
2.4.3.3 Survey Results on 2022 Flood by Advisory Team (Sindh-Karachi)

A field survey and interviews with local government agencies were conducted to ascertain the 2022 flood damage situation in Sindh and to grasp the needs of assistance there.

(1) Sindh Irrigation Department (Irrigation Department, Government of Sindh)

Irrigation Department of Sindh Province (hereinafter referred to as "SID") is responsible for responding to the flooding of the Indus River and river flooding caused by Hill torrent in the province of Sindh. Flooding in August 2022 was caused by Hill torrent flooding from the mountains to the north and west of Sukkur, as well as localized rainfall. In the flooded RBOD area, it took about four (4) months to drain the accumulated water.

Although not much rain fell in Sindh during the 2010 floods, 2022 received five to six times more rainfall than the usual monsoon season. This was the largest rainfall ever recorded. In Larkana city, the average monsoon rainfall was 700 mm/month in 2022, while it was 200 mm/month in normal condition.



Source: Advisory Team (using Google Map) RL.: Reduced Level (The Mean Sea Level is RL.0) (1 ft=0.3048 m)

Figure 2.4.6 Location Map of Flood Damage Hearing Survey in Sindh Irrigation Department

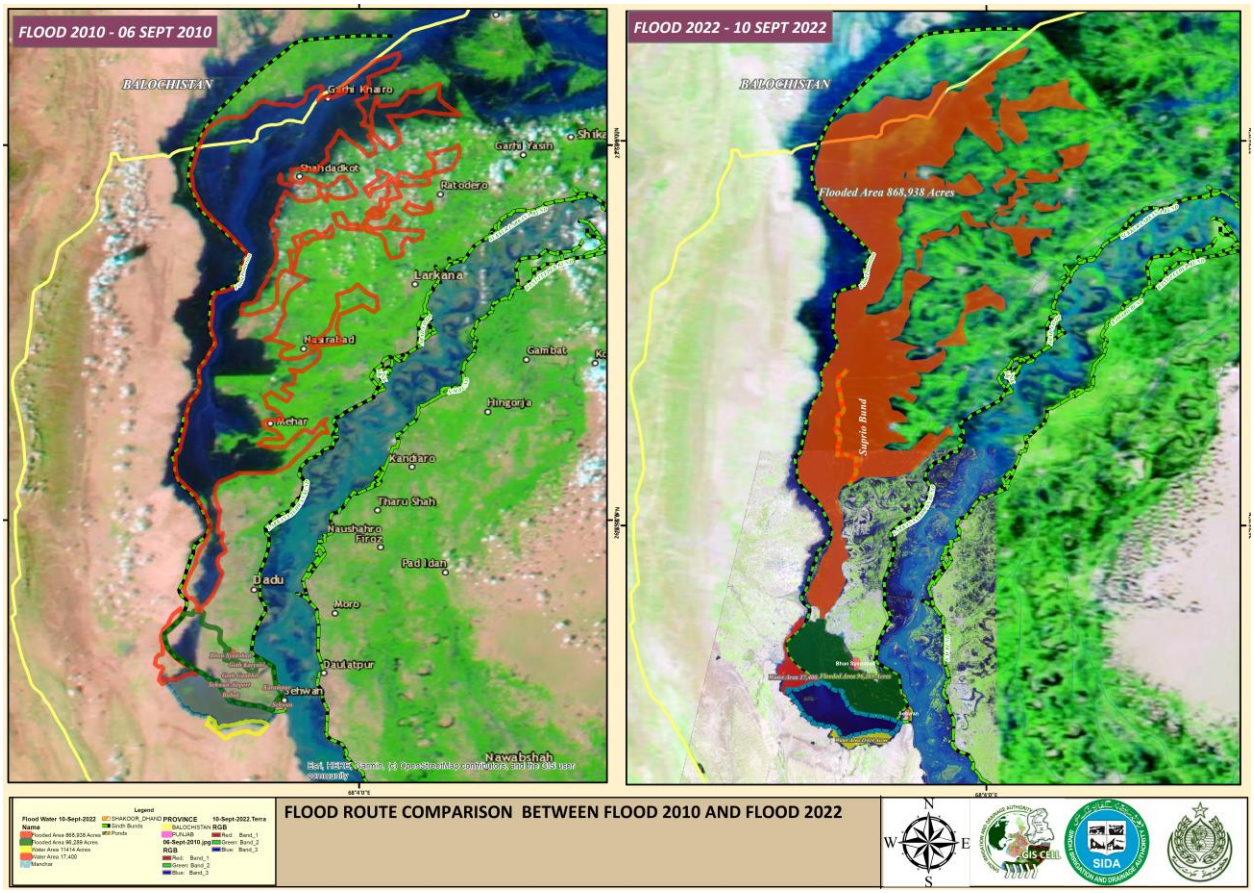
1) Right Bank Outfall Drain (RBOD) Area

A large area of farmland on the right bank side of Indus River downstream of Guddu barrage is called RBOD area. It is bounded on the west by the Flood Protective Bund (FP Bund), and water flowing into farmland within the RBOD area flows to the west side and accumulates on the east side of FP Bund on the west side of RBOD area. Accumulated water flows into Manchar Lake via

Main Nara Valley Drain (MNV Drain). Manchar Lake water is drained into Indus River by the Aral Canal and Danister Canal.

Water flowing down from the mountains west of RBOD area flows south along the west side of FP Bund, with some flowing across FP Bund into the RBOD area, and the rest flowing south along the west side of FP Bund and eventually into Manchar Lake.

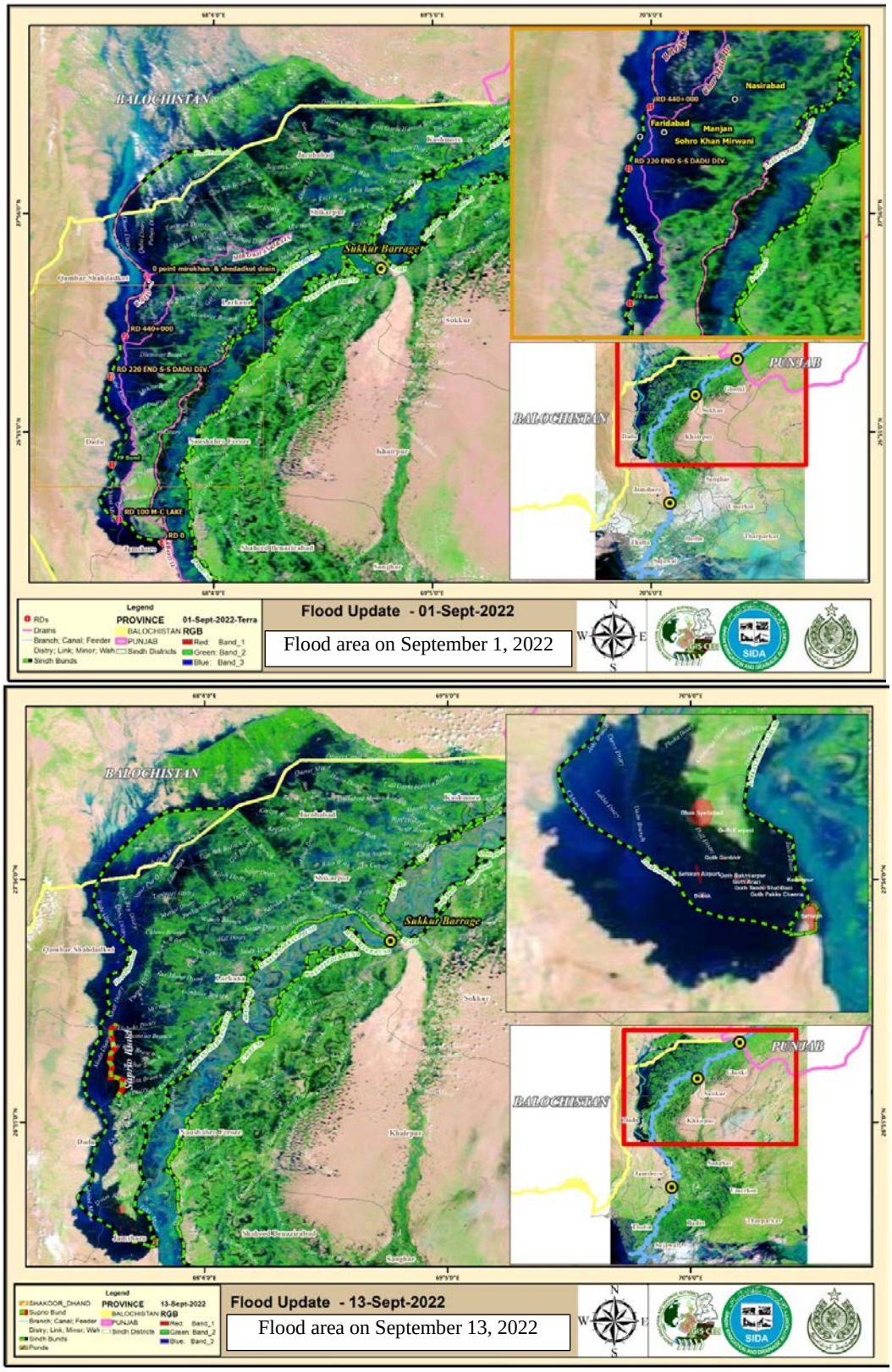
The figure below compares the extent of flooding in the RBOD area during the 2010 flood with that during the 2022 flood. In the 2010 flood on the left (the red line shows the extent of flooding in 2022), the upper (North side, top of figure) flood zone is widened because Indus River flooded in the area due to breach of Tori Bund, the right bank upstream of Sukkur barrage. On the other hand, in the 2022 flood on the right, flooding from hill torrents on the north and west sides and rainfall within RBOD area caused flooding, and the extent of flooding within RBOD area is wider than in the 2010 flood zone, as is the extent of water surface of Manchar Lake.



Source: SID

Figure2.4.7 Comparison of the 2010 and 2022 Floods in the RBOD Area

Next figure shows the chronological changes in the extent of flooding during the 2022 flood in the RBOD area. The extent of flooding on September 13, 2022, compared to the extent of flooding on September 1, 2022, confirms that the area of flooding around Manchar Lake in the south has increased.



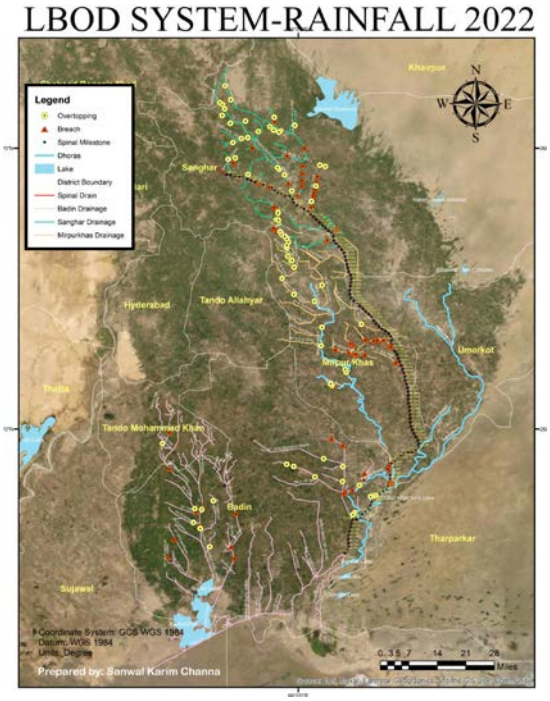
Source: SID

Figure2.4.8 Time Series Changes in the Extent of Submergence of the 2022 Flood in RBOD Area

2) Light Bank Outfall Drain (LBOD) Area

A large area of farmland on the left bank side of Indus River downstream of the Sukkur barrage is called LBOD area. Water drawn from Indus River by the Sukkur and Kotri barrages flows southward and eventually drains into Arabian Sea.

In the 2022 flood, rainfall within LBOD area caused many channel overflows and overflow breakdowns, causing flooding.



Source: SID

Figure2.4.9 Damage to Drainage Networks in LBOD Area during the 2022 Flood

3) Manchar Lake

Manchar Lake is surrounded on the south by high-elevation terrain connected to hills and on the north by dikes. The top elevation of the northern embankment is RL.128 (128 feet above sea level) in the range of RD.0~62 and RL.131 in the range of RD.62~100, and the water level RL.123 of the lake surface is regarded as the dangerous water level in consideration of heights of waves and freeboard.

Table 2.4.6 Top Elevation of Dike of Lake and Flood Water Lavel of Manchar Lake

Item	At the time of the 2010 flood	At the time of the 2022 flood	Remarks
Top Elevation of Dike [RL.ft]	125	128	In RD.0~62 (RL.131 in RD.62~100)
Critical Lake Water Level [RL.ft]	121.6	123	
Lake Water Level during Flood [RL.ft]	122.65	123.3	

Source: SID
RL.: Reduced Level (The Mean Sea Level is RL.0) (1 ft=0.3048 m)

In order to improve the drainage capacity from Manchar Lake, SID considers the renovation of three drainage facilities (Aral Head, Aral Tail, Danister) to be effective.

4) Malir River

For well water use and irrigation water supply in Malir district, there are three groundwater recharge dams (Malir Weir 1, 2 and 3) and a groundwater recharge dam (Thaddo Dam).

At the downstream of Malir Weir 1, the left bank abutment was destroyed during the 2020 flood and has not been repaired yet. The extent of the damage spreads to the upstream and downstream

revetments and apron of the weir. As a result, water can not be stored and the purpose of the weir can not be fulfilled. In addition, the river bed is scored and fallen at upstream and downstream of the weir.

In Malir Weir 2 and Malir Weir 3, which are located upstream of Malir Weir 1, sub-dam, riverbed protection and revetment are damaged. There is no damage to the main body of the weir, and although the purpose of recharge of groundwater has been achieved as of now, it is expected that the main body will eventually be affected if not repaired.

Malir Weir 1: Abutment section on the left bank has been destroyed.
Since ground consists sand and gravel, it is easily eroded.

Malir Weir 1: Foundation of weir exposed due to lowered riverbed at downstream of weir

Malir Weir 1: Left side wall separated from main body

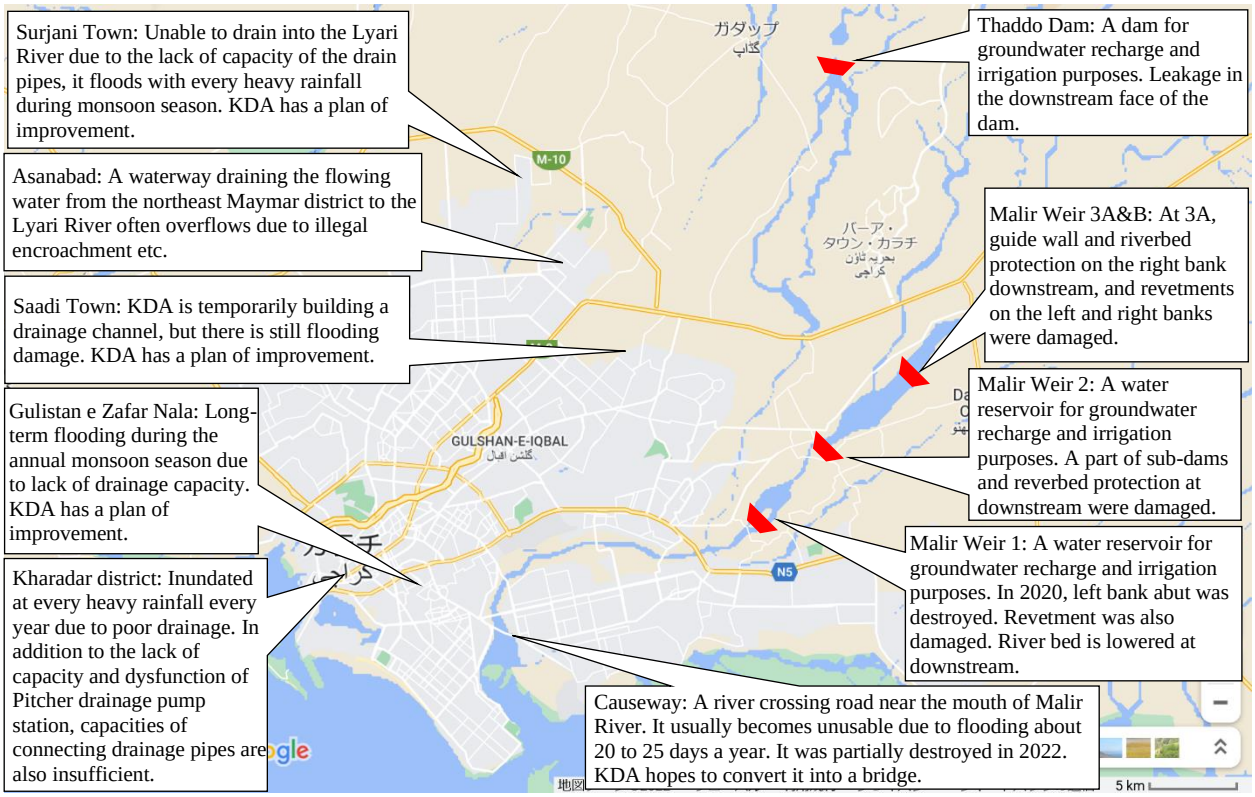
Source: Photo by Advisory Team

Photo 2.4.1 Situation of Malir Weir 1, Sindh (September 2022)

Leakage can be seen in the downstream face of the main body at Thaddo Dam. At present, the reservoir level is maintained. Main body of dam is earth fill dam and surface of the earth dam is covered with concrete. This type of structure is not suitable as overflow weir. Small leakage may become large leakage and it may lead to the failure of the dam in the future. A detailed investigation is needed.

(2) Karachi Development Authority (KDA)

KDA is responsible for inland flooding, water supply, sewerage and road management in Karachi. There are many drainage problems in Karachi, and the Causeway, which was built near the mouth of Malir River, is damaged every time it floods and is a major impediment to traffic.



Source: Advisory Team

Figure2.4.10 Karachi Development Authority (KDA) Interview Location Map

1) Inland Water Flooding Problem in Karachi

Inland water drainage problems occur frequently in Karachi. In addition to the lack of capacity of existing drainage facilities (drainage channels, drainage pipes, drainage pumping stations), insufficient maintenance works (especially cleaning work) of drainage facilities, a decrease in drainage capacity due to a large amount of garbage flowing into drainage canals, and illegal occupation of drainage canals (construction of buildings, encroachment) prevent adequate drainage of rainwater, resulting in frequent flooding during rainy season rains.

Drainage facilities in Karachi: (left) buildings constructed within drainage channel, (right) Pitcher drainage station, installed in 1993, aging and lacking drainage capacity

Source: Advisory Team

Photo 2.4.2 Existing Drainage Channels and Drainage Pumping Station in Karachi (September 2022)

To resolve the inundation problem, it is necessary to develop drainage facilities in a planned manner based on the results of technical investigations and study. In addition, since KDA doesn't have any equipment and knowledge of maintenance of drainage pipes, clogged drains are renewed through

replacement work by KDA. In order to carry out proper maintenance of drainage facilities, it is effective to procure equipment for maintenance of drainage pipes, such as sludge suction vehicles, high-pressure washing vehicles, and drainage pump vehicles.

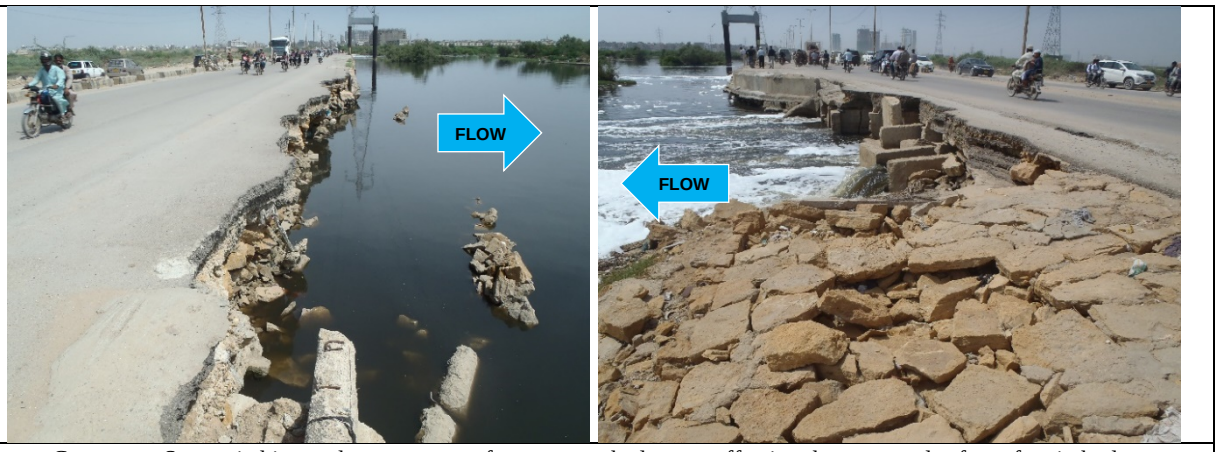
2) Causeway

The river crossing structure in Karachi, called Causeway, is a river crossing road near the mouth of Malir River. The Causeway becomes unusable due to flooding for 20 to 25 days every year. During the monsoon season in 2022, a part of the Causeway was damaged by overflow of river water and was cut off. The city of Karachi has hopes of converting the Causeway into a bridge.

The Causeway is a structure in which an embankment is constructed across a body of water or wetland to construct a road. It has a gentle slope in the longitudinal direction of the road, and water flows down the surface of Causeway. Normally, the Causeway is one of the options for a river crossing road that can be adopted under socioeconomic conditions that allow temporary impassability due to flood overflows during floods, and is constructed as a structure that is less likely to be damaged by flowing water overflows.

In Pakistan, the Causeway is generally used to cross the Hill Torrent River (which is not always water running), and the elevation of road surface is almost the same as the riverbed, making it resistant to overflow.

On the other hand, the Causeway, built near the mouth of the Malir River in Karachi, is constructed by embankment of earth material on the bed of the river, protecting the upper and lower sides of slopes with stone pitching, and surface of embankment is paved by asphalt concrete. The height of the Causeway from the riverbed is about 2 m, and these structural conditions of the Causeway are not strong against overflow.



Causeway: Stone pitching at downstream surface was washed away, affecting the structural safety of main body.

Source: Advisory Team Photography

Photo 2.4.3 Situation of Causeway near the mouth of Malir River, Karachi (September 2022)

2.4.3.4 Survey Results on 2022 Flood by Advisory Team (Punjab-Lahore)

A field survey and interviews with local government agencies were conducted to ascertain the 2022 flood damage situation in Punjab and to grasp the needs of assistance there.

(1) Punjab Irrigation Department (Irrigation Department, Government of Punjab)

Irrigation Department of Punjab Province (hereinafter referred to as "PID") is responsible for Indus River, Jhelum River, Chenab River, Ravi River and Sutlej River, Barrage, Main Canal (Primary Canal), Branch Canal (Secondary Canal) and Tertiary Canal, responding to the river flooding and Hill torrent floods in the province of Punjab.

In Punjab province, only D. G. Khan Irrigation Zone was affected by the 2022 floods. The flooding

was caused by the amount of Hill Torrent runoff from the Suleman Range exceeding the capacity of drainage facilities.

D.G. Khan Irrigation Zone suffered similar damage during the 2010 floods. Other major floods that occurred in Punjab include the 2014 floods, when Chenab, Jhelm and Ravi rivers overflowed and flooded.

The PID classifies flood protection areas into A (large cities), B (small and medium-sized cities), and C (towns and villages, agricultural lands) for countermeasures. Following the 2014 floods, the height of dikes of the above three rivers was raised by 6ft (about 1.8m). Some dikes in Multan Irrigation Zone were reinforced with steel sheet piles.

1) Damage in D. G. Khan Irrigation Zone

Largest ever Hill Torrent outflow from Suleman Range (discharged from Balochistan to Punjab) caused flood damage in D.G. Khan and Rajanpur.

Source: PID

Figure2.4.11 Damage of Facilities in D. G. Khan Irrigation Zone during the 2022 Flood

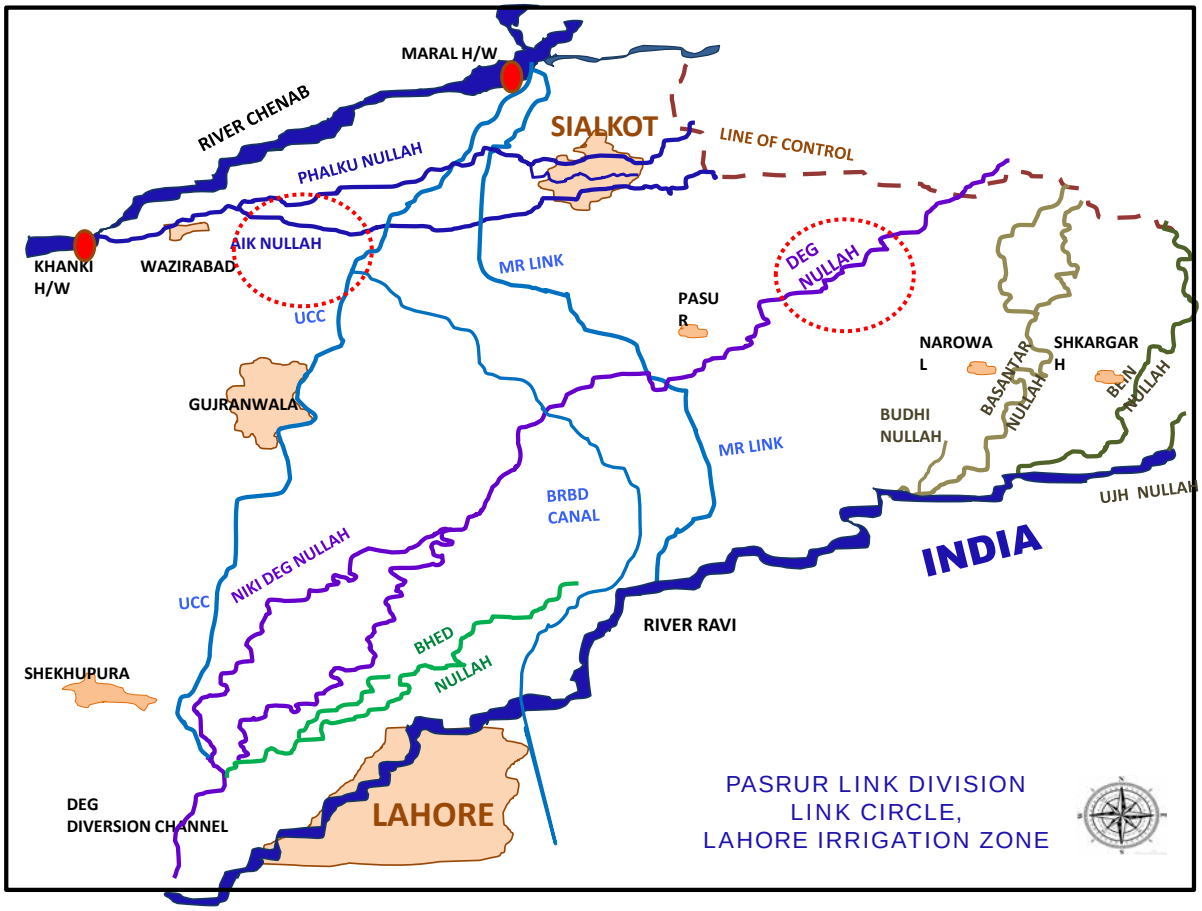
Water overflowed in several Canals and Drains and spread to the hinterland. 520,651 acres of the 3,706,580 acres of irrigation area were flooded.

The total number of damaged main irrigation facilities, such as canals, embankments and drains, due to flooding was 169 (Source: “Rehabilitation of Flood Affected Areas in Punjab.pptx” prepared by PID, Drainage & Flood, Zone Lahore). PID has the plan of rehabilitation work to be carried out under the budget of the Punjab Province.

Long-term structural measures against flash flooding from the Hill Torrent are planned by PID, including construction of dikes, spillways and retarding basin. ,Total project cost is expected to be around PKR165 billion.

2) Flood Issues in the Vicinity of Lahore

Ravi River flows from northeast to southwest at north of Lahore City, but the river does not overflow on its left bank near Lahore City. Right bank of Ravi River rarely overflows, but the damage is minimal because the land is farmland.

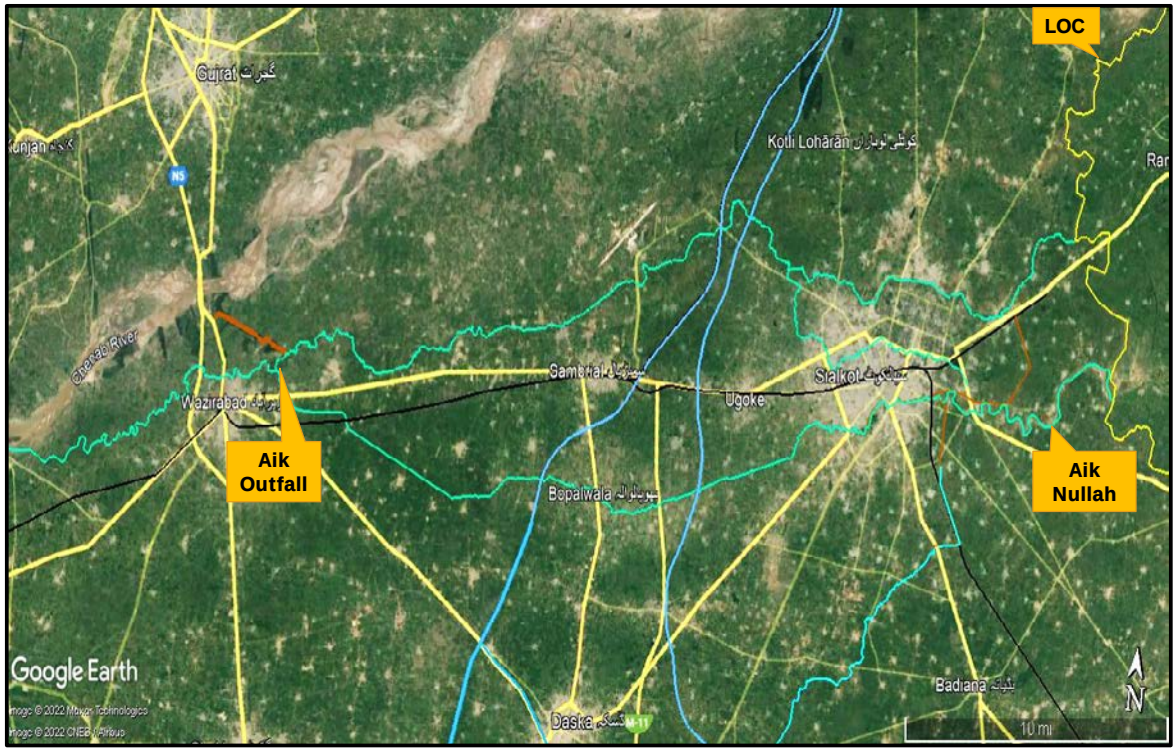


Source: PID

Figure2.4.12 Location Map of Rivers around Lahore

(a) Aik Nullah

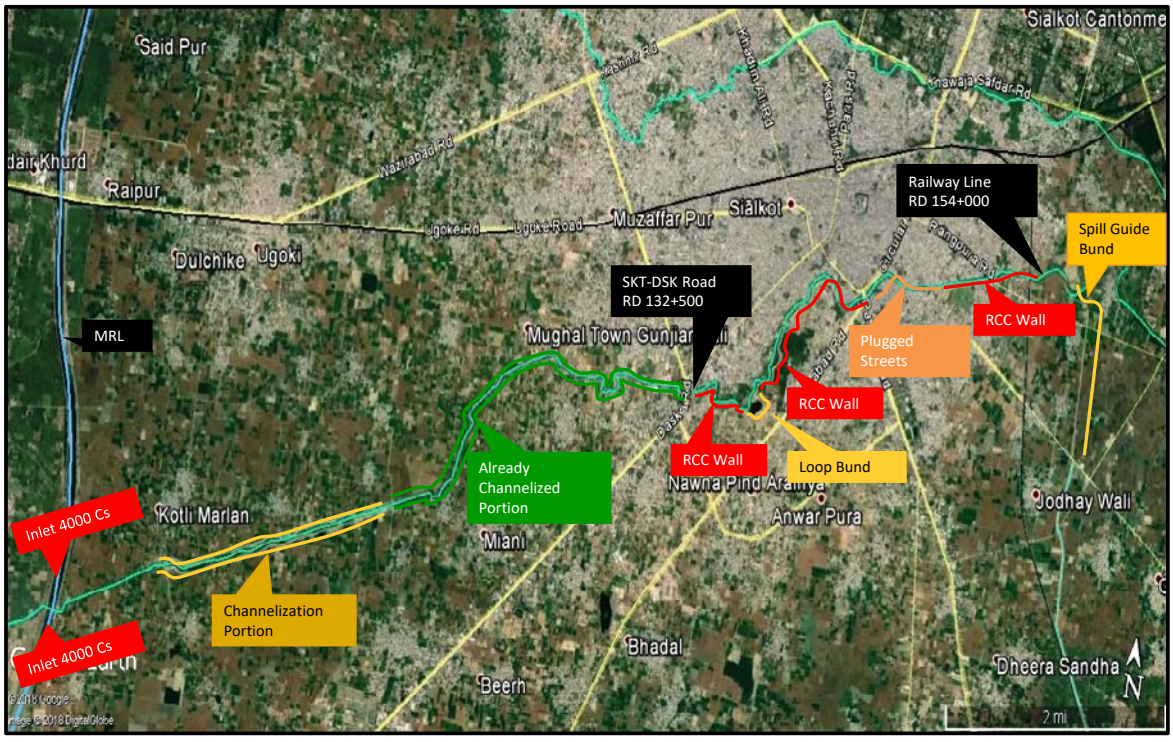
Some flood damages were reported in the city of Wazirabad (population approximately 500,000) near the point where the Aik Nullah and Palkh Nullah join upstream of the Khanki Barrage.



Source: PID

Figure2.4.13 Location Map of Aik Nullah, Wazirabad and Sialkot

Under the Annual Development Program (ADP) of PID, with the name of "Flood Protection of Sialkot against Aik Nullah", PID has a plan of construction of embankments, revetments, widening of Aik Nullah, and improvement of channel crossing facilities in the vicinity of Sialkot. A consulting firm named Barqab conducted the Feasibility Study.



Source: PID

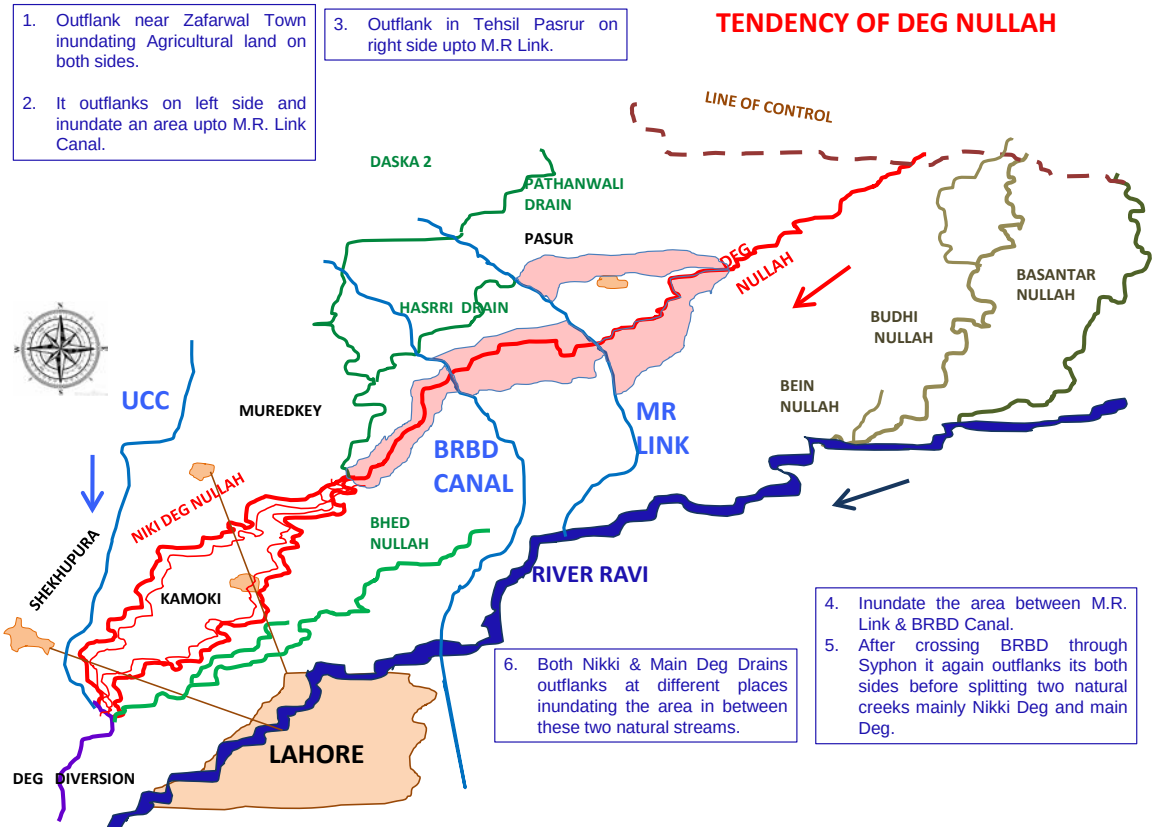
Figure2.4.14 Location Map of "Flood Protection of Sialkot against Aik Nullah"

(b) Deg Nullah

Deg Nullah flows into Pakistan from Indian territory and flows into Ravi River from northeast direction of Lahore City.

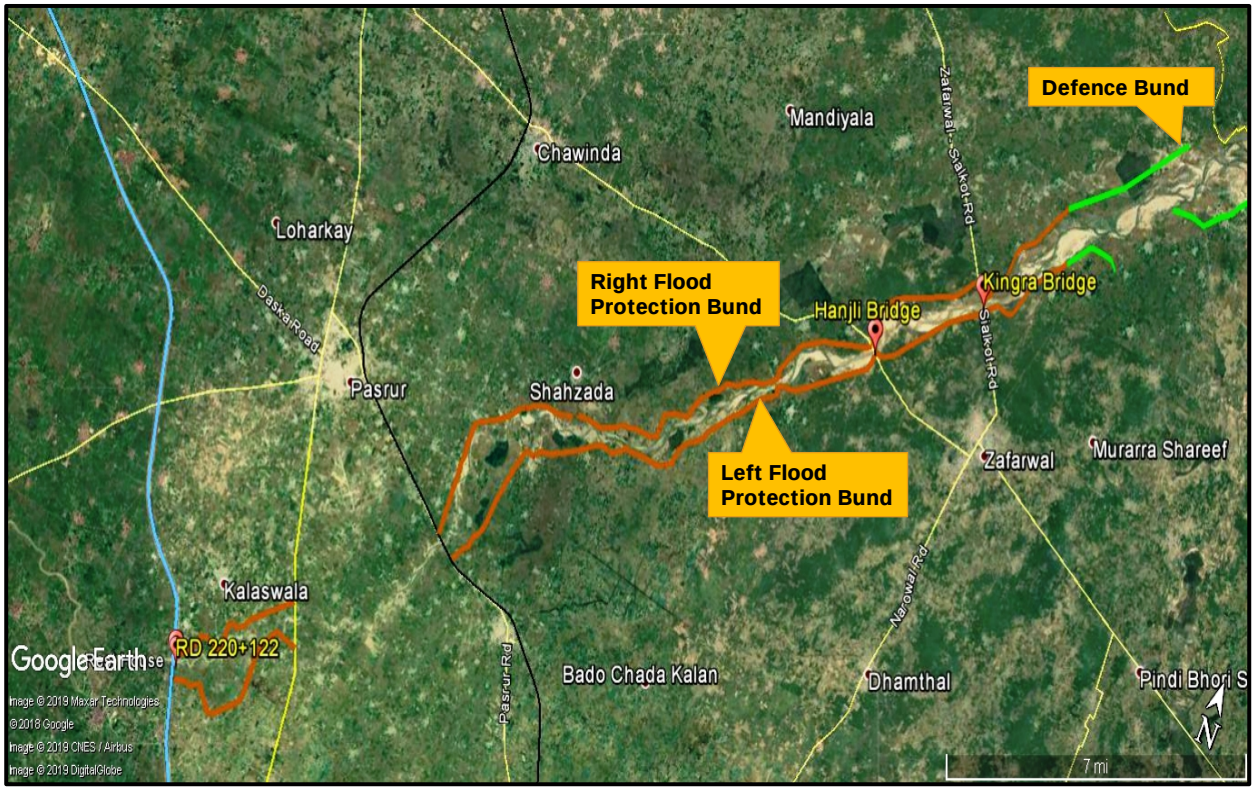
In Deg Nullah, where riverbank erosion is significant due to meandering, the erosion is controlled by strengthening of dikes and constructing studs.

Almost every year, minor damage to river structures (mainly studs) is caused by flash floods during the monsoon season, and repair works are made.



Source: PID

Figure2.4.15 Explanation Map of Deg Nullah



Source: PID

Figure2.4.16 Location Map of River Structures (Dikes) in Deg Nullah

3) Punjab Barrage Rehabilitation and Modernization Projects

Project Management Office (PMO) of PID is responsible for the management of the intake weir (Barrage) and "Punjab Barrage Rehabilitation and Modernization Project", a rehabilitation project of the Barrage in Punjab.

(a) Ongoing Barrage Widening Works

PMO of PID is undertaking following barrage widening works by ADB fund.

- Panjnad Barrage: Widening by adding 5 gates, July 2022
- Trimmu Barrage: Widening by adding 13 gates, December 2020 commenced.

It is expected that the breach at upstream of these barrages will cease in the future once the widening work at each barrage is completed. It is anticipated that increased flow from Panjinad and Trimmu Barrages may cause problem at Guddu Barrage.

(b) Improvement of Taunsa Barrage

Among 65 gates of the Taunsa Barrage, 29 gates were renovated by Japan's Grant Aid Project. Gate opening/closing devices were electrified and construction machineries were procured by the Project (completed in 2009). Gate openers are relay systems that are manually turned on and off, but PID hopes to introduce automatic operation system.

36 gates of 65 gates in Taunsa Barrage were renovated by a Chinese company with World Bank funds. The Chinese company installed system of the "Supervisory Control and Data Acquisition (SCADA)", a remote monitoring and control system for the barrage, but it is not working now.

Table 2.4.7 Present Status of SCADA installed in Punjab Province

Name of Barrage	Present Status	Note
Jinnah	Working	
Trimmu	Working	
Panjnad	Value Engineering is in progress	
Khanki	Working	Installed by Schneider Electric
Baloki	Value Engineering is in progress	
Taunsa	Not Working	
Taunsa	Working	Installed by Chinese company

Source: PID-Barrage, SCADA : Supervisory Control and Data Acquisition

(c) Improvements of Hydraulic Testing Facilities

PID Research Zone would like to upgrade an existing test laboratory near Sialkot (90 km from Lahore) for hydraulic testing of dam and barrage facilities, but they need the technical and financial assistance of donors.

(2) Flood Forecasting Division (FFD)-Pakistan Meteorological Department (PMD), Lahore

Since meteorological observations began in Lahore in 1860, the average atmospheric pressure during monsoon season has been 994mmb, while it was 991mmb in 2022. In 2022 Monsoon season, movement of nimbus was the first such case in the past 100 years.

In 2022, the Glacial Lake Outburst Flood (GLOF) began in late April. There are plans to establish Automatic Weather Stations (AWS) at 24 locations for GLOF observations. FFD has a study report on the relationship between GLOF and temperature.

Two tidal level (Tide) stations were established with World Bank funds.

In coordination with WAPDA, flood peak cut operations are undertaking at Mangla Dam and Tarbela Dam.

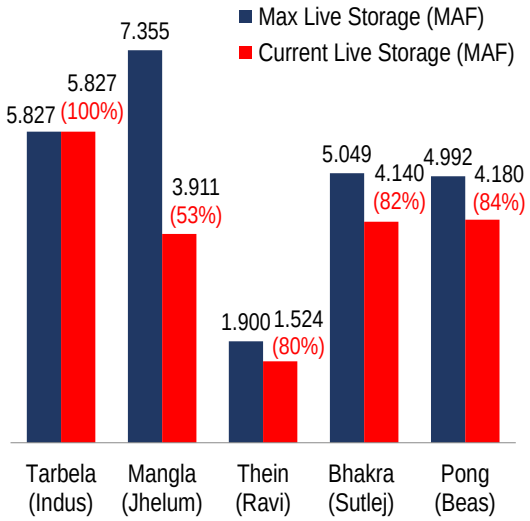
(3) Water and Power Development Authority (WAPDA), Lahore

The main purpose of dams under WAPDA jurisdiction is irrigation and hydropower generation. Although they do not have flood control capacity, they are capable of substantially regulating floods by manipulating their storage levels. Flood control operation is being carried out at the Tarbela Dam, Mangla Dam and Chasma Barrage.

WAPDA's contribution for flood protection/management consists of (1) Dam-based Flood Control (i.e., pre-discharge from dam based on the results of rainfall and flow observation in the upstream area to predict peak flows) and (2) Hydro-Met Data Sharing.

In coordination with the PMD, operations are underway to shift flood peaks at Mangla Dam and Tarbela Dam.

In 2022, the water level of Tarbela Dam began to drop in February and dropped to the Dead Level (lowest level) on July 10, 2022. During the period July 11-August 24, precipitation was low, but warm temperatures allowed snowmelt to flow into the dam and restore reservoir levels. Water volume stored in reservoir and storage ratio of the dam as of September 8, 2022 are shown in the next figure.



Source: WAPDA/PID

Figure2.4.17 Water Storage for Major Dams under WAPDA Jurisdiction (September 8, 2022)

Tarbela dam on Indus River was full, but there is plenty free space of storage in dams on the tributaries.

Currently, WAPDA has plans underway for the following five dams, which it believes will contribute to flood control once completed.

Table 2.4.8 On-going Dam Construction Plan/Project of WAPDA

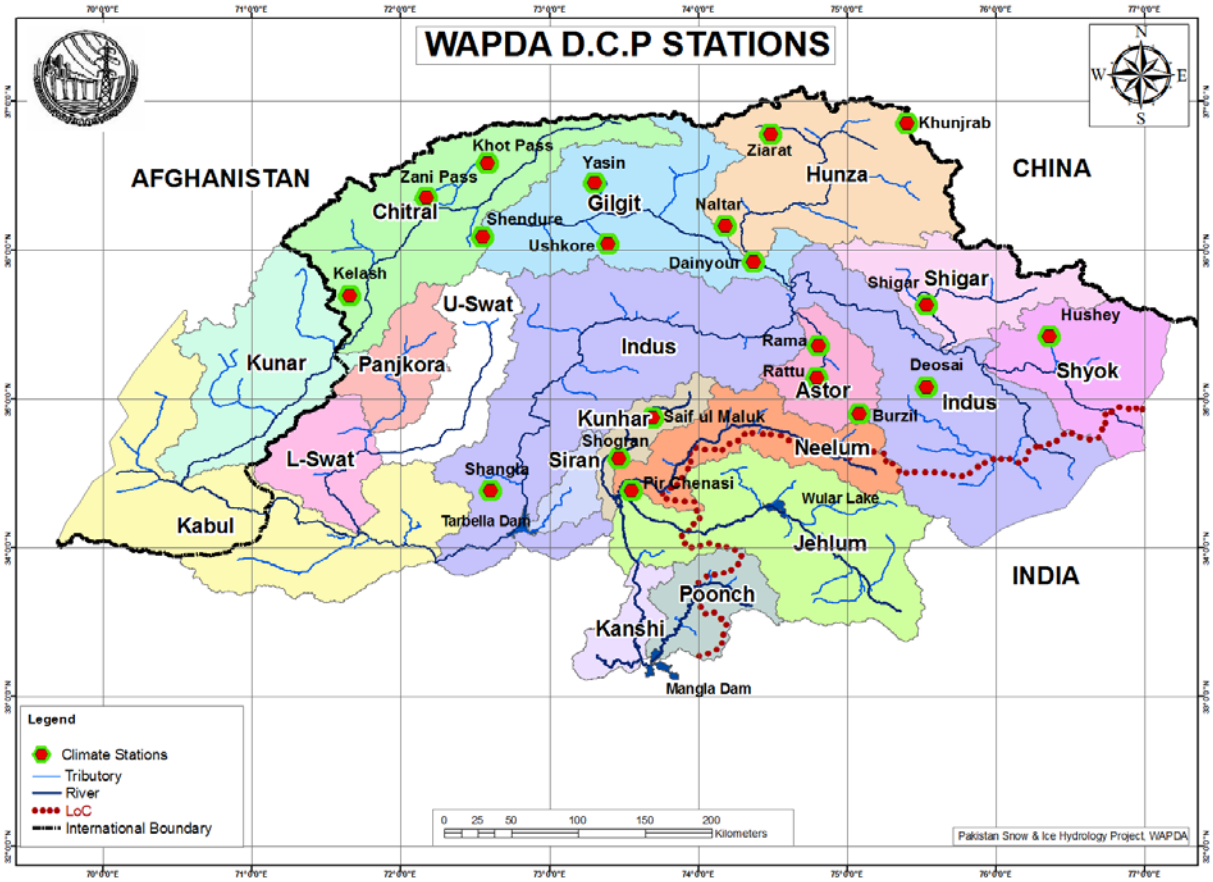
Name of Dam	River	Province
Mohmand Dam (Munda Dam)	SWAT River	KPK
Diamer Basha Dam	Indus River	Gilgit
Naulong Dam	Mula River	Balochistan
Chiniot Dam	Chenab River	Punjab
Nai Gaj Dam	-	Sindh

Source: WAPDA

Source: WAPDA

Figure2.4.18 Location Map of On-going Dam Construction Plan/Project of WAPDA

In addition to above, Glacier Monitoring & Research Centre of WAPDA uses Data Collection Platforms (DCP's) for GLOFs Monitoring.



Source: WAPDA

Figure2.4.19 Location Map of WAPDA's GLOF Monitoring Stations for Data Collection Platforms

(4) Water and Sanitation Agency (WASA), Lahore Development Authority (LDA)

WASA-LDA formulated "Master Plan for Water Supply, Sewerage and Drainage System for Lahore" in 2019. Based on this master plan, 11 Water Storage Tanks (underground rainwater reservoir) are being planned in Lahore, one of which has been completed and two of which are under construction. PC-1 for implementation of the remaining construction of Water Storage Tanks with ADB funds has been submitted to the Government of Pakistan and is awaiting approval.

The completed Water Storage Tanks have a capacity of 1.4 million gallons. Before the construction of Water Storage Tanks, inundation with depth of 2~3 ft was often occurred near there, but after the construction, no inundation has occurred. Only rainwater drainage is stored and no sewage flows in. The stored water is to be used by Punjab Horticulture Authority (PHA).

Source: WASA, Lahore

Underground Rainwater Reservoir: Outside

Underground Rainwater Reservoir: Inside

Source: Advisory Team Photography

Photo 2.4.4 Underground Rainwater Reservoir of WASA, Lahore (September 2022)

Currently, Lahore city is experiencing inundation in several locations, but the damage is not severe and will be resolved in about 3-4 hours.

There are 14 large drainage pump stations under the jurisdiction of WASA in Lahore, and many smaller ones as well. Shadbagh Disposal Station is one of those large drainage pump station and was rehabilitated by Japan's Grant Aid Project from 2007 to 2012. This project consisted of replacement of pump equipment and auto raking machine of trash screen, and procurement of equipment for maintenance and management. Pump equipment and auto raking machine of Shadbagh Disposal Station have been properly repaired and maintained, and have been in good condition for 10 years since their rehabilitation.

Auto Raking Machine, installed in 2012:
Working in good condition

Auto Raking Machine, installed in 2012:
Garbage collection in progress

Pumping Station, Rehabilitated in 2012:
Inscription plate on the wall of pumping station

Pumping Station, Rehabilitated in 2012:
maintenance work of pump equipment

Source: Advisory Team Photography

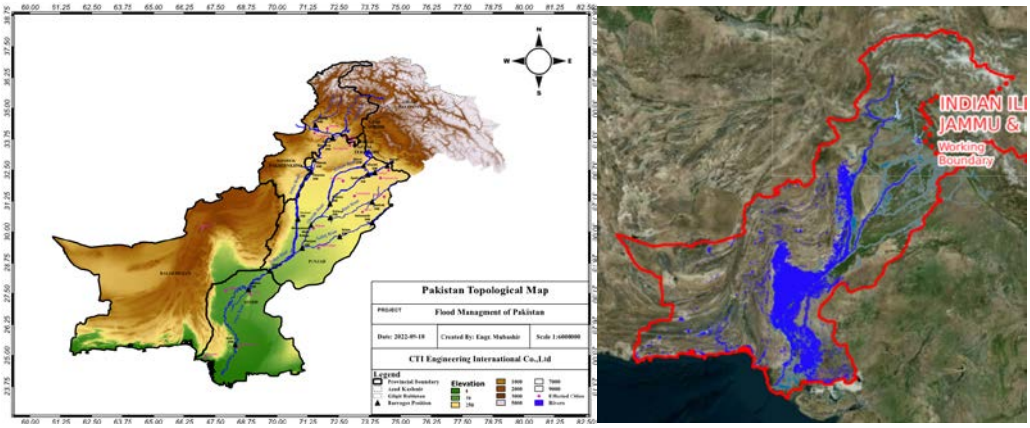
Photo 2.4.5 Present Status of Shadbagh Disposal Station, WASA (September 2022)

2.4.3.5 Flood Damage Situation and Potential of Damage Occurrence

Based on the cumulative damage amount and frequency of occurrence by disaster type shown in Figure 2.4.20, water disasters are the natural disasters that most impede Pakistan's economic growth. Certain low-lying areas are that are particularly prone to severe flood damage, and Figure 2.4.44 shows the low-lying areas that have been inundated by floods since the 2010 flood. This figure is a superimposition of satellite flooding images from multiple major floods, created by the Space & Upper Atmosphere Research Commission (SUPARCO) (currently developing information with support from the World Bank).

In addition, looking at the population distribution confirmed in the JICA internal survey on "Information Collection and Confirmation Survey on Disaster Prevention Investment Projects in the Flood Control Field", the population is concentrated near the main bunds of the Indus River, where there is a high possibility of flood hazards occurring. The 2010 and 2022 floods inundated irrigated areas in south-central Pakistan and relatively populated areas along the middle and lower reaches of the Indus River. Once the bund breaches, this area can easily be flooded, and when combined with heavy monsoon rains and runoff from Hill Torrents, it can cause very severe damage. Projects to reduce the risk of flood damage in such areas are essential for Pakistan's future economic growth. For reference, the flood design targets/criteria were set based on the conditions of 2010; however, the setting conditions did not include the fact that the flooding from the main river channel in the middle of the Indus River to the floodplain. In other words, since the plan was not based on basic flood design discharge which can be estimated on the condition that the all-flood water conveys in river channels. Therefore, there is a high possibility that the risk to the downstream area is increasing,

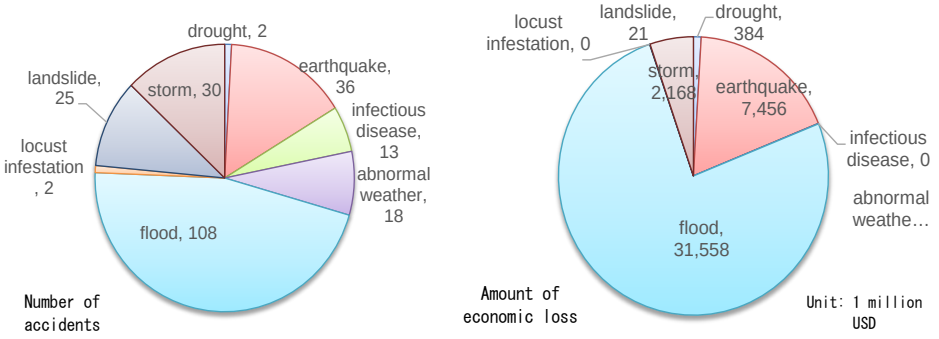
now that the bunds in the upstream area have been strengthened. It can be said that Pakistan is in a situation where they have no choice but to use artificial embankment cuts for the increment of flood water.



Source: Advisory Team (left)、SUPARCO (right)

Figure 2.4.20 Topography and Rivers in Pakistan (left) and Frequent Flood Areas (right)

Incidentally, inundation during the monsoon season in low-lying areas along the Indus River basin is often caused by water flooding from the main river with tributaries and Hill Torrent Nallah (seasonal rivers originating in mountainous areas). In addition, since it relies on agricultural drainage facilities for inland water treatment, wide-area flooding occurs due to regional heavy rains. As a result, the low-lying areas along the Indus River in the central-south part of the country are regularly flooded with water, to a greater or lesser extent, even during medium- to low-scale floods. Additionally, in 2014, there were reports that damage caused by bund partial breaches occurred in low-lying areas of the four major tributaries of the Indus River. Floods in these tributaries require a more detailed analysis because they are greatly affected by the water management of upstream catchment areas in India.



Source: Advisory Team based on EM-DAT

Figure 2.4.21 Frequency of Disaster Occurrence and Amount of Damage

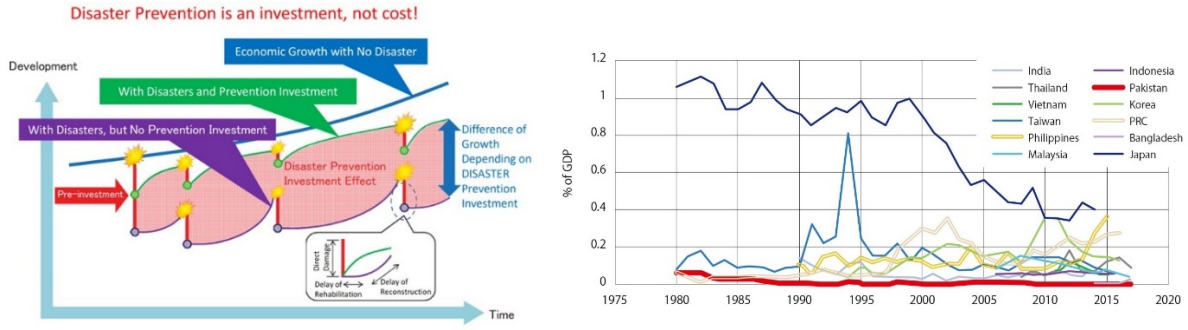
2.4.3.6 Necessity of Flood Management Policy for Effective Economic Growth

At the 3rd United Nations World Conference on Disaster Risk Reduction (Sendai Framework for Disaster Risk Reduction (2015-2030) was formulated), the gap between the Hyogo Framework for Action (HFA) and reality was sorted out as a lesson. One states, "During the ten years under the HFA, disaster prevention efforts have progressed; however, the human suffering, economic, social, health, cultural, and environmental damage caused by disasters has increased, hindering sustainable development.

In light of such gaps and the history of flood control in Japan, in developing countries where flood control is inadequate, not only humans protected by developing non-structural measures such as an early warning system, but also protection of farmland and buildings with their assets through pre-investment by structural measures is still essential in Pakistan for sustainable and effective economic growth. In recent years, Japan has implemented comprehensive flood management as a keyword for both (non-) structural treatments, but

considering the situation in Pakistan, where investment in flood control has been relatively small compared to other countries, flood control facilities may still be insufficiently developed.

Therefore, in Pakistan, urgent priority would be given to the development of sufficient flood protection plans and facilities. Flood control projects would be examined with the policy of implementing projects that are highly effective in reducing flood risk.



Sources: Book (Relationship between Economic Grouth and Disaster)(Left)、Bridging the Gaps in Infrastructure Investment for Flood Protection in Asia-JICA-RI Working Paper, Mikio Ishiwatari and Daisuke Saka (Right)

Figure 2.4.22 Relationship Between Economic Development and Disasters (left), and Comparison of Trends in the Proportion of Investment for Flood DRR in GDP in Asian Countries (right)

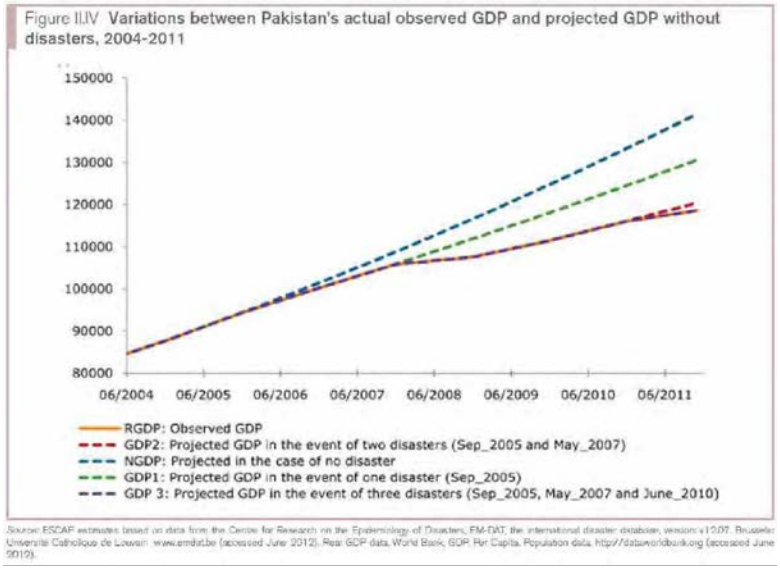


Figure 2.4.23 Simulation Results of Economic Growth with and w/o 2005 Earthquake and 2010 Flood

2.4.3.7 Objectives on Flood Control from the Perspective of Natural and Social Conditions

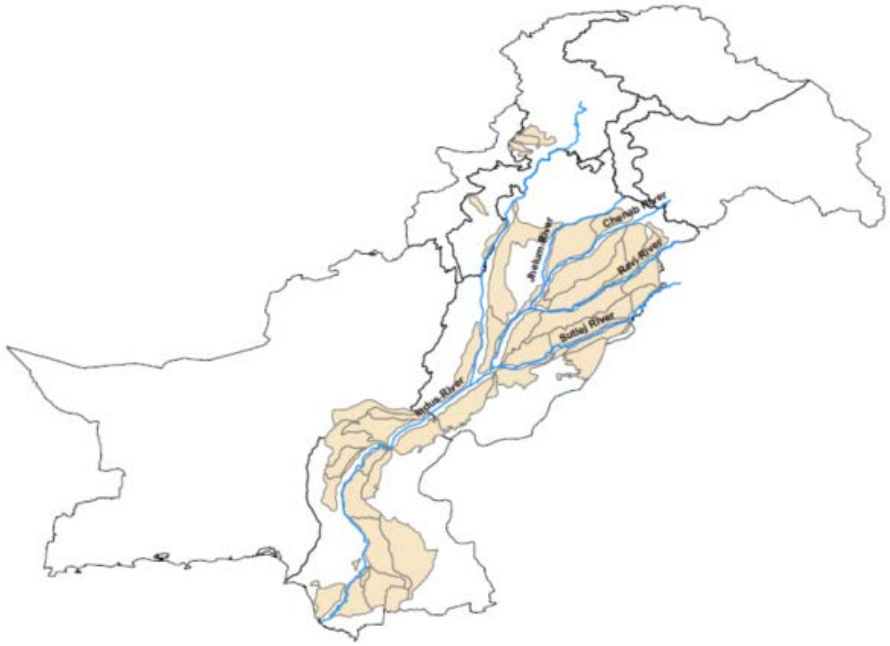
Floods are the most frequent disaster in Pakistan, and judging from the history of disasters, they cause damage to both human life and property almost every year. Approximately 60% of the country's land is mountainous and the rest is low-lying area along the Indus River system, and both areas have been exposed to water disasters. In addition, the flood risk is increased by the uncontrolled concentration of population and assets in flood-prone areas (see Figure 2.4.25) and inadequate technical and institutional guidance for river basin management. Figure 2.4.24 shows the irrigation areas where water is distributed using the gravity water supply method (development began around 1854, and approximately 60-70% of the potential area has been developed) and these low-lying areas are exposed to flood damage.

Based on the above social and natural conditions, the flood risk situation and objectives of projects in Pakistan are organized into northern, central, southern, and western regions as shown in Table 2.4.16. Among them, the central and southern low-lying areas (Punjab and Sindh provinces) in particular are

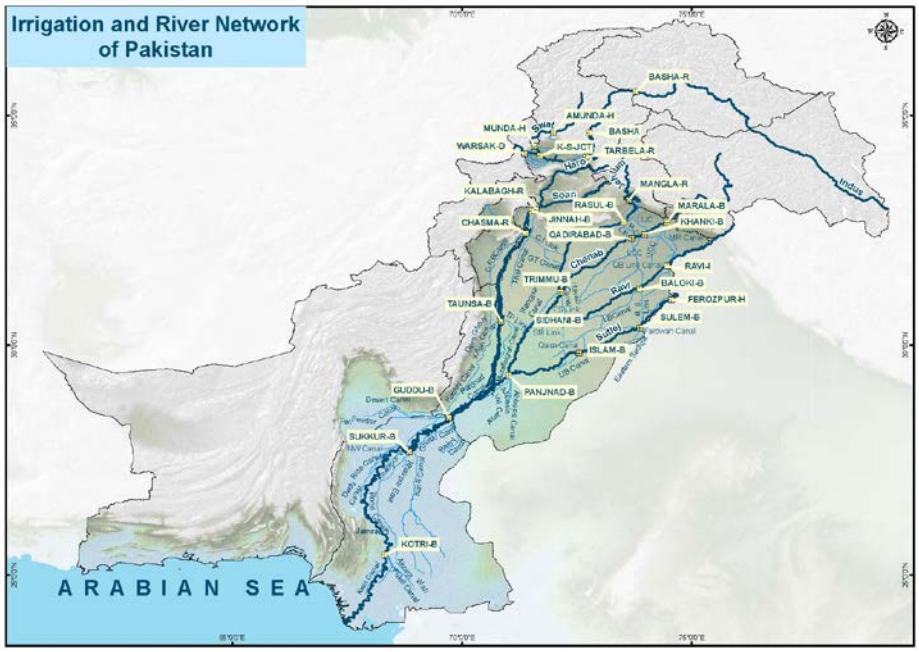
affected by the flooding of seasonal rivers (Nullah) originating from the mountains of Balochistan or local hills and mountains, and the main and tributaries of the Indus River system. Although structural measures are underway in these areas by reinforcing river facilities, irrigation facilities, and inland water drainage systems, flooding from both rivers and downpours still occurs frequently and is hindering Pakistan's economic development.

Coupled with the gentle slope of the floodplain and inadequate drainage systems against floods, the period of flooding in these areas is relatively long. In particular, the low-lying land along the right bank of the Indus River in Sindh and Punjab province has the Hill Torrent of Balochistan to the west, and the water level of the Indus River in the east tends to be higher than the ground during the monsoon season. As a result, drainage is poor compared to other areas. The limits of drainage in these areas and the height of groundwater levels during the monsoon season also contribute to prolonged flood inundation.

On the other hand, in the mountainous regions of the north (mainly north of KPK Province), towns and villages are affected by unpredictable flash floods, debris flows, glacial lake outbursts, landslides, etc. and the infrastructure of public facilities has been damaged. Large-scale floods in 2010 and 2022 caused damage to a large social impact, such as the collapse of buildings and houses due to riverbank collapses and the destruction of bridges due to flash floods. Moreover, since there are many poor people in the mountainous area, it can be inferred that the economic recovery will be slower than in the Punjab and Sindh provinces. Although WAPDA and PMD have installed early warning systems and river management equipment in these areas, and have set up forecasting/warning/observation systems as appropriate, looking at past human losses, it is clear that such information is not being properly communicated to the inhabitants. Since there are many rapid-flow rivers, it is difficult to quickly reduce hazards through only structural measures.

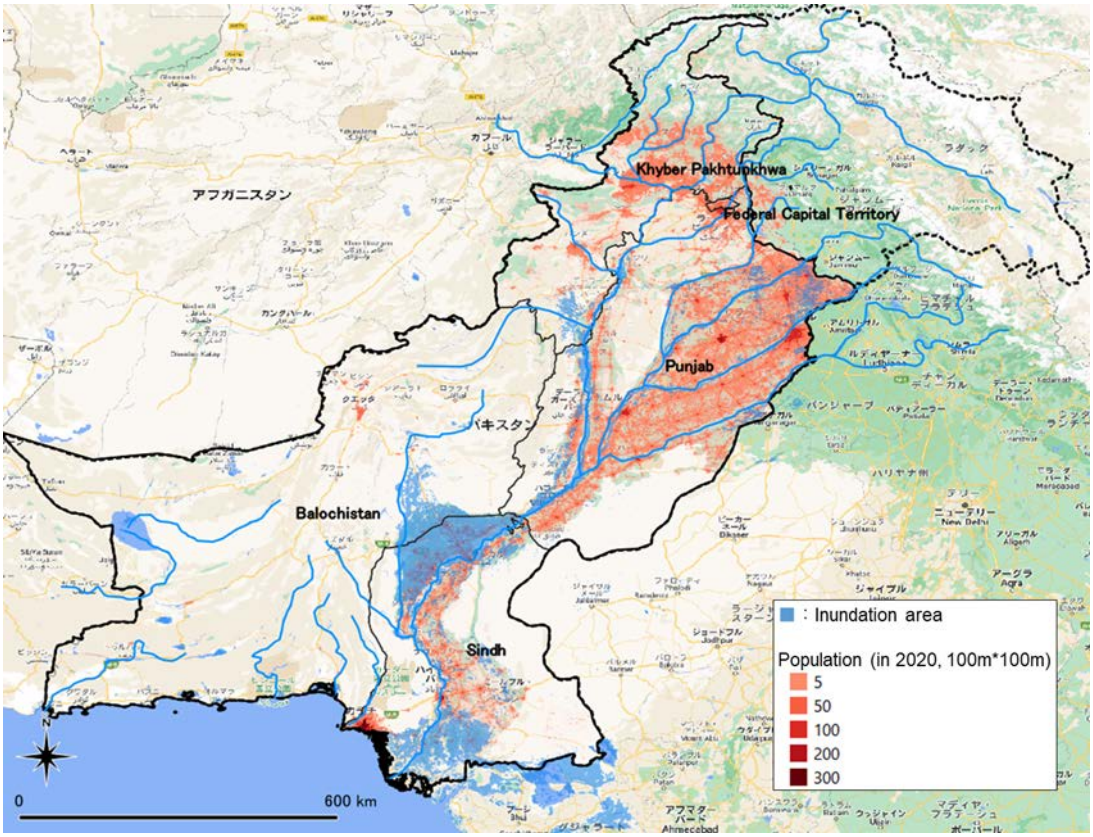


Source: An empirical analysis of the hydropower portfolio in Pakistan (2012, Afreen Siddiqi)



Source: IRSA

Figure 2.4.24 Irrigation Command Area by Gravity Transfer System



Source:UNOSAT and Worldpop

Figure 2.4.25 Population Distribution and 2022 Flood Area

2.4.3.8 Weaknesses of Legal and Fund Allocation System for IFM

FFC is mainly responsible for planning national-level flood protection projects and managing issues before MoPS-PC approval. However, some flood control projects are not managed by FFC (especially in progress and completion confirmation). In particular, for (1) direct financing projects from Multi Development Bank (MDBs) to provinces and ministries, and (2) NDRMF projects in which FFC is not involved, FFC would be placed in an administrative system that would not formally inform FFC about commencement, progress and completion of the projects.

This situation is not suitable for overall flood management in the Indus River system. For example, inconveniences may occur in the following situations.

As FFC cannot grasp the timeline of the commencement and completion of flood control projects,

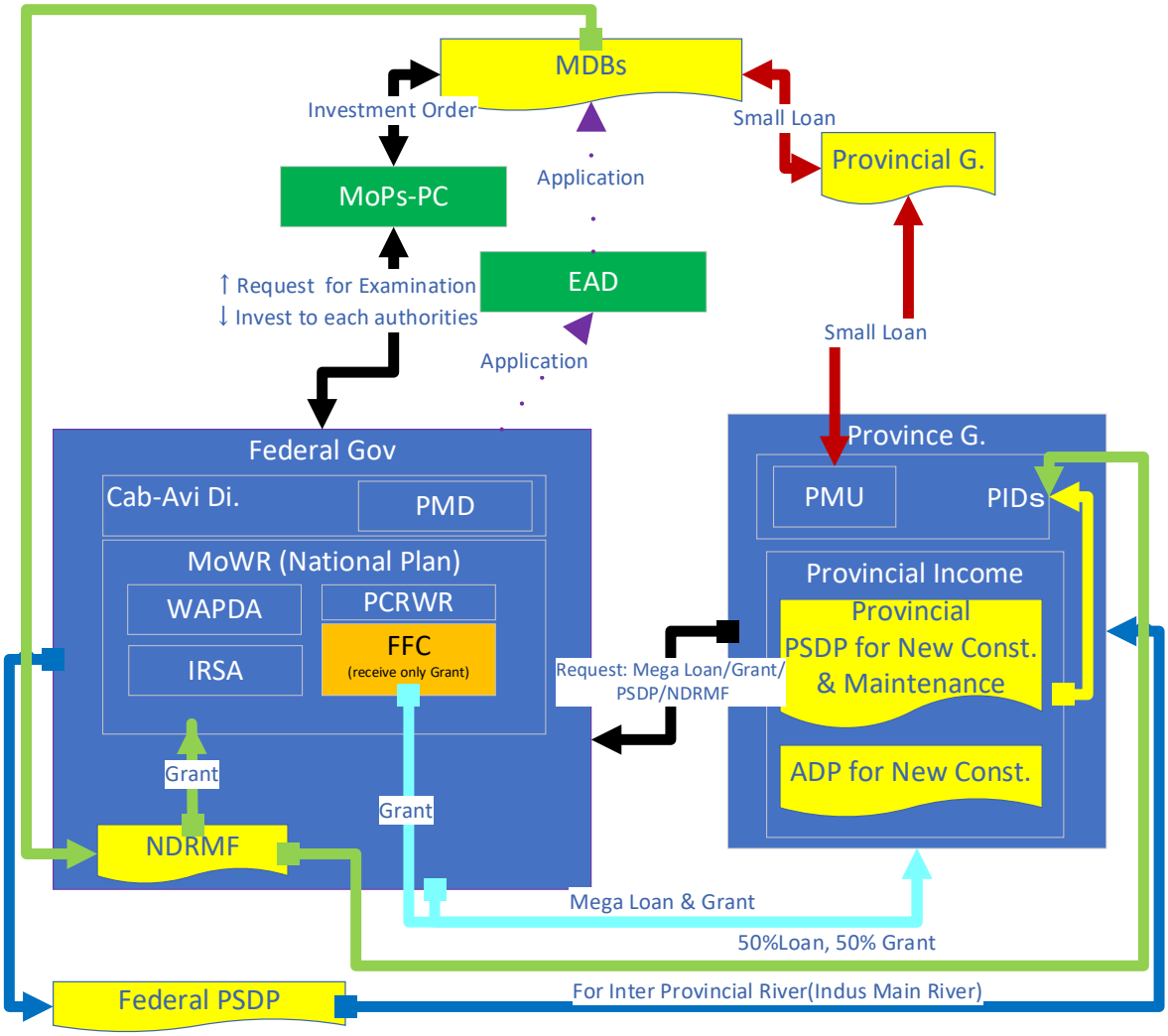
- After a disaster and during the normal phase, it becomes difficult to make quick and accurate independent adjustments through FFC for the sake of related organizations and development partners.
- FFC is unable to harmonize flood control levels in Inter-Provincial River basins such as the Inter-Indus River and Hill Torrent. Furthermore, it is impossible to propose appropriate projects from a bird's-eye view of the entire target basin.

Therefore, it is necessary to develop the following legal and financial systems:

- Management competence of MoWR-FFC for the commencement, progress and completion of flood control measures for especially inter-provincial rivers and basins will be legally strengthened.
- FFC and PID should prepare digital communication tools/databases that will make monitoring of flood control measures implemented by PID and related organizations more efficient and easier.
- Hold a donor meeting hosted by FFC to encourage information sharing and coordination among development donors and funds, and understand the intentions and policies of development donors as

appropriate.

- Require donors or project management agencies such as PMUs in charge to report to the FFC promptly on the progress and completion of projects implemented with investment funds by development donors.



Source:Advisory Team

Figure 2.4.26 Outline Flow of Investment in Flood Control Measures

2.4.3.9 Developing Laws, Guidelines, and Information for Drafting and Updating National Flood Control Plans

By National Water Policy 2018, the Integrated Flood Management (IFM) advocated in the NFPP-IV should be organized more rationally based on scientific evidence. In workshops and weekly consultations with the Chairman of FFC, the advisory team has pointed out that DRR measures that provide better protection of human lives and assets should be prioritized. Furthermore, to implement and manage flood protection projects, FFC will need further information and system/tool development. The advisory team recommends promoting the development of the following legal/organizational/information management systems.

Table 2.4.9 Items to be Developed and Promoted for the Formulation of an Appropriate NFPP by FFC and System of Project Management

No.	Items	Background/Contents
1	Appropriate revision of the River Act	The old River Act continues to be used as it is, instead of complying with the River Act proposed by the FFC. Due to the influence of influential people who have vested interests in river areas, it seems difficult to revise it.
2	Developing a Bund Manual according to regional characteristics	Since there is only a manual for the Sindh province, a manual tailored to the characteristics of the region is needed. To this end, it is important to establish a forum for technical exchange of opinions on policies and methods for bund maintenance and inspection at FMC to improve manuals and practical skills.
3	Integrated management of basic information on rivers	Since the basic maintenance status of bunds and water systems cannot be grasped by the FFC, it is difficult to formulate overall basic policies for bund development and measure the appropriateness of related projects.
4	Aggregation and management of data necessary for runoff/flood analysis	Aggregate and accumulate information such as (1) hydrometeorological data, (2) watershed exposure data, (3) river channel data, (4) LiDAR data, and (5) satellite image data, which are necessary for runoff/inundation analysis. Hydro-Met data will be sent to FFC, the co-host agency for WAPDA's Telemetry System, in the near future. In addition, PID & PMD daily observation data are preferably sent to FFC. Also, ensure PC approval of the existing LiDAR data creation plan. Regarding satellite images, information should be shared with SUPARCO..
5	Building a runoff analysis model to verify the effectiveness of flood countermeasures	A runoff analysis model for the Indus River will be constructed to verify the effectiveness of the proposed flood countermeasures. It is also used for hazard management of flood inundation caused by man-made and natural breaches of bunds. It is efficient to utilize/improve existing models owned by PMD. Influence of breach will also be used in the Breach Operation Committee.
6	Formulation of climate change adaptation policy and guidelines	Based on the climate change policy formulated by MoCC, technical guidelines for developing and planning adaptation measures should be developed.
7	Development of clear planning and design criteria	Formulate guidance for determining the design scale of flood control facilities for provinces and PIDs.
8	Creation of Hazard Map	Using the above model, create a hazard map on GIS in preparation for a bund breach case. Share with NDMA and use for Response activities.
9	Asset management of flood control infrastructure stock	Manage the location of flood control assets and associated information that contributes to long-term O&M of flood control and water utilization facilities on a GIS database.
10	Reinforcement of bund management system to help ensure better DRR effect	Based on the asset information (item 9) above, reduce flood damage caused by bund erosion/infiltration (sliding, piping etc.)/collapse as much as possible
11	Organizational improvement of FFC	Reformation of the FFC organizational structure that enables the execution of the above items (1 to 10) and the resolution of bottlenecks described in 2.4.3

Source:Advisory Team

2.4.3.10 Fundamental Policy of JICA on Formulation of Flood Protection Project Policy

Based on the results of the advisory activities mentioned above, the advisory team discussed with JICA to formulate the policy on the formulation of the JICA project for Flood DRR. As a result, JICA will form a priority cooperation project based on the policy in .

The outline of the policy was explained by JICA to the related governments of Pakistan and other development partners in November 2022. In addition, the advisory team also explained through presentations to FFC staff and Chairman, and ADB-FPSP-III officials.

Table 2.4.10 JICA Support Policy on Flood Risk Reduction in Pakistan

Items	Description
Overriding Principle	Develop supports that contribute to reducing economic losses in Pakistan through disaster risk reduction by flood protection measures in the Indus River Basin.

Items	Description
Policy for Project Formulation	【Approach】 ➢ Responding to the Sendai Framework for Disaster Risk Reduction focusing on economic development ➢ Intensive deployment according to the largest disaster risk of the Indus River ➢ Reduction of flood risk using existing assets ➢ Development of cooperation according to the flood mechanism
	【Narrative Description for the Approach】 ➢ Since considering disaster risk reduction as a development issue is essential for Pakistan along with the Sendai Framework for Disaster Risk Reduction, it is important to develop assistance that focuses on the reduction of economic damage. ➢ To this end, based on the actual damage caused by the 2022 and 2010 floods, JICA will concentrate his/her support on the main river of the Indus River system, which is considered to have a large concentration of assets to be protected and a high disaster risk in the event of a flood disaster. The relevance of expanding it systematically is high. ➢ JICA has prioritized flood risk reduction in Pakistan and is managing its existing programs. Therefore, since last year, JICA has conducted a preliminary survey of river basins that have a large macroeconomic impact, and has already started technical cooperation for the "Review and Update of the National Disaster Management Plan" and "Flood Management Advisor," so these assets will also be utilized. ➢ In Pakistan, the causes and mechanisms of damage are different among upstream, midstream, and downstream, so cooperation should be considered accordingly.

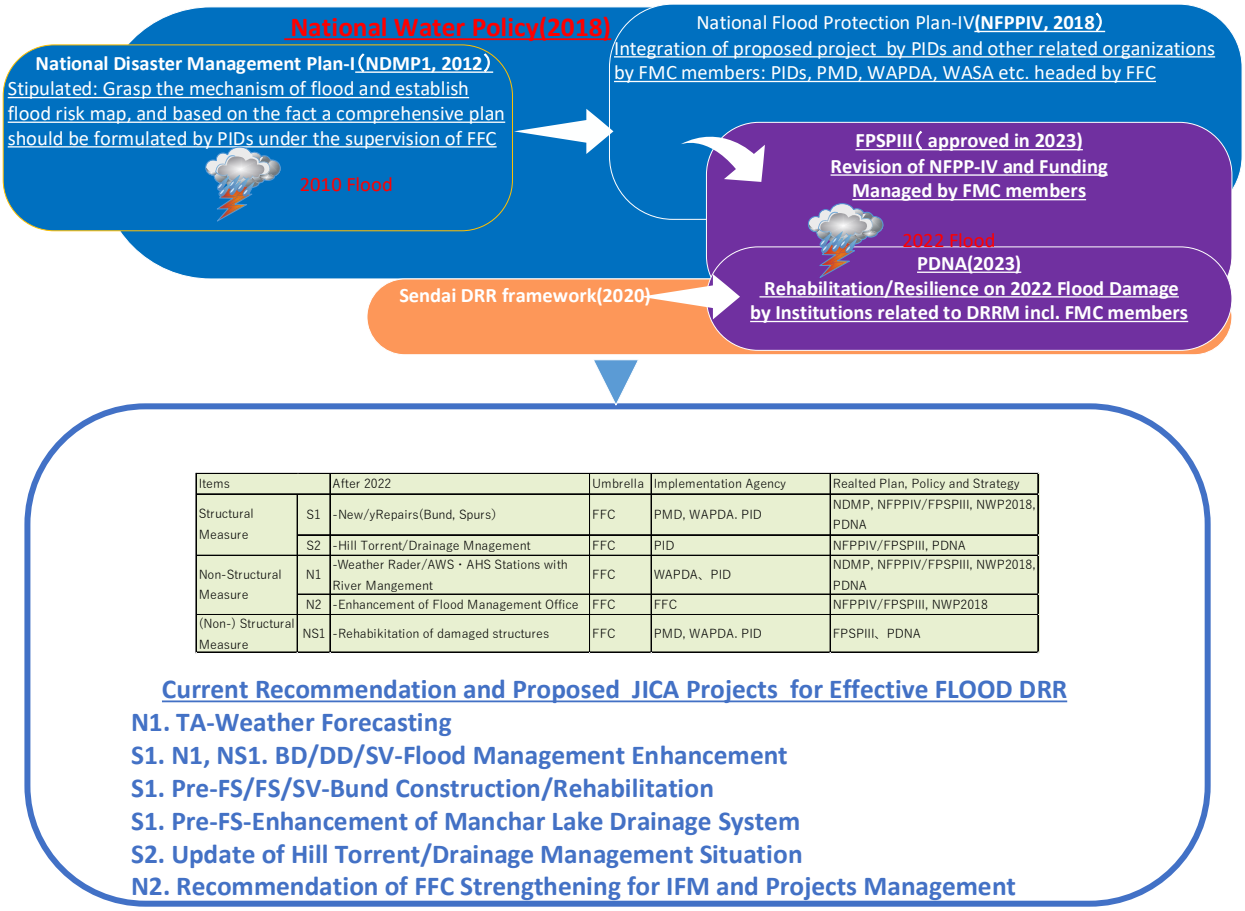
Source: JICA with Advisory Team

2.4.4 Activity 3-3 (1) Among the flood control projects examined in Activity 3-2, financial and/or technical cooperation projects should be organized and prioritized by JICA (Flow of Project Formulation)

The JICA projects proposed so far during the advisory activities are based on the flood management/protection policies on NFPP-IV based on NDMP and National Water Policy 2018. It is also consistent with the approach to recovery and rehabilitation in the flood sector based on PDNA which is harmonized with the Sendai Framework for Disaster Risk Reduction. The projects examined and formulated during the advisory activity are capable of implementing DRR more effectively in the following points.

- Protect populated areas along rivers by rebuilding, repairing, and reinforcing structures damaged by the 2022 flood.
- By constructing the main Indus River Bunds and strengthening the drainage capacity in developed low-lying areas, JICA will ensure the safety of social infrastructure, private facilities, and human lives in the floodplains where population and industry are concentrated.
- By introducing a river management system, related organizations will be able to easily understand the flood situation during the rainy season and ensure the safety of the target area and residents.

Figure 2.4.27 shows the flow that led to the formation of the project that JICA should undertake.



Items		After 2022	Umbrella	Implementation Agency	Realted Plan, Policy and Strategy
Structural Measure	S1	-New/yRepairs(Bund, Spurs)	FFC	PMD, WAPDA. PID	NDMP, NFPPIV/FPSPIII, NWP2018, PDNA
	S2	-Hill Torrent/Drainage Mnagement	FFC	PID	NFPPIV/FPSPIII, PDNA
Non-Structural Measure	N1	-Weather Rader/AWS・AHS Stations with River Mangement	FFC	WAPDA、PID	NDMP, NFPPIV/FPSPIII, NWP2018, PDNA
	N2	-Enhancement of Flood Management Office	FFC	FFC	NFPPIV/FPSPIII, NWP2018
(Non-) Structural Measure	NS1	-Rehabikitation of damaged structures	FFC	PMD, WAPDA. PID	FPSPIII、PDNA

Current Recommendation and Proposed JICA Projects for Effective FLOOD DRR

N1. TA-Weather Forecasting
S1. N1, NS1. BD/DD/SV-Flood Management Enhancement
S1. Pre-FS/FS/SV-Bund Construction/Rehabilitation
S1. Pre-FS-Enhancement of Manchar Lake Drainage System
S2. Update of Hill Torrent/Drainage Management Situation
N2. Recommendation of FFC Strengthening for IFM and Projects Management

Source: Advisory Team

Figure 2.4.27 Flow of JICA Project Formation

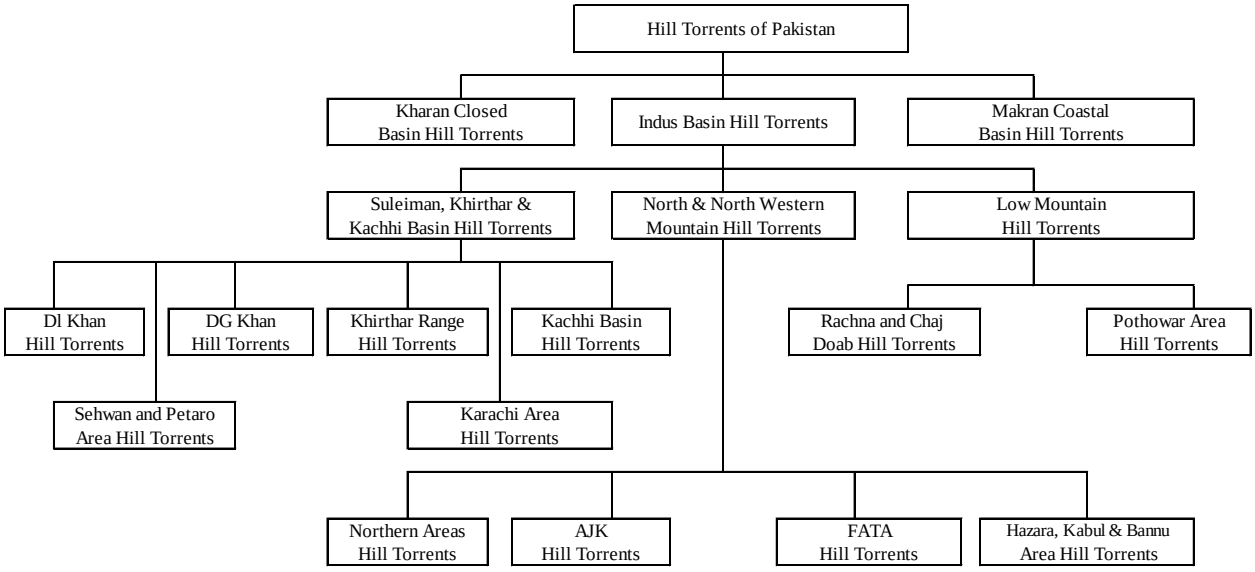
2.4.5 Activity 3-3 (1) Among the flood control projects examined in Activity 3-2, financial and/or technical cooperation projects should be organized and prioritized by JICA (Preliminary Feasibility Study: Pre-F/S)

2.4.5.1 Update of Projects of Hill Torrent

(1) Classification of Hill Torrent

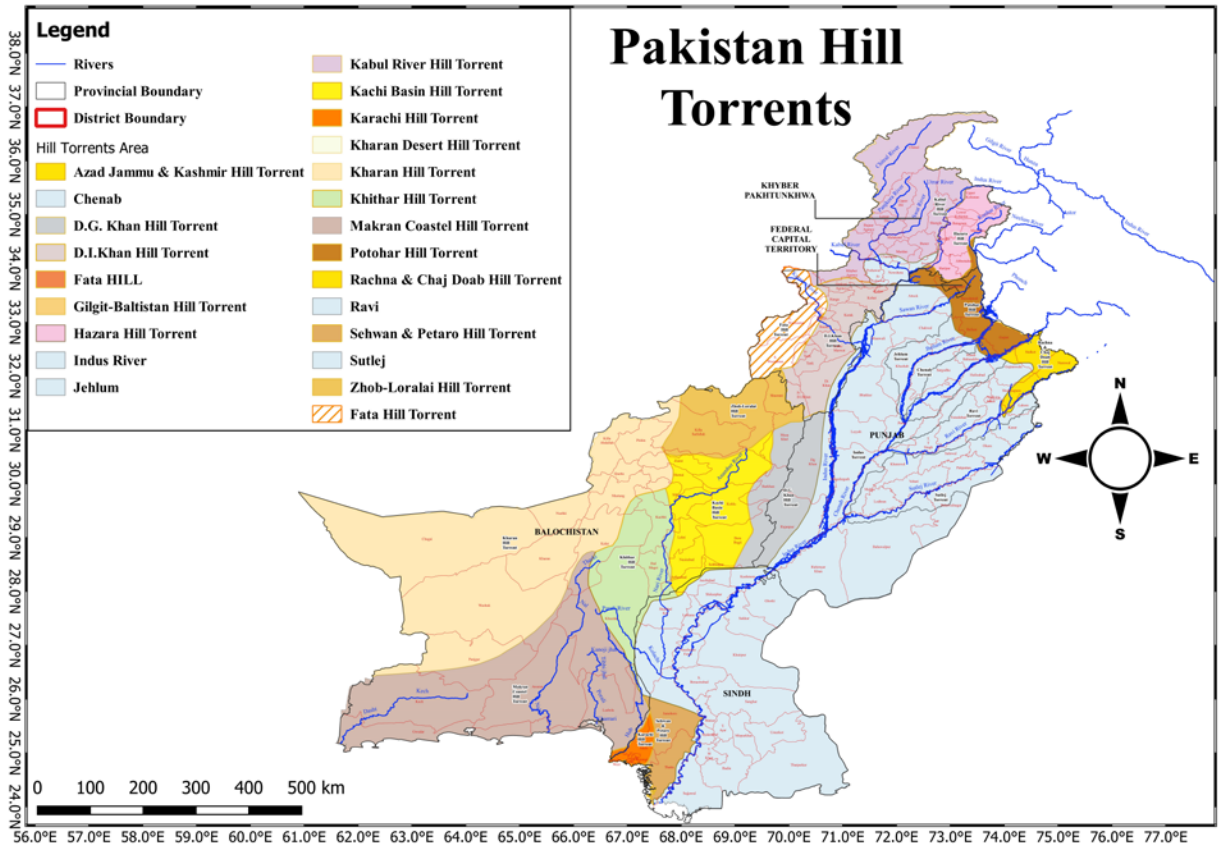
As shown in Figure 2.4.28, the Hill Torrent area can be roughly classified into the following three categories according to the topographic features of the area and the outfall of the flood. Among them, the Indus River Basin (IRB) Hill Torrent eventually flows into the Indus River, while the other two directly into the Arabica Sea.

- Indus River Basin (IRB) Hill Torrents.
- Kharan Closed Basin (KCB) Hill Torrents, and
- Makran Coastal Basin (MCB) Hill Torrents.



Source: M/F Study 1998

Figure 2.4.28 Classification of Hill Torrent



Source: Advisory Team prepared based on M/F Study 1998 と Survey of Pakistan

Figure 2.4.29 Location Map of the Hill Torrent Areas

(2) Current Status of Hill Torrent Project

"Master Feasibility Studies For Flood Management of Hill Torrents of Pakistan (FFC, 1998)" (hereinafter referred to as M/F Study 1998) summarizes Hill Torrent management projects by provinces, as shown in Figure 2.4.30. The projects are proposals for facility measures aimed at water conservation and/or flood prevention, and are classified into core projects and sub-projects in each

province.

These Hill Torrent management projects have been implemented by the provincial government of Pakistan with donor funds. As of 2023, most of the core projects of the proposed Hill Torrent management projects have been completed, on the other hand most of the sub-projects have not been implemented yet or partially implemented. This is because due to the characteristics of the Hill Torrent region, many projects are low in cost-effectiveness, making it difficult to receive funding from ADB, WB, etc.

The most cost-effective area is the Hill Torrent which mainly flows into the irrigation area (low-lying land) along the Indus River. In response to the flood damage caused by the 2023 floods, including damage to public facilities, flood countermeasures for Hill Torrent and its downstream low-lying areas are receiving attention.

FEDERAL AREAS	NORTH WESTERN FRONTIER PROVINCE (NWFP)	PUNJAB PROVINCE	SINDH PROVINCE	BALOCHISTAN PROVINCE
CORE PROJECT	CORE PROJECT	CORE PROJECT	CORE PROJECT	CORE PROJECT
- Nothing	- DI Khan Area	- DG Khan Area	- Khirthar Range Area	- Indus Basin Component including Quetta Region
SUB PROJECTS	SUB PROJECTS	SUB PROJECTS	SUB PROJECTS	SUB PROJECTS
- Northern Areas - FATA - AJK	- Hazara, Kabul & Bannu Basins - FATA	- Pothowar Area - Rachna and Chaj Doabs	- Karachi Area - Sehwan & Petaro Area	- Kharan Closed Desert Basin - Mekran Coastal Area

Source: M/F Study 1998

Figure 2.4.30 Summary of Each Hill Torrent Project

(3) Major Structural Measures

Most of the proposals are structural measures, and when calculating the benefits, damage reduction by structures is estimated not only for damage to structures but also for water resource utilization effects. Some proposals are only for water utilization structures.

In most Hill Torrent areas, the following structures have been constructed for water conservation, utilization, and flood protection. The water flowing from these structures is utilized through canals, curries, dug wells, etc. A common water utilization method is to gather water into a closed area and store it at about 1.0 m depth, then it is utilized for sowing and cultivation. Note that the names in parentheses are the ones used in the report.

- Dispersion Structure
- Flood Convey Channel (FCC)
- Diversion Embankment
- Delay Action Dam
- Storage Dam
- Flood Wall
- Flood Diversion Channel
- From barrages along Indus River to the Irrigation Area in the Downstream

(4) Area to Implement Countermeasures

1) Status of MDBs' Investment in Candidate Areas

Flood damage is relatively frequent in the low-lying areas on the right bank (western part) of the Indus River, where the population and assets are concentrated, and such areas were inundated during the 2022 heavy rains and other floods. In particular, the Indus River Basin (IRB) Hill Torrent area, namely D. I. Khan (Dera Ismail Khan), D.G. Khan in Punjab-Balochistan and RBOD areas in Sindh, are affected by intake from Hill Torrent in Balochistan. In these areas, investment in the D. G. Khan and RBOD areas has been more active.

Among the above regions, investment is particularly progressing in the D. G. Khan region of Punjab province due to FPSP-III and World Bank projects. On the other hand, in the case of the RBOD area in Sindh province within the Manchar Lake Basin, a concept note on what kind of structure should be constructed has been created between Balochistan Province, which is the source of the flood water, and Sindh province, which is the receiver (outfall).

2) FFC's Hill Torrent Regional Development Policy

FFC holds National Drainage Management Meetings in June and August 2023. As of September 2023, it is working to develop a master plan (M/P) for each Hill Torrent area and is preparing a TOR for it. FFC is requesting the Japanese side to participate in the technical assistance for the preparation of this M/P.

3) Significant Areas Where JICA Intervenes

Most Hill Torrent basins have a scheme in which inflows from individual seasonal rivers are drained into the main river without converging. However, the RBOD region has a relatively large number of Hill Torrent rivers that cannot directly flow from the mountains of Balochistan into the Indus River, and such runoff is diverted to Manchar Lake by irrigation canals and FP Bund within the RBOD region.

Despite such a situation, according to the Sindh-Balochistan concept, several structures have been proposed that will further increase the inflow load to Manchar Lake. Furthermore, the World Bank is currently investing in the repair and reinforcement of flood and water utilization facilities around Manchar Lake without considering such a future concept.

When the Advisory Team pointed this issue out to the FFC, during the FMC meeting (1st National Drainage Management Meeting) in June 2023, the FFC requested technical support from the Japanese side to formulate a highly accurate M/P.

2.4.5.2 Bund Constructions/Enhancement in the Right Bank of the Indus River

The area to be protected in this study is the low-lying RBOD area which is in the downstream of the Sukkur Barrage on the right bank of the Indus River in Sindh Province. It is the area with the highest population concentration, among the areas in the upstream and downstream side along the Indus River. There are low-lying areas called D. G. Khan and D. I. Khan on the right bank side of Punjab province. However, the right bank of the main river is in the form of an excavated river channel (the left bank has an embankment), and the origin is from the mountain ranges of Balochistan province in the west of the main river. Flood damage is mainly caused by the Hill Torrent River (a rapid-flowing seasonal river).

(1) Risk of Bund Breach

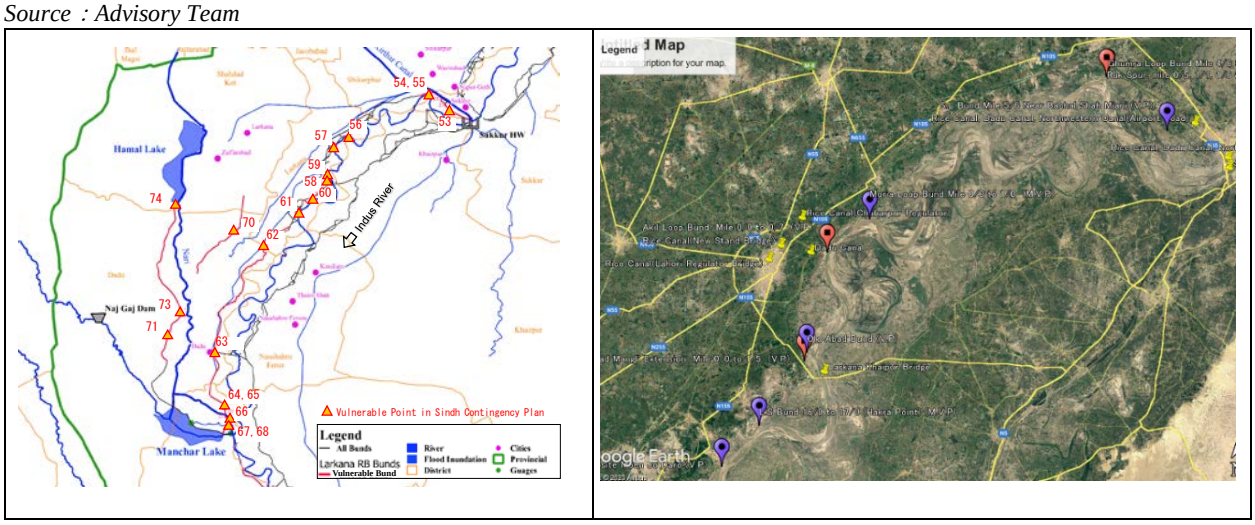
To analyze the risk of existing bund breaches, satellite image analysis was conducted considering the list of vulnerable bunds prepared by the vulnerability study of the Sindh Irrigation Department (conducted in the Sindh Contingency Plan,2023). As a result, 5 locations out of 17 vulnerable points along the Indus River (a total of 22 points are listed as vulnerable points, including 5 points in the FP Bund etc.) listed by Sindh Irrigation Department and 1 location identified during the site inspection conducted August, 2023 were picked up and the total 6 locations were recognized that the risk of collapse was high(see Figure 2.4.31. The presence or absence of vulnerabilities was studied using the following 11 indicators. In addition, at most of these six selected locations, the main channel and bund are located closely now.

Table 2.4.11 Criteria to Identify Vulnerable Points

Sindh Contingency Plan,2023	Advisory Team (Satellite Image Analysis and Site Inspection)
1. Any history of Cut or breach, if so then that site is considered vulnerable. 2. Total number of populations to be affected or living along the site.	8. The distance between the irrigation canal and the bund is close, or the river channel is close to the existing bund. 9. The flow direction of the waterway is towards the existing embankment.

3. Huge public or private important infrastructure around the site. 4. Existing site and local soil conditions and available Flood protection works. 5. Underground water levels to bunds. 6. Any big road networks etc. 7. Condition of flood bunds its X-section, top levels, side slopes and quality of soil used for its construction.	10. There are development areas such as cities and towns in the hinterlands of existing embankments. 11. The altitude of the hinterland is relatively low, and there is a high possibility that flood water will reach the development area.

Source : Advisory Team



Source : Advisory Team Prepared based on the image obtained from Google Earth

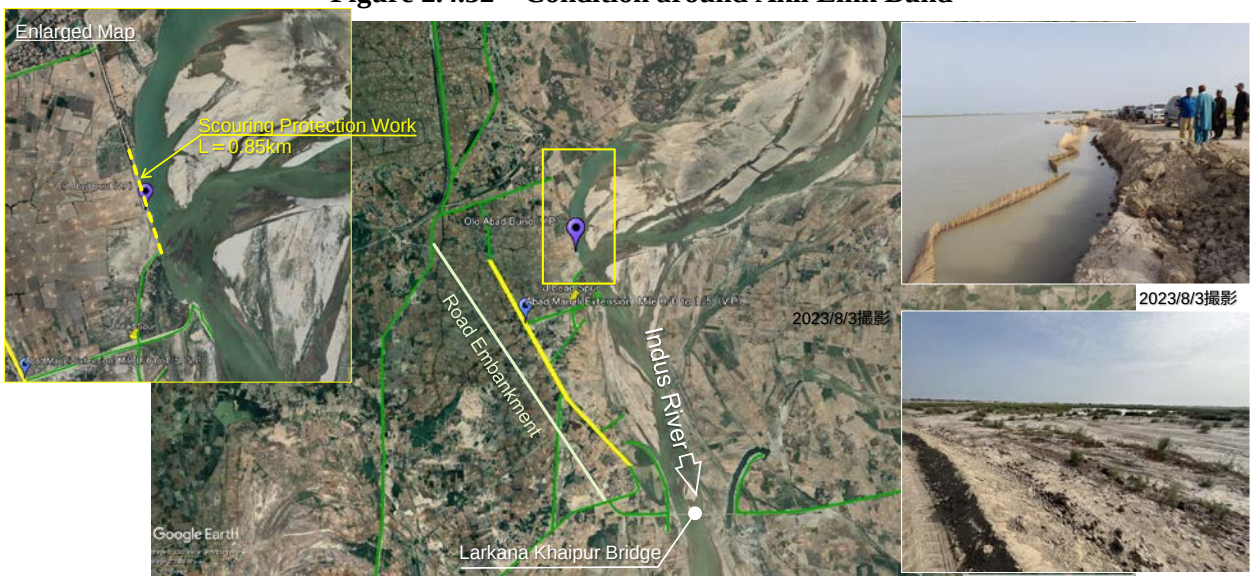
Figure 2.4.31 Location Maps of Vulnerable Points
(Left: By Sindh Province, Right: Advisory Team)

(2) Target Bund studied in the JICA Project

The target bunds were selected based on site inspection and interviews with the Sindh Irrigation Department, considering (1) the rehabilitation budget has not been allocated at this time, and (2) the possibility of damage or collapse due to a similar disaster. As a result, Akil Link Bund and Old Abad Bund (total length of about 3km) were selected as target bunds for the JICA project, and the selection was explained to the FCC. At the Akil Link Bund (see Figure 2.4.32**)**, leakage was occurring around the land side toe of the bund, and at the Old Abad Bund (see Figure 2.4.33), scouring and erosion was occurring due to the main channel of the Indus River directly hitting to this site. Although it is possible to temporarily repair and strengthen these bunds with conventional methods by the Sindh Irrigation Department, there is still a risk that they will be damaged again due to a similar type of damage. To the bunds that are repeatedly damaged by small and medium-scale floods of the Indus River, it will serve as a better practice for BBB to present the effects of countermeasures which is for the cause of damage when repairing and reconstructing bund in the future.

Source ：Advisory Team Prepared based on the image obtained from Google Earth

Figure 2.4.32 Condition around Akil Link Bund



Source ：Advisory Team Prepared based on the image obtained from Google Earth

Figure 2.4.33 Condition around Old Abad Bund

(3) Influence of the Bund Breach and Effect of Strengthening the Bund

1) Development in the Area Behind the Target Bund and Expected Damage

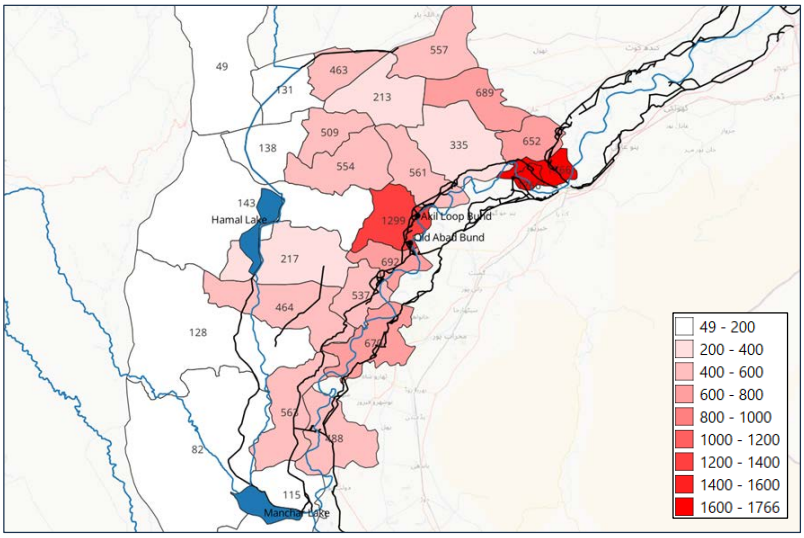
The table below shows the flood damage when breach or overflow occurs at the left bank bund near the Sukkur Barrage. Based on the population distribution organized with the GIS polygon data obtained from “Information Collection and Confirmation Survey on Disaster Prevention Investment Projects in the Global Flood Control Field" by JICA, the population in Tehsil (city) units (in the order of Province-Districts-Tehsil) Density is shown in the figure. And, shows the maximum inundation area when breaks or overflow occur at each target bund.

In the floodplain of the hinterland, there are cities such as Larkana (1.5 million people) and Sehwan, and considering the scale of the damage, it is considered that these bunds shall be rehabilitated or reinforced as soon as possible. About Sehwan, part of the lakeshore bund of Manchar Lake was intentionally cut away as an emergency measure to prevent Sehwan from flooding during the event of the 2022 flood.

Table 2.4.12 Expected Damage on Each Bund Breach Case

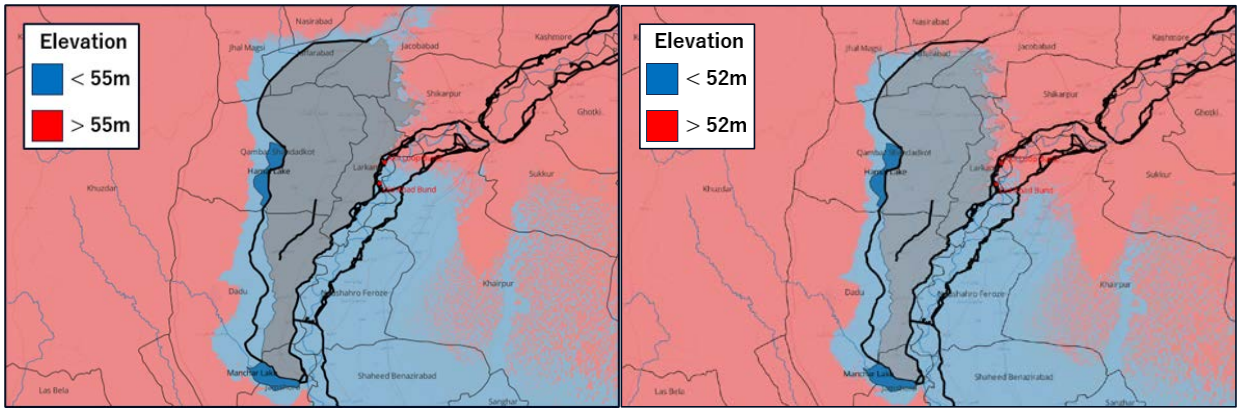
Location where breach/overflow occurs	Possible Inundation Area (Km^2)	Damage on Houses (bil. PKR)	Damage to Agricultural Area (bil. PKR)	Total Damage (bil. PKR)
Around Sukkur Barrage	9,600	3,613	83	3,697
Akil Link Bund	8,419	3,169	73	3,242
Old Abad Bund	7,193	2,375	55	2,429

Source : Advisory Team



Source : Advisory Team

Figure 2.4.34 Population Density in Each Tehsil along the Left Bank of the Indus River



Source : Advisory Team

Figure 2.4.35 Expected Inundation Area in case of Breach or Overflow at the bunds (Left: Akil Link Bund, Right: Old Abad)

2) Influence on Other Bunds Located in the Upstream/Downstream

Heightening of bunds along the main river of the Indus River basin in Sindh and Punjab provinces was implemented after the 2010 flood, and the bund height was designed to protect against the magnitude of the 2010 flood. Therefore, even if the bunds targeted in this study are reinforced with Japanese technical support, the possibility of overflow from the other existing bunds in the upstream and downstream will not immediately increase. On the other hand, the possibility that the bunds upstream and downstream of the target bund will collapse due to long-term flooding during the monsoon season will remain due to their structural inadequacy with river characteristics and

qualitative fragility.

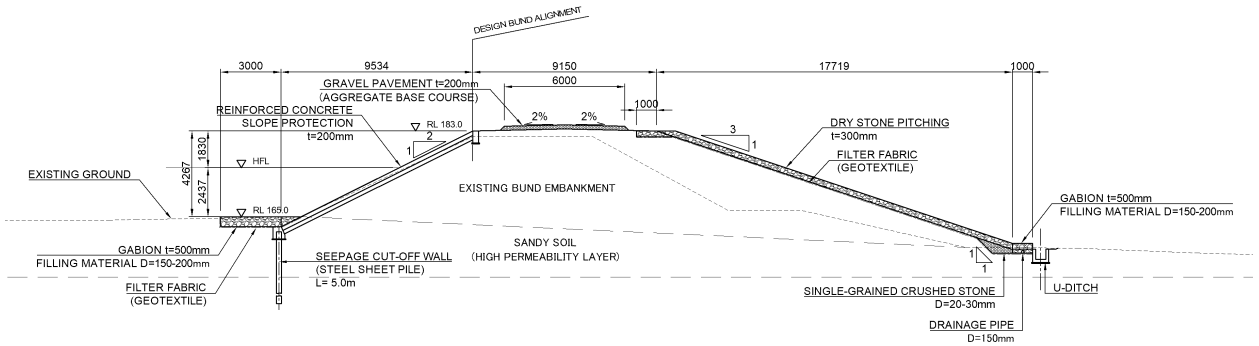
In the PDNA survey after the 2022 flood, although there were reports of partial damage to bunds, it was recognized that the bund heights had been maintained. However, after this site inspection, it was observed that some of the bunds' tops had collapsed after the 2022 floods. Even under such circumstances, the proposed rehabilitation by the budget of development donors (structural measures are being implemented by the World Bank in Sindh province) after the PDNA survey due to the 2022 floods or FPSP-III project has been scheduled at most of the locations. In addition, PID is considering repair works through the long-term funding route of local finance ADP and provincial finance PSDP.

At the target bunds, such budget allocation has not yet been scheduled. As part of this large-scale bund development process, it is necessary to take care of these targeted areas. Normally, it would be necessary to set priority levels in each agency's development plan, such as in the case of the stage-wise development of the Edogawa River in Japan.

(4) Structure, Scale, Characteristics, Construction Cost etc. of the Target Bund

1) Strengthening Akil Link Bund

The Akil Link Bund requires seepage control work(mainly against leakage). The scale and structure of the bund are shown in the typical cross-section (see Figure 2.4.36). Since the stability of the slope has not been an issue so far, the basic dimensions such as the design bund height and side slope will follow the current typical cross-section. As seepage control works, drain works, seepage cut-off walls, reinforced concrete facing on the riverside slope, and geotextile and stone pitting on the land side slope would be proposed to prevent further collapse due to the influence of seepage as much as possible.



Source：Advisory Team

Figure 2.4.36 Typical Cross Section of Akil Link Bund(for Seepage Control Works)

Table 2.4.13 Construction Cost and Dimensions of Proposed Bund at Akil Link Bund

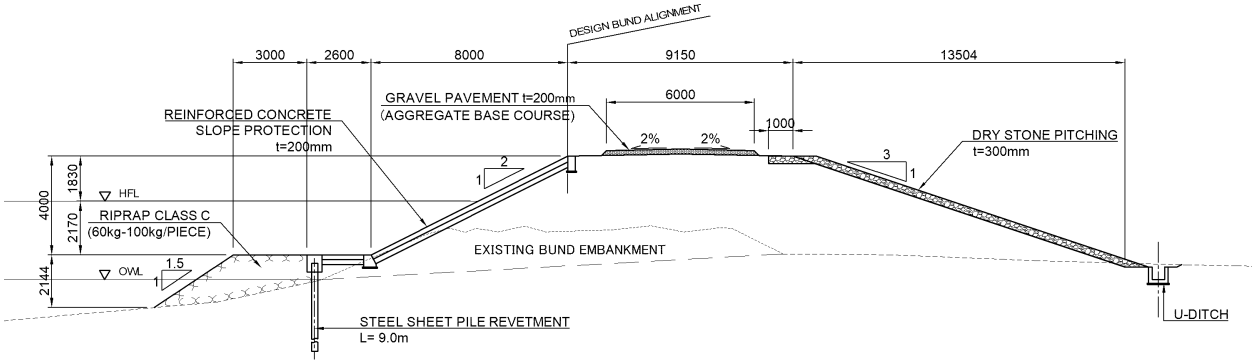
Item	Value	Verification
Height of Existing Bund	RD.181.9ft (55.44m)	Considering typical cross-section of existing Akil Link Bund
Proposed Bund Height	RD.183.0ft (55.79m)	Same as above
Top Width	30 ft (9.15m)	Same as above
Side Slope	River Side：2.0:1 Land Side：3.0:1	Same as above
Length	1.9 km	Based on Site Inspection and Satellite Image
Construction Cost	1.76 Billion PKR (Approximately 0.84billion JPY)	

Source：Advisory Team

2) Strengthening Old Abad Bund

At the Old Abad Bund, direct erosion and lateral erosion are occurring mainly on the slope and toe of the bund due to the river flow directly hitting the main Indus River, so stronger erosion countermeasures than the current one is required. The scale and structure of the bundt considering

erosion countermeasures are shown in the typical cross section (See Figure 2.4.37). At this location, information for the basic dimensions of the bund, such as the current survey drawing and typical cross-section, have not been obtained. Hence, the basic dimensions of the bund will follow the current cross-section. To resist against erosion and scouring in front of the bund, countermeasures such as concrete facing and steel sheet pile revetment are mainly applied to the riverside, and short spurs are proposed to reduce the flow velocity in front of the bund, to prevent further collapse as much as possible.



Source：Advisory Team

Figure 2.4.37 Typical Cross Section of Old Abad Bund(Scouring Protection Work)

Table 2.4.14 Construction Cost and Dimensions of Proposed Bund at Old Abad Bund

Item	Value	Verification
Height of Existing Bund	Approximately 4m	Based on Google Earth, referred the shape of the adjacent bunds
Top Width	30 ft (9.15m)	With reference to typical cross section of existing Akil Link Bund
Side Slope	River Side：2.0:1 Land Side：3.0:1	Same as above
Length	0.85km	Based on Site Inspection and Satellite Image
Construction Cost	1.96 Billion PKR (Approximately 0.94 Billion JPY)	

Source：Advisory Team

2.4.5.3 Enhancement of Drainage Capacity of Lake Manchar

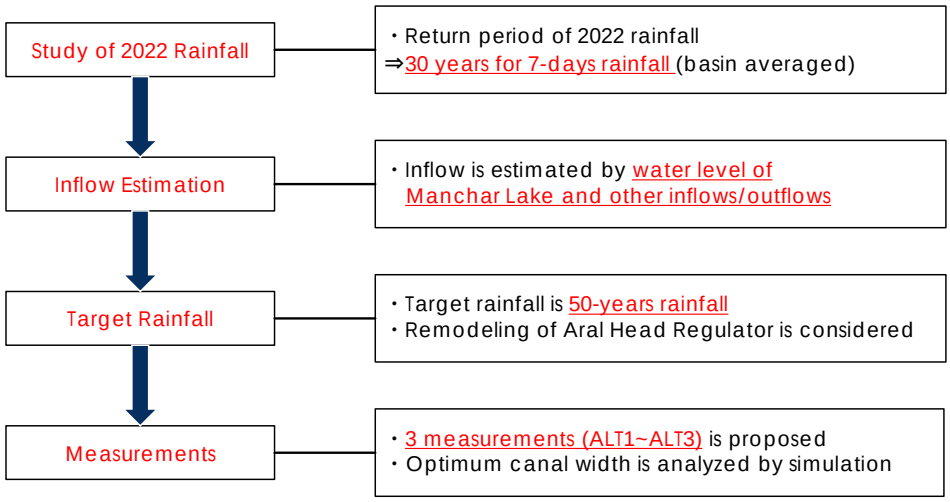
Lake Manchar receives runoff from the basin, which includes population and asset centers on the right bank of the Indus River in Sindh Province. All floodwater in this region is temporarily stored in Lake Manchar, and then it is discharged to the Indus River thought drainage gates and waterways. However, in the 2022 flood, due to flooding and heavy rain from Hill Torrents, the amount of inflow exceeded the drainage capacity, and in order to avoid flooding damage to Sehwan, a city located in the eastern part of the lake, artificial breach was conducted at Manchar Containing Bund (MCB) which is located in the northern part of Lake Manchar. In order to improve this situation, a Pre-F/S was conducted with the aim of increasing the drainage capacity of Lake Manchar.

(1) Hydrological and Hydrological Analysis of Lake Manchar Basin

1) Construction of Water Balance and Hydraulic Analysis Model

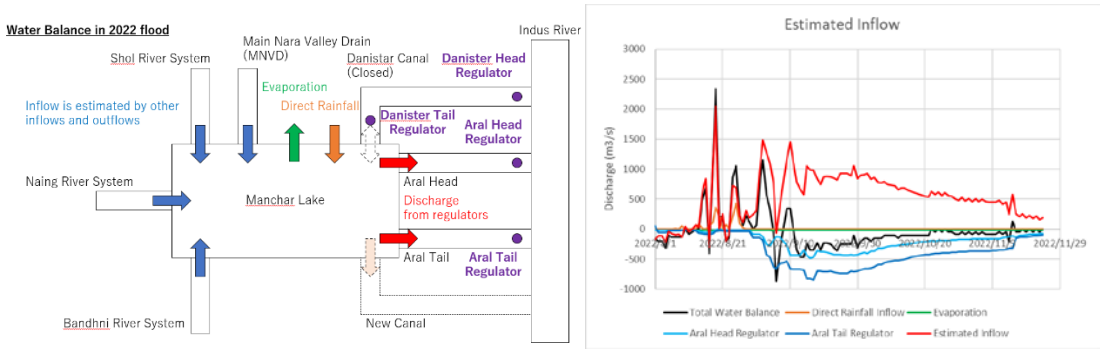
The basic waveform of the inflow of the water balance of Lake Manchar basin was constructed by estimating the inflow, outflow and overflow from artificial breach in the 2022 flood, which is based on daily hydrological and meteorological data such as water level of Lake Manchar and the discharge of each regulator. A comprehensive analysis was needed to describe the 2022 flood due to the overflow from the bund during the flood period, the rainfall analysis, the relationship between the water level and the storage volume of the lake, the current drainage capacity, the drainage capacity

after the improvement of Aral Head (ALT0) and the description of the Irrigation Manual (drainage gate operation) were considered in this analysis. In addition, the inflow waveform for each flood probability scale in Lake Manchar basin, which is used when formulating the plan, is given by extending the basic waveform for each probability based on the results of the rainfall analysis, and the discharge of drainage gates is calculated by non-uniform flow calculations.



Source: Advisory Team

Figure 2.4.38 Flow Chart of Water Balance and Hydraulic Analysis of Lake Manchar Basin



Source: Advisory Team

Figure 2.4.39 Concept of Water Balance Model of Lake Manchar (Left), Result of Estimated Inflow Calculation in the 2022 Flood (Right)

2) Setting of the Planning Probability Scale

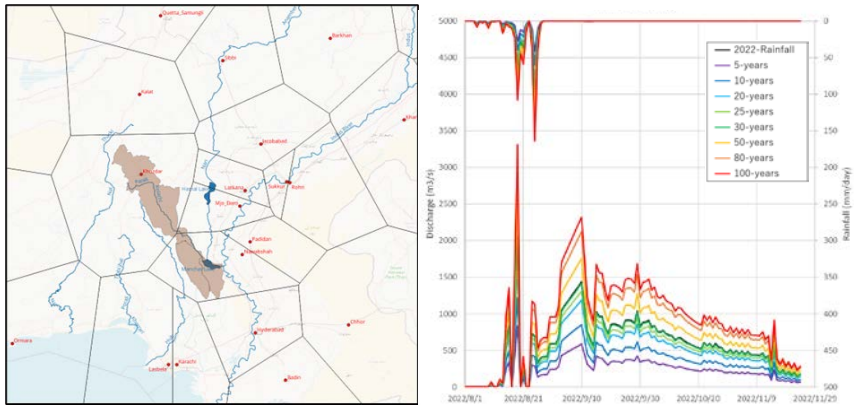
At present, NFPP-IV generally states the probability scale of major rivers, but leaves that of other tributaries up to the provinces. According to the provinces of Sindh and Punjab, for example, river channels and river facilities other than dams in the Hill Torrent area used to have a 25-year return period, but now, in relatively developed areas, they have a 40- to 50-year return period for planning and designing. In addition, the Irrigation Manual of the province of Punjab states that the Protective Bund will be constructed with a 50-year return period as the target.

An analysis of 7 consecutive days of rainfall over 30 years of data shows that each observation station has a 20- to 95-year return period of the 2022 flood, and the average rainfall in the basin was about a 30-year return period. Further analysis is required because the scale is different from the analysis results from satellite rainfall by Hokkaido University. The causes of different results may

be that the observation density of ground observation is very sparse, and the rainfall volume of manual observation stations (cylinder) was not significant.

According to Sindh Irrigation Department, for the latter cause, observation stations can observe localized heavy rain on a daily basis because they use a PAN (similar to a Tarai).

Therefore, in this study, the drainage capacity enhancement plan is aimed at a target equivalent to a 50-year return period scale with comprehensively considering the intentions of Sindh Province and FFC and content of planning guidelines such as the Irrigation Manual.

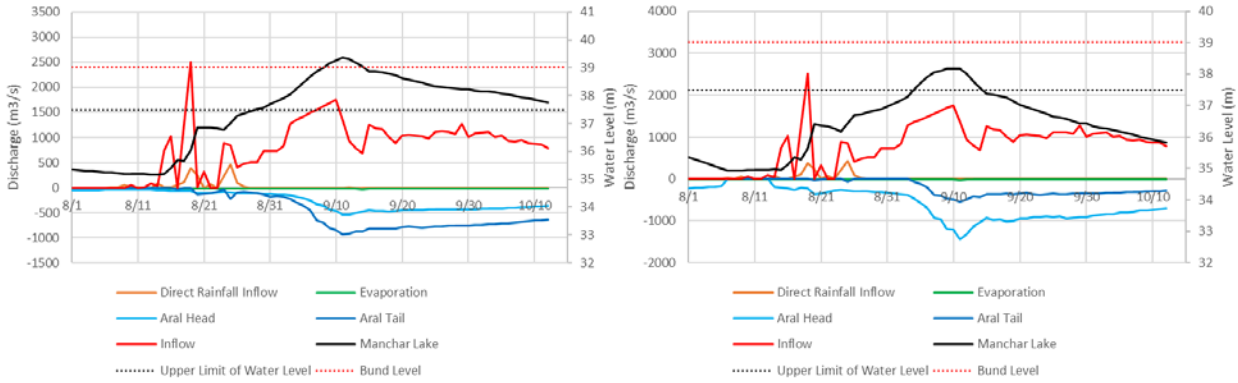


Source: Advisory Team

Figure 2.4.40 Thiessen Division of Basin-Average Rainfall (Left),
Basin Averaged Hydrograph and Hyetograph of Inflows of each Probability Scale (Right)

3) Results of Case Simulations

The size of the drainage gate and the drainage channel was determined by trial simulations of the planned inflow volume (equivalent to a 50-year return scale) with the water level of Lake Manchar not exceed the current bund height.



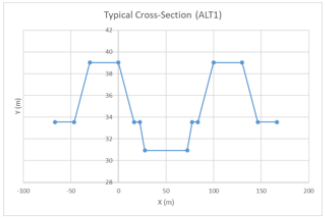
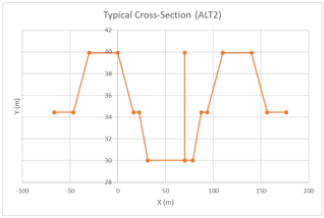
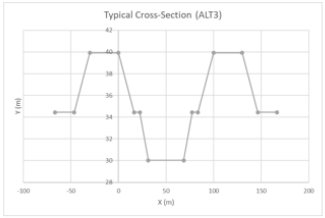
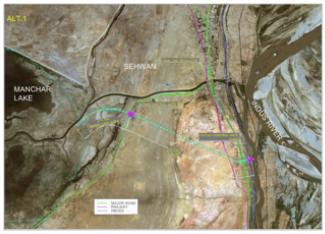
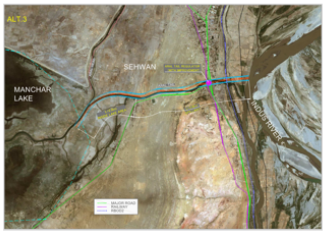
Source: Advisory Team

Figure 2.4.41 Simulation Results for 50-Year Inflow Scale, Current Model (Left), ALT0 (Right)

(2) Planned Facilities

The size of the drainage channel was set so that the water level of Lake Manchar would not be lower than the bund height with the allowance height by hydraulic calculation, which considering the head

difference between Lake Manchar and the Indus River for each of the three drainage routes shown in the figure to secure drainage capacity equivalent to the 50-year return period scale. The outline drawing and project cost of each alternative plans are summarized in Figure 2.4.42.

	ALT1 New Canal Construction	ALT2 Aral Tail Improvement + Linking to RBOD2	ALT3 Aral Tail Improvement
Typical Cross-Section			
Map of Measurements			
Project Cost	43.6 Billion PKR	39.2 Billion PKR	27.1 Billion PKR

Source: Advisory Team (based on Google Earth)

Figure 2.4.42 Drainage Canal Size in 3 Alternative Plans

Aral Tail improvement plan (ALT3) was selected from 3 alternative plans by comparing the characteristics of each plan, the impact of the surroundings, economic efficiency and so on. The construction cost is 24.7 bil. PKR (about 12.3 billion yen). The biggest advantage of this plan is that it is cheaper than the other plans, but it is necessary to pay attention to the impact on the structure and operation of existing facilities and the sedimentation of existing waterways.

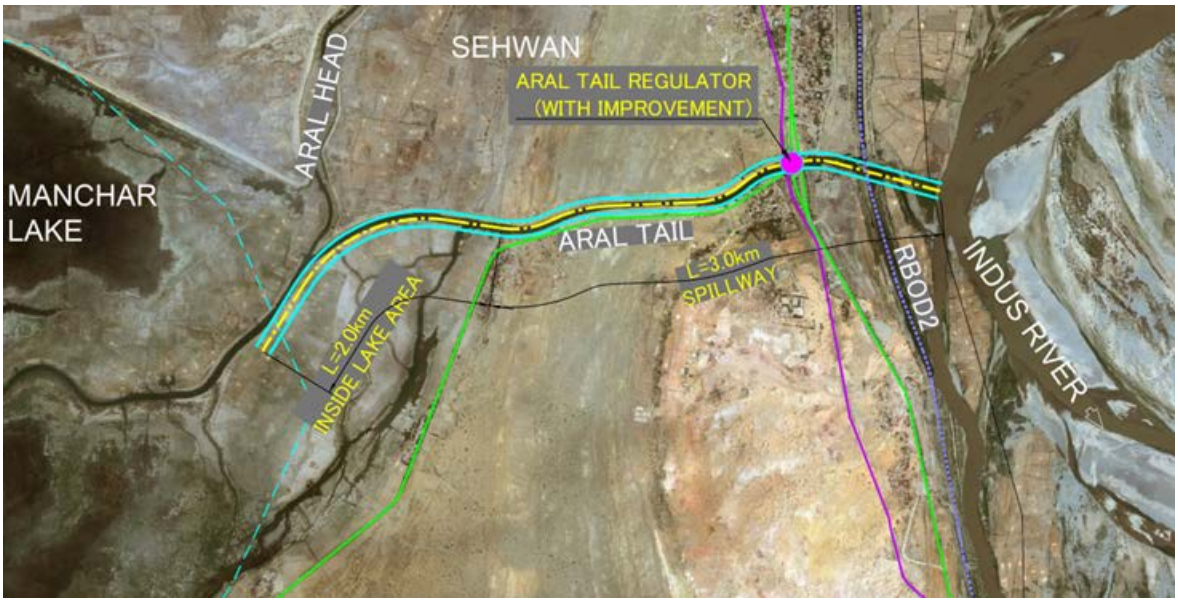
As a plan that can reduce the impact on the structure and operation of existing facilities and the impact of sedimentation, there is the room for consideration of selecting new canal construction (ALT1), which has a large head difference (difference between the water level of Lake Manchar and the Indus River), although the cost is high. In the F/S phase, the optimal plan should be selected by comparison of ALT1 and ALT3, considering the cost of channel excavation to maintain the flow cross-section of Aral Tail and the maintenance and management system.

Table 2.4.15 List of Necessary Construction/Renovation Facilities for ALT3

Name of Facility	Quantity / Specifications	Remarks
Spillway	L=3.0km + （Inside Lake）2.0km Width of Spillway: W= 80 m → 100m	The guide channel within the lake will need to be examined by conducting bathymetric surveys in the future.
Aral Head Regulator Improvement	5 gates x 6 m x 7.3 m → 7 gates x 15 m x 7.3 m	Normal: Full open or intermediately open. Lake Manchar Flood: full open, the Indus River Flood: full close In ordinary times, it is necessary to adjust the opening in consideration of water utilization (same as the current situation).

Name of Facility	Quantity / Specifications	Remarks
Railway Bridge	1 nos. / L=100m, W=5m	Estimated by Google Earth
Road Bridge	2 nos. / L=100m, W=12m	Estimated by Google Earth

Source: Advisory Team



Source: Advisory Team (based on Google Earth)

Figure 2.4.43 Plan View of ALT3 (Existing Canal Widening and Gate Renovation)

2.4.6 Activity 3-4 Explain the results of Activity 3-2 to the Pakistani government and other donors and obtain an agreement on the direction of flood control projects to be undertaken in the future.

In Pakistan, where decentralization is progressing, appropriate coordination by the central government and the coordination and cooperation between provinces are extremely important factors in implementing the integration of flood control measures in the inter-provincial rivers of the Indus River system. Additionally, to stably secure such a situation, it is necessary for the FFC to systematize the flood protection measures for the Indus River system from a bird's-eye view of the basin, and to formulate and disseminate flood protection policies. In addition, the flood protection policy should be designed to improve the gaps analyzed in the Hyogo Framework for Action (the reasons why targets could not be achieved). In other words, the contents of the policy should be in line with the Sendai Framework for Disaster Risk Reduction 2015.

Fundamentally, flood protection needs to be carried out based on the flood management goals and policies set by the FFC, taking into account the local natural and social environment. Table 2.4.16The following is a rough outline of the natural and social environments that are considered necessary for setting goals and policies, and the direction of development of flood protection by those environments. The direction of regional flood protection is partly based on the history of projects that the Pakistani government has implemented to date.

Specifically, it is essential to implement pre-priority investment in structural measures for the Indus River system in Pakistan, especially in the central and southern regions, followed by fragile urban areas, to improve the effects of economic development in Pakistan. On the other hand, there is an urgent need to implement measures to protect communities in the northern and western regions from sudden and powerful water-related disasters such as debris flows, flash floods, glacier outbursts, landslides etc. that occur frequently during the monsoon season. In Hill Torrent areas that flow into the main Indus River, it is necessary to implement measures that are consistent between Balochistan, the source of Hill Torrent floods,

and Punjab and Sindh which receive floods.

Table 2.4.16 Regional Direction of Flood Protection based on Natural and Social Environment

Region：North Mountainous Area Major social and natural situations： Many rapid rivers flow through the mountains at high altitudes, and water-related damage has been occurring by flash floods, debris flows, landslides, and glacier bursts. As a result, it is relatively difficult to protect assets by structural means compared to other regions. Towns and villages are scattered along the rushing river. There is a corridor to China in the northernmost part.	River System：Hill Torrent Rivers/Nullah Draft Flood Control/Protection Direction： Control exposure and vulnerability with a focus on non-structural measures (for example, strengthening immediate response capabilities, early warning/evacuation systems, river monitoring system and strengthening resilience through land use planning). Enhancement of river embankment will also be strengthened in consideration of the characteristics of rapid currents and valley bottom rivers. DRR by Non-Structural Measures ➢ Development of flood monitoring, forecasting, and evacuation systems according to the hydrological, meteorological, geological, and topographical characteristics of various tributaries. ➢ Awareness of hazard areas, land use regulations, and revision of construction standard ➢ Development of organizational and legal systems for the above ➢ Temperature-burst response research of glacier bursts and promotion of EWS development Local hard measures ➢ Riverbank reinforcement and maintenance around urban areas such as Kabul, Swat, Kunhar rivers etc.
Region：Central plain and hilly area Major social and natural situations: It is the largest granary region with irrigated areas spread out on flat land, and cities with more than 1 million people are scattered on relatively high ground. Irrigated areas along rivers are prone to frequent flooding. If the bunds of rivers breach, cities and farmland will generally be flooded, causing great damage.	River System：The Indus River and the major 4 tributaries in Punjab Draft Flood Control/Protection Direction： Focus on strengthening structural measures to reduce hazards. A better mixture of (non-) structural measures in the urbanization area. DRR by structural measures ➢ Qualitative improvement of the bands of the Indus River and its major tributaries. ➢ Improving drainage capacity of regularly flooded areas (non-) Structural Measures in Urban Area Inventions to urban floods (river training, water collection/drainage channel, equipment provision for drainage maintenance, land use regulations, reformation of legal system, hazard map creation/dissemination, flood forecasting/warning system, rainwater infiltration/storage system, etc.), Formulation of Master plan for low-lying area in the right bank of the Indus River.
Region：Southern plain Major social and natural situations: Vast irrigated land spreads over low-lying land. Due to the gently sloping topography and high groundwater level, the drainage capacity becomes poor during the Indus River floods. There are few cities with populations of over 1 million people, but the population is concentrated in low-lying areas. If the Indus River breaks its banks in various places, low-lying areas will generally be flooded and remain submerged for a long period. In 2022, torrential rains, flooding of Hill Torrent, and partial damage to embankments are expected.	River System: The Indus River in Sindh Draft Flood Control/Protection Direction： Focus on strengthening the stock of structural measures to reduce hazards or water retarding in flood tolerance zone. Creation of hazard map for low-lying areas. DRR by Structural Measures ➢ Qualitative improvement of the band of the Indus River. ➢ Improving drainage capacity of regularly flooded areas ➢ Improvement of rainwater infiltration and storage capacity in urban areas DRR by Non-Structural Measures ➢ Creation and dissemination of hazard map in the flood-prone areas out of second bunds ➢ Formulation of a Master Plan for low-lying areas to better deal with hill torrent water and rainfall floods.
Region：Western Hill Torrent Area	River System: Hill Torrent Nallah flowing to Punjab and Sindh

Major social and natural situations:	Draft Flood Control/Protection Direction :
The altitude is higher than the central and southern areas, and there are Hill Torrent rivers that flow into the central and southern low-lying areas. Floods from Hill Torrent during the 2022 flood flowed into flood-prone areas of Punjab and Sindh and caused large damage. Compared to the central and southern regions, small and medium-sized irrigation areas are scattered. Due to the low rainfall, facilities that contribute to groundwater recharge are prominent. Karachi, the most populous port city, is located in the coastal area.	**The better mixture of (non)-structural measures** Flood control in mountainous and hilly areas ➢ The priority of flood countermeasures is relatively low. A river basin management project that combines (non-) structural measures to utilize floods and rainwater for agriculture and to control landslide disasters through cooperation between the agricultural sector and the flood and forest control sectors is suitable. ➢ Regulate inter-provincial Hill Torrent rivers with the neighboring provinces. (Non-) Structural measures in urban areas ➢ Comprehensive measures for water-related infrastructure in Karachi, the largest city in population (including inland water treatment measures) ➢ Master plan for inter-provincial hill torrent river basin

Source: JICA with Advisory Team

Regarding the above, the advisory team has explained and confirmed consultation meetings with the FFC chairman and staff using presentations.

2.4.7 Activity 3-5 Based on Activities 2 and 3-1 To 3-3, Organize Important Philosophy for Formulating Future Flood Control Plans, and Share Awareness with FFC Chairman and Staff.

In line with the Sendai Framework for Disaster Risk Reduction (2015-2030), which covers the general gaps identified in the Hyogo Framework for Action (2005-2015), the advisory team collaborated with the FFC Chairman on the direction of flood protection that is appropriate for the natural and social conditions of Pakistan as shown in . These are set based on the Sendai Framework for Disaster Risk Reduction, the degree of achievement of NDMP and the National Water Policy, the progress and issues of NFPP-IV, and restoration investment targets based on the PDNA after the 2022 flood. At the discussion in the workshop on August 28, the following philosophy was explained to the FFC Chairman and staff, and their agreement was obtained.

Table 2.4.17 Flood Control/Protection Policy in Pakistan and Necessary Actions

Items	Contents
Policy of Flood Management	Promote economic growth in Pakistan by effectively reducing disaster risk based on a comprehensive flood control plan that incorporates climate change impacts.
Actions to Sustain the Policy	- Preparation of adaptation guidelines to incorporate climate change impacts into integrated flood management plan - Implementation of appropriate damage risk analysis and maintenance of information for risk analysis -Formulation of basic plans and selection of priority projects for national and regional/provincial economic growth -Optimization of legal systems related to land use in river areas and flood-plain -Building a system to strengthen cooperation between central and local governments to appropriately manage flood protection projects and infrastructure assets -Strengthening flood management function and procurement management capacity of FFC

Source: FFC with Advisory Team

2.4.8 Other Relevant Project

Before the Advisory Team was dispatched, the JICA Pakistan Office received the following projects: (1)~(3). In March, an FFC advisor was introduced to a flood management project in Islamabad (Item (4)).

(1) Umbrella PC-I for Flood Protection Sector Project-III

This is a request for financing (PKR 95 bil.) to a business group extracted from NFPP-IV. FFC once requested JICA, but now it has also requested ADB through the EAD. Most of them are bund improvement projects.

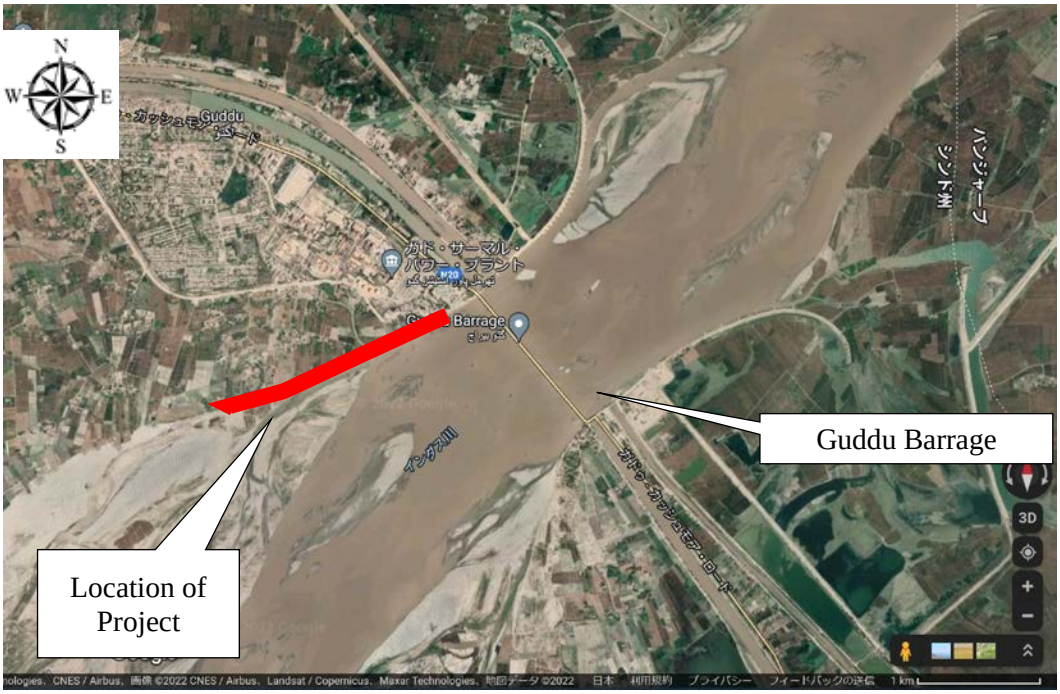
(2) Concept Clearance Paper of Two Floods Protection Projects in Sindh

This is a request for grant aid from Japan for the construction of two river facilities in Sindh province, derived from NFPP-IV. However, the two river structures are not related to each other.

1) Construction of Retaining Wall along Downstream Right Marginal Bund of Guddu Barrage

This is a request for a revetment construction project at the right bank downstream of the Guddu barrage located in Kashmore, Sindh. The requested amount is PKR 8 million (about 560 million yen).

The request is to provide a revetment in front of the embankment, which is currently an earth dike, on the right bank side of the 2.4 km downstream section of the Guddu barrage to protect the embankment from erosion due to flooding during the flood season.



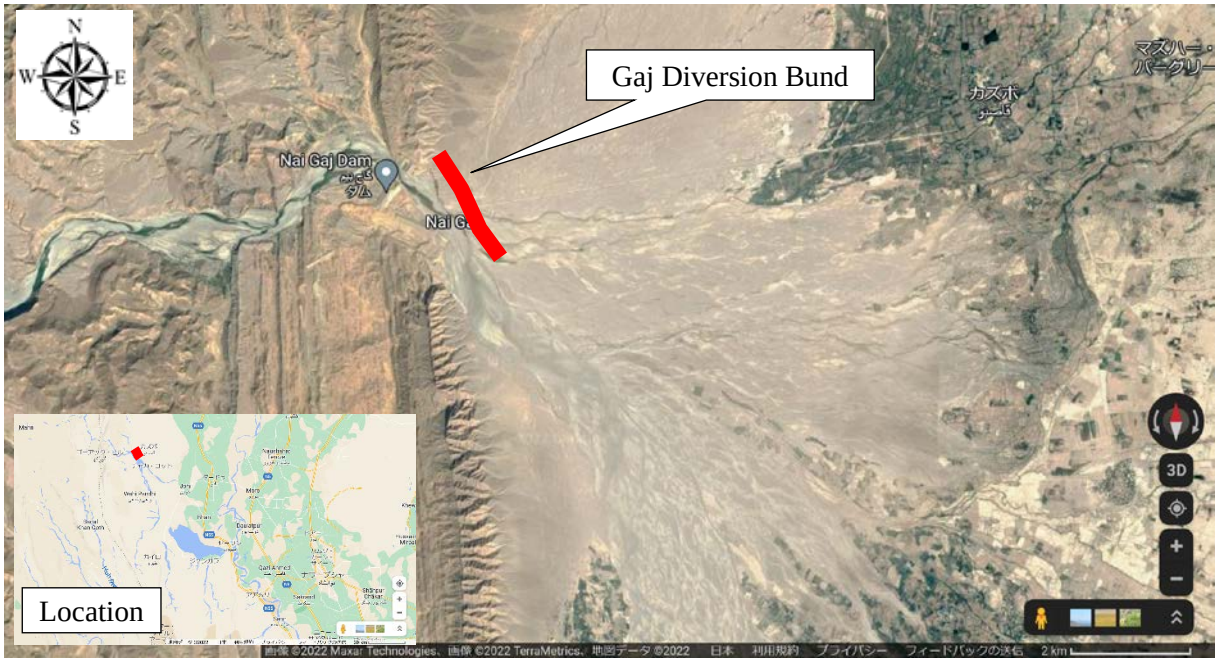
Source: Advisory Team

Figure 2.4.44 Location of Retaining Wall at Downstream Right Marginal Bund of Guddu Barrage

2) Retaining Wall along Gaj Diversion Bund in Johi Division, Dadu

This is a request for a retaining wall construction project for Gaj Diversion Bund, located in Johi Taluka, Dadu Province, Sindh. The requested amount is PKR 5 million (about 350 million yen).

The Gaj diversion bund is located about 65 km northwest of Dadu City in Dadu Province, where the Gaj River (Nai Gaj), which flows from Balochistan across the Kirthar Mountains into Sindh, flows from the mountains to the plains. The Gaj River always flows eastward, but there are villages and farmlands scattered in the same direction, and major flood damage has occurred in the past (1976, 1995). The Gaj diversion bund is being constructed to divert the flow of the Gaj River to the southeast and lead it to Lake Manchar to mitigate flood damage during the flood season. Due to the strong current during the flood season, part of the main body of the Gaj diversion has been damaged.



Source: Advisory Team

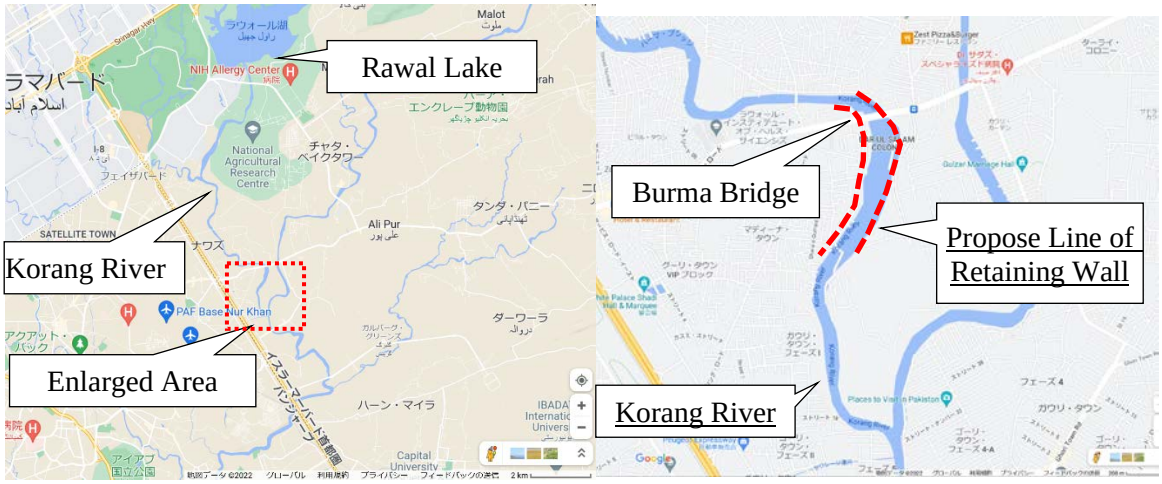
Figure 2.4.45 Location of Gaj Diversion Bund

(3) Installation of 45 Flood Telemetry Hydro-Met/Early Warning Stations through JICA Financing

About this matter, discussions and work are currently being carried out with the Pakistan Office of JICA in consultation with the telemetry MP (WAPDA-ADB).

(4) Urban Flood Management in Korang River, Downstream of Burma Bridge, Islamabad

NPO "Masajid & Madaris Foundation (MMF)" requested Japan's grant aid for the construction of a retaining wall revetment for flood protection in the Korang River flowing out of Lake Rawal. The project is located 10 km downstream of Rawal Dam, and there are plans to construct concrete gravity retaining walls (height 23 feet (7 m)) on both the upstream and downstream banks of the Burma Bridge.



Source: Advisory Team

Figure 2.4.46 Location of Request for the Construction of Retaining Wall for Flood Protection from Korang River under Japanese Grant Aid

Table 2.4.18 Requested Length of Retaining Wall for Flood Protection from Korang River under Japanese Grant Aid

Right Bank of Korang River		Left Bank of Korang River	
Upstream of Burma Bridge	Downstream of Burma Bridge	Upstream of Burma Bridge	Downstream of Burma Bridge
300 feet (91 m)	2,250 feet (686 m)	350 feet (107 m)	2,200 feet (671 m)
2,550 feet (777 m)		2,550 feet (777 m)	

Source: Concept Clearance Paper

2.5 Activities Related to Output 4

Output 4: FFC's implementation capacity (Capacity to: (1) formulate flood control MP; (2) formulate flood control projects; (3) facility operation and maintenance, etc.) will be strengthened.

2.5.1 Activity 4-1: Based on the Analysis Results in Activity 1, Examine Contents that Should be Challenged for Capacity Enhancement of FCC Staff

Based on the results of discussions with FFC and JICA, the Advisory Team will examine issues that need to be addressed to enhance FFC capacity, and conduct seminars and workshops. The conducted seminar/workshop implementation plan is as follows.

Table 2.5.1 Summary of Workshops

The challenge of Capacity Building	Status	Contents
Problem analysis	Implemented in July 2022	FFC convened governmental stakeholders such as Flood Management Committee members to identify and sort out issues concerning flood management in Pakistan. For the explanation of the procedure of problem analysis, the advisory team used the JICA training VIDEO. Most of problems that were extracted in the workshop are linked to the issues/subjects listed in the NFPP-IV survey report.
Maintenance of bunds and river facilities; and discussion on better management/appropriate structures corresponding to rivers	Implemented on November 2022	Based on the technical experiences of Japan ODA loans and grant aid projects on river improvement and the knowledge of bund maintenance in Japan, the advisory team explained the O&M of bunds. Pakistan PIDs also provided information on the bund maintenance in their provinces. Finally, comprehensive discussions and consultations on bunds' maintenance were done among stakeholders and the advisory team.
Inspection of Bund	Implemented on August 2023	Japanese and Pakistani sides made presentations, and then knowledge on maintenance and inspection of bund and river facilities was brought together, and discussions and recommendations were made.
Formulation of a master plan for integrated flood management with a tabletop exercise	Implemented on August 2023	The current NFPP projects were assembled by the FFC based on projects proposed by the province and relevant ministries and agencies. However, to make IFM, with a more national or basin-wide perspective, the FFC should not only screen the proposed project, but should also take the initiative in formulating a reasonable and scientifically based plan. The advisory team explained the procedure of basin-wide planning in Japan and conducted (1) tabletop training using the Korong river basin map, and (2) a discussion of the implementation schedule of countermeasures with the comment on DRR effect and the necessary social and environmental and budgetary assessment before the establishment of plans.
Philosophy of Integrated Flood Management	Implemented on August 2023	Discussed with the FFC chairman and staff to gain their understanding of the principles of flood protection measures necessary for Pakistan. Finally, the IFM direction and necessary activities to achieve the direction were confirmed and established.

Source: Advisory Team

2.5.2 Implementation of Workshop and the Results

2.5.2.1 1st Workshop on Problem Analysis

After the pre-monsoon meeting on March 15, 2022, the JICA Advisory Team had time for a problem analysis workshop, but it was interrupted due to a hurried ministerial meeting. Therefore, this workshop was held in July 2022.

As a result of conducting the problem analysis workshop, FMC participants mainly have the following issues. The core problem was set as "extremely large flood damage", and the participants extracted the problems and causes and organized them. The problems can be broadly categorized into “issues in structural measures,” “issues in non-structural measures,” and “issues in management and governance.” The most fundamental causes seem to be the "government's flood policy" and "insufficient control and coordination among related organizations." This information was used as a reference when recommending promoting NFPP-IV and future project formulation.

2.5.2.2 2nd Workshop on Operation & Maintenance of the Flood Protection Infrastructure

On November 22, 2022, a workshop on "Operation & Maintenance of the Flood Protection Infrastructure" was held. In the morning session, the following contents for the "Reinforcement of Bund" were presented.

- Introduction of general matters such as the definition, type, purpose of use, etc. of embankment (bund) and revetment as the flood protection infrastructures
- Major types of damage to bund and revetments and their factors
- Possibility of occurrence by type of damage
- Case studies for each type of damage, and the causes and mechanisms leading to each damage
- Conditions that are likely to occur for each type of damage, and matters to be considered during planning and design
- Countermeasures for each type of damage, applicable and effective construction methods
- Issues in the current state of bund and river management facilities in Pakistan and necessary items for strengthening
- Recommendations for the management of Bund and other river facilities in Pakistan

After the presentation, there was a Q&A session, and discussions were held on strengthening flood protection infrastructure in Pakistan. Each PID gave a presentation, grasped the damage to the flood protection facilities in Pakistan and the countermeasures currently being taken, and held a Q&A session. In addition, Balochistan and KPK received individual consultations regarding damage caused by flash floods from Hill Torrent. In this context, issues of particular concern of river structures in Pakistan are found as follows.

- Check dam (Sabo dam): Check dams in Balochistan Province are constructed in mountainous areas to temporarily store water runoff from the Hill Torrent and to mitigate damage from debris flow and mud flow. However, according to official of Balochistan PID, many of these dams have been washed away due to overflow during flood. Since check dams are structures that are expected to be overtopped by floodwaters and debris flows at the time of flood, check dams in Japan are generally constructed of concrete. Check dams in Balochistan are constructed as fill dams (made of earthern material and rocks) to reduce construction costs. Fill dam type is generally not suitable for check dams due to the low overtopping resistance as well as bund.
- River Structures in Rapid Rivers in Mountainous Area: In KPK Province, many of flood protection structures such as guide bunds, revetments, and flood bunds are constructed using gabion works or stone masonry because stones are locally available in abundance and at very low cost. Rivers in KPK are located in mountainous areas and are likely to have high velocities during floods. Gabion works and stone masonry are generally employed as temporary structures and are not suitable for

areas where river velocities exceed 5 m/s. In areas where runoff damage is occurring, river velocities may exceed the allowable velocity.

Source: Advisory Team

Photo 2.5.1 Workshop held on November 22, 2022

2.5.2.3 3rd Workshop on Inspection of Bunds

On August 22, 2023, a workshop on " Reinforcement of Bund ~Inspection of Bund~" was held. The morning time was used to give a presentation mainly on the inspection and maintenance of bunds and how to evaluate the health of bunds through numerical analysis, with the following content.

- Actual examples of bund damages based on the results of a field survey conducted in early August 2023
- Examples of failures/damage and their characteristics, critical inspection points, items, and contents at the top of bunds and at berms
- Examples of failures/damage on bund slopes and their characteristics, critical inspection points/items/contents
- Examples of failures/damage on the land side of bunds, their characteristics, critical inspection points/items/contents
- Examples of failures/damage in revetments, their characteristics, critical inspection points, items and contents
- Evaluation method of bund integrity by numerical analysis, such as stability calculation, seepage flow analysis, erosion resistance evaluation, seismic stability, liquefaction evaluation.

At the end of the presentation, The Advisory Team explained that it is not wrong to build flood protection facilities that employ gabion works using locally generated stones to reduce construction cost, and to perform restoration work every time damage occurs, but that their stability and durability can be evaluated with less difficult numerical analysis. The Advisory Team also explained that a durable structure can be constructed by selecting and constructing an appropriate structure in accordance with external forces such as the flow velocity of the river.

The Advisory Team also made recommendations on maintenance and frequency of inspections required for proper inspections, creation of a bund ledger and database, and improvement of bund quality by controlling the degree of compaction of embankments during bund construction.

In the Q&A session after the presentation, it was reported that PIDs in Punjab and Sindh manage bunds by subdividing them into the scope of authority of the Executive Engineer class, and that each Executive Engineer conducts an annual pre-monsoon inspection of bunds and keeps paper records of the inspections. In response, the Advisory Team recommended the creation of a bund ledger and its electronic database, and the promotion of information sharing among PIDs and FFC regarding the database.

Presentation Session

Discussion, Q&A Session

Source: Advisory Team

Photo 2.5.2 Workshop held on August 22, 2023

2.5.2.4 4th Workshop on Planning for Flood Control/Protection

On August 28th, a three-hour workshop was held on “how to formulate a flood control/protection plan” with 13 FFC officers and the Chairman. The workshop consisted of 1) a presentation from the advisory team with a Q&A session (2 hours), and 2) tabletop planning using an A0 size map (1 hour). In the presentation, the following items (1) to (2) were explained, and at the end (item (3)) FFC made a tabletop proposal for formulating flood control/protection measures and discussed a master plan with the points of DRR effectiveness and long-term perspective.

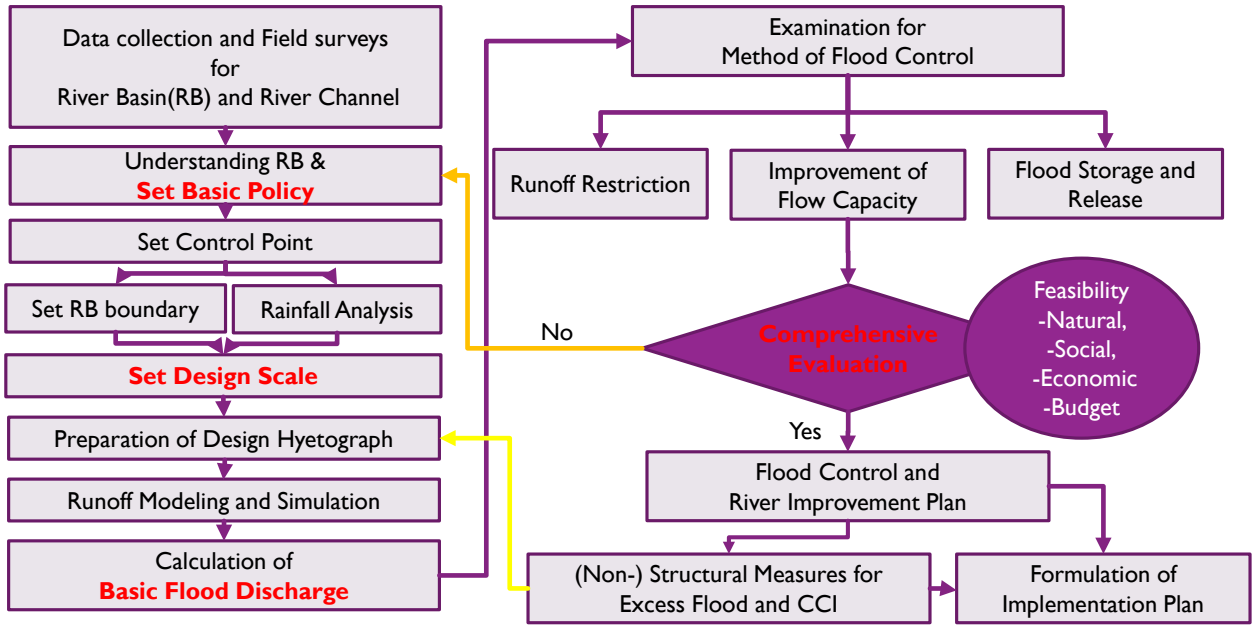
(1) Comparison of IFM declared by FFC in NFPP-IV and Comprehensive Flood Management in Japan

The advisory team explained the general definition of IFM and Japan's comprehensive flood management and discussed how to make a balance between non-structural and structural measures in developing and developed countries (historically). The results confirmed that in Pakistan, it is still possible to increase the effectiveness of DRR by protecting both human life and assets through structural measures.

(2) Regarding the drafting of flood control plans

The advisory team explained the planning flow (see Figure 2.5.1) based on Japanese technical guideline formulated by the Ministry of Land, Infrastructure, Transport and Tourism (MILT) and discussed each step with participants during the presentation. The points of explanation, discussion, and Q&A are as follows.

- Perspectives necessary for flood protection/control planning (i.e., flood management, water use, environmental impact, land use management and sediment control)
- Data and information necessary for planning and designing flood protection/control measures (meteorological and hydrological data, exposure data, cadastral information, structure information, basic river information, and information necessary for environmental impact assessment such as flora and fauna with rare species)
- Existence and formulation of high-level plans (Confirmation of high-level plans in Pakistan, especially in terms of consistency with NDMP and National Water Policy)
- Essential items and activities to be described in a flood management plan (i.e., long-term perspectives that include specific measures targeted for 20-30 years linked to the higher level plan, and the need to build consensus with residents)
- Definition of the river basin and setting of reference points (the participants discussed the setting points of design flood discharge using the Indus River as an example. The design discharge/water level ais set upstream of the barrage based on the discharge release capacity of barrage and the 2020 flood. The design water level was set to see the 2010 flood with the condition of upstream flooding. At the current bund height, if the breach is not carried out, there is a possibility of overflow from bunds downstream again.)
- Meaning and calculation method of (basic-) design discharge (basic design discharge is “the discharge in case of all flood water upstream conveys through river channel without overflow from bunds”. However, the flood design discharge is just adjusted with the size of barrages some of which have a condition that the magnitude of the flood is reversed upstream and downstream.)
- Regarding the setting of the planning scale (it was confirmed that the scale should be set according to the importance of the river in terms of DRR. The main Indus River is set to have a 100-year scale. However, the plan is not based on basic design discharge but the 2010 flood discharge with overflow from the upstream stretch as mentioned above).
- Regarding the setting of planned/subject rainfall as input data into runoff analysis (extrapolate the scale of rainfall time series by probable rainfall and add climate change impacts as necessary. However, such official guidelines do not exist in Pakistan.)
- Relationship between layout plan for flood control/protection measures and design discharge (explaining that flood control measures arrange to reduce the basic design discharge calculated using the runoff analysis model to the planned design discharge. The importance of dissemination of the design discharge distribution diagram to PIDs is confirmed)
- Brainstorming discussions on components of a comprehensive flood protection/control plan



Source: Advisory Team and Guideline of MILT

Figure 2.5.1 Flood Control/Protection Planning Flow

(3) Tabletop Training: Flood Control/Protection Planning and Overall Formation

The theme was ``Protect cities (assumed to be megacities) along the river downstream of dams from flooding," and FFC staff listed possible flood control facilities on an A0 size map of the Karong River basin on a tabletop. We discussed the need for a plan to implement measures in stages according to priority and cost.

Presentation and Discussion using Whiteboard

Comments from the Chairman

The Beginning of Tabletop Training

Discussion using proposed measures on the Map

Source: Advisory Team

Photo 2.5.1 Workshop Held on August 28, 2023

2.5.2.5 Consensus Building Workshop on Implementation Policy for Flood Control Protection Plan and Projects in Pakistan

Up until now, the advisory team has clearly articulated the challenges of project implementation to FFC. After considering these broad issues, the advisory team and FFC jointly formulated the following policy: "Promote economic growth in Pakistan by effectively reducing disaster risk based on an integrated flood management plan that incorporates climate change impacts". The agreement was reached after consultation with the FFC Chairman in advance (see Figure 2.5.2).

Next, the advisory team used the slides in Figure 2.5.3 to discuss and organize the necessary actions with FFC to realize the implementation policy. In addition, reasons for the proposition of JICA Projects were formulated during advisory activities.

Promote economic growth in Pakistan by effectively reducing disaster risk based on an integrated flood management plan that incorporates climate change impacts.

①Promote economic growth in Pakistan by effectively reducing disaster risk ②based on a comprehensive flood control plan ③incorporates climate change impacts.

①Promote economic growth in Pakistan by effectively reducing disaster risk:
In accordance with Sendai DRR Framework

②based on an IFM plans:
Mentioned in NDMP, NWP2018 & NFPP-IV but not enough comprehensive perspective

③incorporates climate change impacts:
Analyzed by PMD but not incorporation in the planning/designing/operation of (non-) structural measures

Source: Advisory Team

Figure 2.5.2 Implementation Policy for Flood Control/Protection Projects in Pakistan

1.Preparation of adaptation guidelines to incorporate climate change impacts (CCI) into integrated flood management plan
→To reflect the CCI to plan blueprint/overall strategy of IFM and design (non-) structural measures (Dimensions and method)

2.Implementation of appropriate damage risk analysis and maintenance of information for risk analysis→Currently the flood map of NFPP-IV is unsatisfied to grasp the risk of flood plain

3.Formulation of basic plans and selection of priority projects for national and regional/provincial economic growth→To keep opportunity for equally developing economic of provinces in a fair manner

4.Optimization of legal systems related to land use in river area and flood plain
→River Plans were not change. The regulation of riverine area and flood plain should be clear as FFC indicated in the NFPP-IV to effectively manage DRR.

5.Building a system to strengthen cooperation between central and local governments to appropriately manage flood protection projects and infrastructure assets→Currently IFM could not be controlled due to the lack of information of projects (Start, on-going and completed in the provinces). At least, the projects which may be affected Indus main river and 4 Major tributaries should be shared among related agencies, especially to FFC.

6.Strengthening flood management function and procurement management capacity of FFC
→To sustain the blueprint or strategy, FFC should provide governments and donnas with proper information on investment progress for IMF and individual projects

Source: Advisory Team

Figure 2.5.3 Slides for Discussing the Actions Necessary to Achieve the Implementation Policy

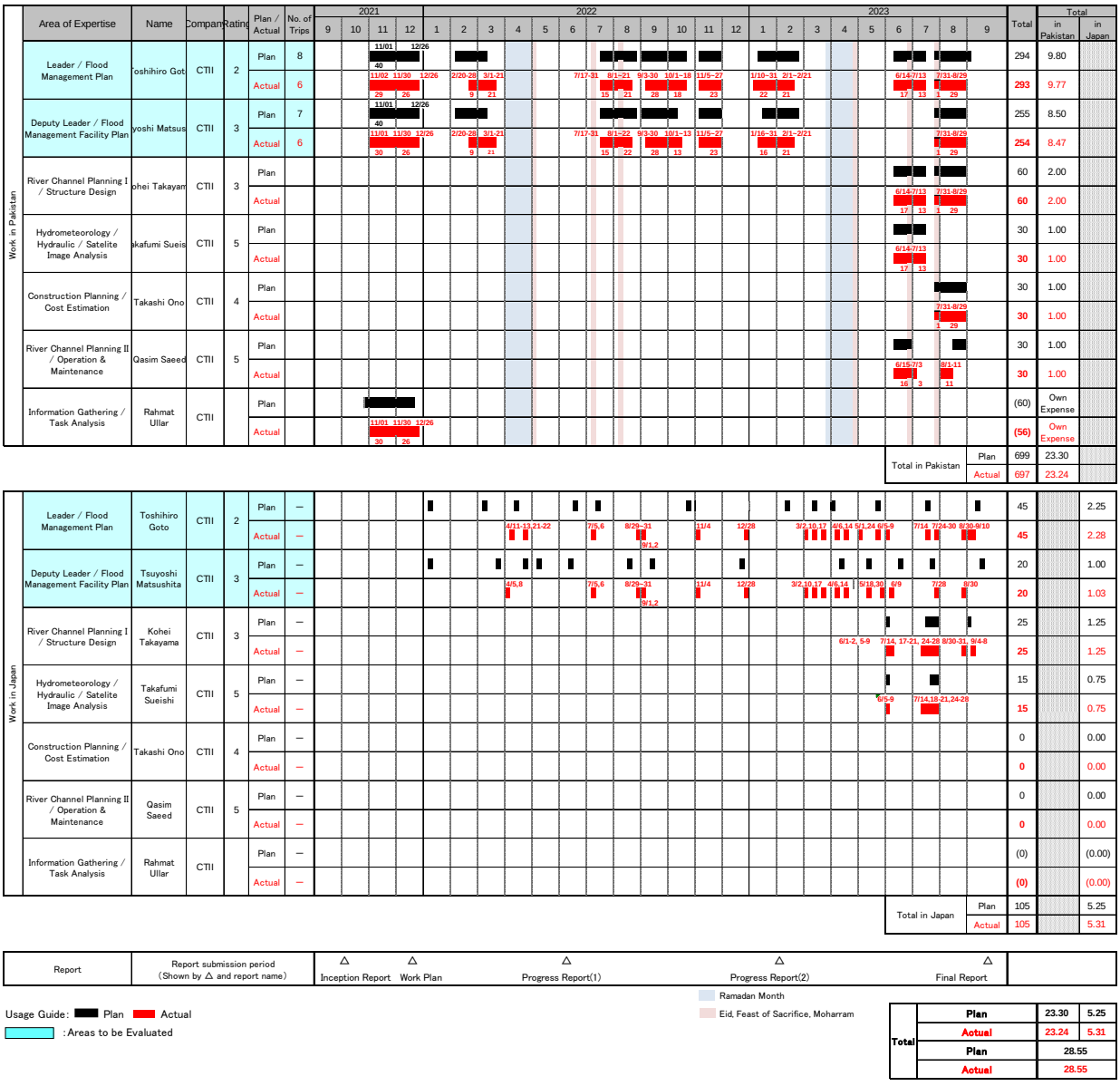
CHAPTER 3 PROJECT INPUT STATUS

3.1 Input by the Japanese Side

3.1.1 Input of Advisors

So far, the two advisors, who are the general manager and the deputy general manager, have traveled eight times each for the activities 1 to 3 and conduct surveys, analyzes, project proposals, and implementation of PDNA immediately after 2022 flood with other donors and the Pakistan government. In addition, update of Hill Trent projects, Pre-F/S for bunds construction in the main Indus River and for improving drainage capacity of Manchar Lake were conducted. Table 3.1.1 shows the advisor's trip records.

Table 3.1.1 Input of Advisor



Source: Advisory Team

CHAPTER 4 LESSONS LEARNED

4.1 Establishment of Project Continuity by Hiring Long-Term Local Mercenaries

To conduct information request, collection and analysis through part-time work by advisors, long-term employment of local staff with appropriate expertise on flood control is very effective. In the Project, two technical assistants (in charge of agriculture, flood and civil engineering, and data collection and GIS) are employed as local staff. The person in charge of agriculture, flood and civil engineering research was a director of the Punjab Irrigation Department who has been employed for two decades as a Japanese consultant for JICA projects. The member assigned for data collection and GIS formulation was an employee of a civil engineering consultant who received an award from the Japanese Embassy in Pakistan.

Gathering data for projects is very difficult even if the information is requested by official letter of the advisors. FFC does not keep all the data of NFPP-IV at the designated places. Even if their existence is confirmed, FFC always try to locate them every time they are requested. If the data requested could not be found inside of the FFC building, FFC requests them from other offices. The most important NFPP-IV electronic data was finally secured from NESPAK, a semi-public consultant in Pakistan (under the Ministry of Water Resources), although it was difficult and took a long time to receive the necessary data from them.

In this respect, local staff with similar expertise and experience with JICA advisors can be very useful. For example, while the advisors were out of the office, FFC was able to understand the content and quality of the information necessary for the advisors based on the opinion of the local staff. To continuously check the progress of data collection, and accurately communicate with FFC instead of the advisors are possible through the remote communication between the advisors and local staff. As for GIS staff, information is obtained from the above local staff through What's Up, etc., and data is visualized by the local GIS staff and provided to advisors. In addition, when GIS data is not available, strong support is provided by digitizing data on paper and PDF media) to enhance advisors' understanding and to create figures/diagrams that can be used in reports.

4.2 Information Professor from Field Experienced Persons in Situations Where it Is Difficult to Conduct Field Investigations

In Pakistan, it is very difficult to inspect flood control facilities such as dikes and dams due to safety issues. In such a case, information from the JICA Pakistan office and in-house staff of JICA headquarters who have experience in flood sector projects in Pakistan were very effective to decide project direction and promote project activities. In particular, explanations, explanatory materials, photographs, etc., from JICA officers who have plenty of experience in on-site investigation of the Indus River and river facilities in the past were very effective for understanding the situation at the river and riverine site. Information such as the condition of weirs and surrounding rivers, and the condition of bunds and water level monitoring in the event of flood, which can be obtained only through on-site inspections, can be efficiently utilized in the discussion with the parties of the government organizations when conducting consultations on structures in the process of project formulation. Therefore, in the future it will be necessary to have dialogue and exchange opinions, not only with the central government, but also with local governmental and private organizations who have experiences in the field.

4.3 FFC's Conferences with Stakeholders

FFC is responsible for convening flood control stakeholders in FFC conferences to discuss necessary issues during the pre-monsoon, during-monsoon and post-monsoon periods, and for proposed project evaluations. Therefore, if necessary to hold seminars/workshops in the Project, it is efficient for the advisors to convene stakeholders before and/or after FFC sponsored meetings.

4.4 Approval for No-Appointment Interviews with the FFC Chairman

The advisory tam is allowed to visit the FFC chairman without appointments to explain the work policy and work progress, collect peripheral information, introduce key persons, and discuss issues and promotion

of NFPP-IV except for the period for response to the flood in August 2022. This treatment for the advisory team is very effective for the purpose of drawing conclusions for any issues on the activities and making a decision for the formulation of flood control/protection development policy in Pakistan.

4.5 Effects Of Recommendations to FFC and Each Wing

The advisory team usually reports the progress and results in activities 2 and 3 to the FFC Chairman. Therefore, during the implementation of the activities, FFC is planning or implementing the following organizational strengthening and information maintenance in order to solve their issues.

- Organizing national dam information and creating reports
- Implementation of FMC meetings regarding the formulation of national (hill torrent) drainage master plans
- Formulation of a project management unit (PMU) to improve the project management efficiency (partially supported by ADB)
- Hiring FFC temporary staff for streamlining the project management and checking/updating NFPP-IV (around 60 staff will be employed by the ADB fund
- Reformation of the information management center (planned to collaborate with JICA project on the River Management Enhancement Project)

CHAPTER 5 RECCOMENDATIONS FOR ACHIEVING THE OVERALL GOAL

The ultimate objective of this Activity is: "In Pakistan, the importance of systematic flood control measures will be understood, and advance investment in flood control measures will be expanded to the level that human and economic losses can shift to a downward trend."

To achieve the ultimate objective, considering the issues clarified during the activities, finally FFC declared that “Promote economic growth in Pakistan by effectively reducing disaster risk based on an integrated flood management plan that incorporates climate change impacts."

5.1 Current Challenges for Achieving Top Objectives

The issues analyzed in the past activities can be broadly categorized into (1) to (3) below.

5.1.1 Betterment of Awareness of the Importance of Flood Control/Protection Measures

It is very difficult to say that the importance of flood control measures is generally understood in Pakistan. As mentioned in Chapter 2, the one of root causes on the slow progress of NFPP-IV is that organizations in charge of allocation of the government budget recognizes that the investment for flood protection project will not bring any benefits. They may be prioritizing investments in other infrastructure. These organizations need to recognize that disaster risk reduction is a development issue.

5.1.2 Improvement of Capacity to Manage Nation-Wide Flood Control/Protection Projects

In addition, the personnel structure and organizational structure of FFC is not sufficiently developed to manage nationwide flood control/protection plans and projects, which will become a bottleneck once the budget is fully allocated.

5.1.3 Necessity of Further Capacity, Tools, and Information to Clearly Understand Priority of Projects

Regarding the current flood control/protection projects, it has been calculated how much economic loss would be prevented if all the countermeasures were implemented, but not at the basin or hill torrent level. It has not been evaluated and therefore projects’ priorities have not been analyzed. In that sense, it can be said that NFPP-IV remains a list of projects rather than a national plan.

5.2 Actions for Achievement

From a technical and administrative functional point of view, in order to realize FFC's flood control/protection project implementation policy, FFC and related organizations promote the actions organized in “”.

On other hand, in order to expand investment in disaster prevention in the future, it will be necessary to hold consultations to deepen the awareness among governments about the efficacy of investment in disaster prevention in Pakistan and to appeal to influential opinion leaders. It is necessary to explain, by referring to good examples in other countries, that social infrastructure is vulnerable to the following, and that once a disaster occurs, it can cause enormous economic losses, and that advance investment can lead to steady economic development. It is necessary for FFC to retain such activity.

ATTACHMENTS

FPSP survey report, flood inundation map of all rivers, request form from FFC, etc., were obtained in addition to the materials so far available.

No	Name	Media	Language	Issued by	Year (Issued)
1	Organization Chart of FFC	Paper and PDF	English	Federal Flood Commission (FFC)	2021
2	Punjab Flood Plain Regulation Act 2016	Paper and PDF	English	Punjab Irrigation Department, Government of the Punjab	2016
3	Federal River Management Act 2014	Paper and PDF	English	Federal Government	2014
4	Three-Year Work Plan	Paper and PDF	English	Office of the Chief Engineering Advisor & Chairman FFC	2021
5	The Khyber Pakhtunkhwa River Protection Ordinance, 2002	Paper and PDF	English		2002
6	Annual Report 2020	Paper and PDF	English	Office of the Chief Engineering Advisor & Chairman FFC	2021
7	Annual Report 2019	Paper and PDF	English	Office of the Chief Engineering Advisor & Chairman FFC	2020
8	National Water Policy 2018	Paper and PDF	English	Ministry of Water Resources	2018
9	Concept Clearance Paper of Two Floods Protection Projects in Sindh (request to JICA)	Paper	English	Government of Sindh	2020
10	PC-I for Strengthening and Capacity Building of Office of the Chief Engineering Advisor & Chairman, Federal Flood Commission, June 2021	Paper	English	Office of the Chief Engineering Advisor & Chairman Federal Flood Commission	2021
11	Development of National Flood Protection Plan-IV and Related Studies to Enhance Capacity Building of Federal Flood Commission. National Flood Protection Plan-IV (Ten Year Plan), **Executive Report**	Paper and PDF	English	NESPAK	2019
12	Development of National Flood Protection Plan-IV and Related Studies to Enhance Capacity Building of Federal Flood Commission. **TASK-A**: Development of National Flood Protection Plan-IV (NFPP-IV) and PC-I (Final Report)	Paper and PDF	English	NESPAK	2019
13	Development of National Flood Protection Plan-IV and Related Studies to Enhance Capacity Building of Federal Flood Commission. **TASK-B**: Development of Inventory of Flood Works and Benefit Monitoring and Evaluation of Flood Protection Works	Paper and PDF	English	NESPAK	2019
14	Development of National Flood Protection Plan-IV and Related Studies to Enhance Capacity Building of Federal Flood Commission. **TASK-C**: Floodplain Mapping and Zoning	Paper and PDF	English	NESPAK	2019
15	Development of National Flood Protection Plan-IV and Related Studies to Enhance Capacity Building of Federal Flood Commission. **TASK-D**: Automation of Flood Situation Monitoring and Reporting (Final Report)	Paper and PDF	English	NESPAK	2019

No	Name	Media	Language	Issued by	Year (Issued)
16	Umbrella PC– I For Flood Protection Sector Project-III (FPSP-III) of National Flood Protection Plan-IV (NFPP-IV)	PDF	English	Office of the Chief Engineering Advisor & Chairman FFC	2020
17	Financing of Prioritized Portfolio of Flood Protection Sector Project-III (Based on NFPP-IV)	PDF	English	Office of the Chief Engineering Advisor & Chairman FFC	2021
18	Sindh Bund Manual (Third Edition)	PDF	English	PID Sindh	1978
19	Sindh Bund Manual (Fourth Edition)	PDF	English	PID Sindh	2008
20	Manual of Irrigation Practice (Volume 1 and 2)	PDF	English	PID Punjab	2017
21	Concept Clearance Paper - Installation of 45 No Flood Telemetry Hydromet/Early Warning Stations Through JICA Financing (request to JICA)	PDF	English	WAPDA	2019
22	PC-II Formulation of National Watershed Management Plan	PDF	English	WAPDA	2020
23	Lai Nullah Presentation of Sep 2021	PPT	English	WASA	2021
24	Lai Nullah Presentation of Nov 2021	PPT	English	WASA	2021
25	Draft Sindh Water Policy	PDF	English	PID Sindh	2021
26	Sindh Water Policy – Executive Version	PDF	English	PID Sindh	2021
27	PC-I for Strengthening and Capacity Building of FFC OCED&CFFC	PDF	English	FFC	2022
28	Annual Report 2021	PDF	English	Office of the Chief Engineering Advisor & Chairman FFC	2022
29	FLOOD HAZARD ATLAS Strategic Strengthening of Flood Warning and Management Capacity of PAKISTAN 2011-2019	PDF (scanned)	English	UNESCO0	2019
30	Pakistan Water Sector Strategy Executive Summary Volume 1	PDF (scanned)	English	Ministry of Water and Power Office of the Chief Engineering Advisor/Chairman Federal Flood Commission	October 2002
31	Northern India Canal and Drainage Act, 1873 , Act No.8 of 1873	PDF (Downloaded)	English	Shri K.K. Sharma(ILS) Assistant Legislative Counsel, Legislative Department, Ministry of Law and Justice, Govt. of India (https://www.indiacode.nic.in)	1873
32	Bengal Embankment Act 1882	PDF (Downloaded)	English	Government of India (http://www.bareactslive.com)	1882
33	Andhra Pradesh (Andhra Area) Rivers Conservancy Act 1884	PDF (Downloaded)	English	Government of India (https://www.lawyerservices.in/Contact)	1884
34	Orissa Public Embankment Construction and Improvement Act 1951	PDF (Downloaded)	English	Government of India (http://extwprlegs1.fao.org)	1951
35	Assam Embankment and Drainage Act 1954	PDF (Downloaded)	English	Government of India **(www.indiacode.nic.in)**	1954
36	Andhra Pradesh Irrigation (Levy of Betterment Contribution and Advance Betterment Contribution) Act 1955	PDF (Downloaded)	English	Government of India (http://extwprlegs1.fao.org)	1955

No	Name	Media	Language	Issued by	Year (Issued)
37	Bihar Irrigation and Flood Protection (Better Contribution) Act 1959 Bihar Irrigation & Flood Protection, (Betterment Contribution) Rules, 1961 Bihar Irrigation Act_1997 Bihar Irrigation, Flood Management and Drainage Rules, 2003	PDF (Downloaded)	English	Government of India (https://www.chawlapublications.com)	1959
38	The Orissa Hydro-Electric Projects and Flood Control Works (survey) Act 1961	PDF (Downloaded)	English	Government of India (https://www.indiacode.nic.in)	1961
39	The Karela Protection of River Banks and Regulation of Removal of sand act 2001.	PDF (Downloaded)	English	Government of India Institute of Land and Disaster Management Department of Revenue and Disaster Management Government of Kerala (http://extwprlegs1.fao.org)	2001
40	フォルダ：National Disaster Risk Management Fund_2018 （at Launching Ceremony & Orientation Workshop of NDRMF) <u>Structures of the document</u> Concept Note & Program Anti-Harassment Policy Diversity, Equal Opportunity, and Affirmative Action Policy Environmental and Social Management System (ESMS) Gender and Development (GAD) Policy	PDF (scanned)	English	National Disaster Risk Management Fund	2018
41	1st Pre-Monsoon 2022 Meeting Presentations: FFC: Agenda, Decisions of Post Flood-2021 meet, Presentation by FFC, Working Paper pPre -Flood Meeting 2022 PID: Pre-Monsoon 2022 Meeting @FFC 15.3.2022 Amended SID: First Pre-Monsoon 2022 Meeting @ FFC_15 March 2022 WAPDA: 1st pre monsoon meeting @FFC 15 Mar 2022 PMD: FFC_Pre_Monsoon2022_15_March GCISC: Presentation Shahbaz FFC Islamabad March2022 MDP: Aft-FFC_(Pre-flood) 15 March 2022 (09Slides) PRCS: Forecast based Financing (FbF) Concept - FFC	PPT Word PDF	English	FFC, Punjab Irrigation Dept.(PID), Sindh Irrigation Dept.(SID), WAPDA, PMD, GCISC (Global Change Impact Studies Centre), Mangla Dam Project (MDP), PRCS (Pakistan Red Cresent Society)	2022
42	PMD-Brief	PPT	English	Pakistan Meteorological Department	-
43	WAPDA_Flood Telemetry Masterplan Final Report 2022-01-31 Flood Telemetry Masterplan Final Report.pdf Flood Telemetry Masterplan draft March 25 2022.doc WAPDA JICA presentation 17-03-2022.pptx H&R Station List & Organ Chart.xlsx	PDF	English	WAPDA	2022

No	Name	Media	Language	Issued by	Year (Issued)
44	Daily Water Level of Gauge of LS Bund SID (2022/08~2022/09)	PDF	English	Sindh Irrigation Department	2022
45	Daily Water Level of Gauge of Dadu Moro River Bridge (2022/07~2022/11)	PDF	English	Sindh Irrigation Department	2022
46	Gauge of Manchar SID (2022/08~2022/11)	PDF	English	Sindh Irrigation Department	2022
47	Feasibility Study Report "PC-II Proforma for Construction of Feeding Canal to Manchar Lake to Eradicate Contamination"	Word	English	Sindh-CSE	2020
48	Report "Proposals for Remedial Works to Improve Feeding of Manchar Lake from Existing Irrigation System"	Word	English	Sindh-CSE	2020
49	Report "Manchar Lake & Dadu Canal System"	Word	English	Sindh-CSE	2020
50	Annual Maximum Water Level of Gauge of Danister & Aral Regulators (2018~2022)	PDF	English	Sindh Irrigation Department	2022
51	Annual Maximum Water Level of Gauge of Manchar Lake (1959~2022)	PDF	English	Sindh Irrigation Department	2022
52	Annual Maximum Water Level of Gauge of Dadu Moro Bridge (2018~2022)	PDF	English	Sindh Irrigation Department	2022
53	Presentation "Consultative Seminar Pre-Flood Season (March 2023)"	PDF	English	Sindh Irrigation Department	2023
54	Contingency Plan CE RBR 18 Div Presentation "Flood Contingency Plan 2022"	Power Point	English	Sindh Irrigation Department	2022
55	Vulnerable Point Larkana	PDF and Excel	English	Sindh Irrigation Department	2022
56	Map Showing the Vulnerable Points	PDF	English	Sindh Irrigation Department	2022
57	Answer of JICA Team Questions for Vulnerable Points	PDF	English	Sindh Irrigation Department	2023
58	Sindh Flood Emergency Rehabilitation Project (Irrigation Component)	PDF	English	Sindh Irrigation Department	2023
59	Six Hourly Gauge and Discharge Data of Indus River System (A few days of 2023/07, excessing flood limit)	PDF	English	OFFICE OF THE DIRECTOR FLOOD / SECRETARY PUNJAB FLOOD COMMISSION	2023
60	Organogram of Irrigation Department Government of Sindh	PDF	English	Sindh Irrigation Department	2022