



Training Workshop on Flood Risk Management
(Dakar, Senegal, March 18-19, 2013)

Flood Risk Management In Pakistan

By: Ahmed Kamal, Chief Engineer (DSC)
Ministry of Water & Power
Government of Pakistan
(ifmengineer@gmail.com)



Pakistan Geo Location



Pakistan



Floods in Pakistan

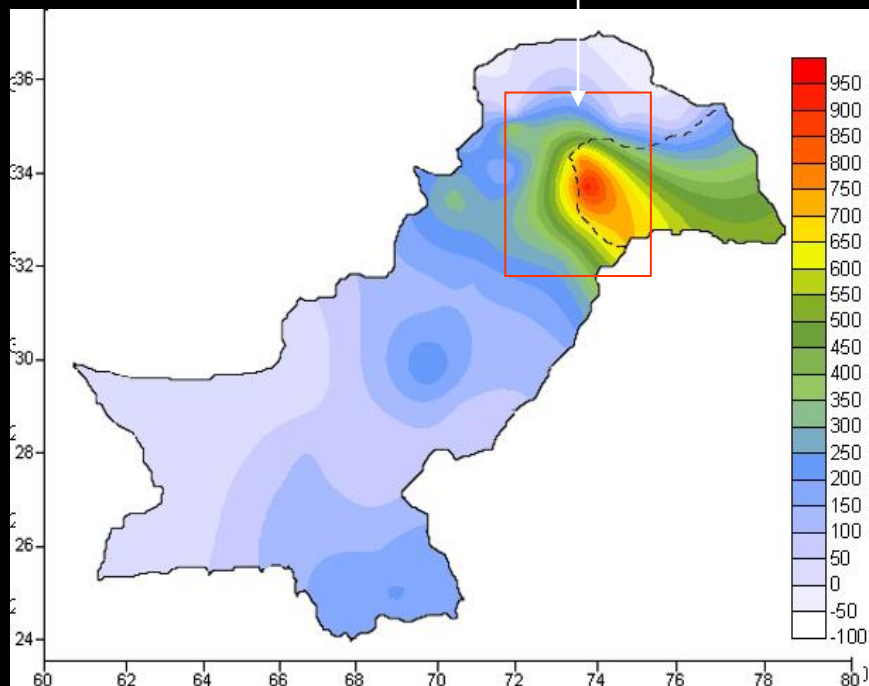
- **During the last over 65 years Pakistan has suffered a cumulative financial loss of more than US \$ 39 billion on account of 20 major country-wide flood events;**
- **Over 11,200 precious lives have so far been lost besides;**
- **Dislocation of millions of people and damage to private & public property.**

Causes of Floods in Pakistan

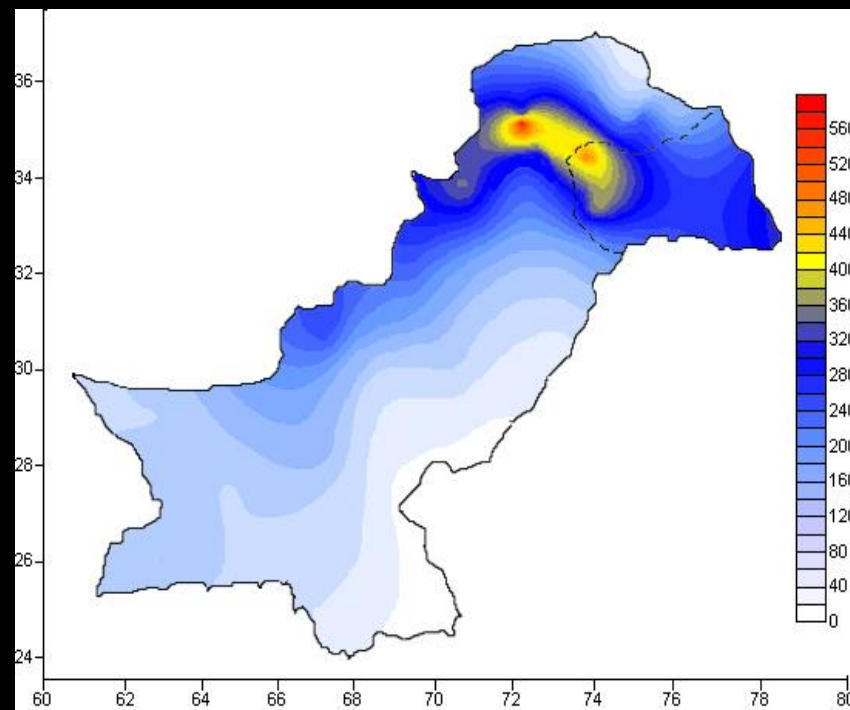
- **Floods in rivers are caused by heavy concentrated monsoon rains;**
- **Sometimes augmented by snowmelt flows;**
- **Monsoon depressions originating from the Bay of Bengal (India) often result in heavy downpour;**
- **Additional contribution by weather systems from Arabian Sea (Seasonal Low), and Mediterranean Sea (Westerly Wave) producing destructive floods in one or more of the main rivers of the Indus System;**
- **Temporary natural dams as a result of landslide or glacier movement also sometimes cause floods;**
- **Flash floods due to cloud bursts, hill torrent flows;**
- **Urban flooding due to chocking of drainage outlets, un-planned urbanization.**

Climate of Pakistan Rainfall Distribution

Monsoonal Zone



Monsoon (JJAS)
65% of Annual Rainfall



Winter (DJF)
25% of Annual Rainfall

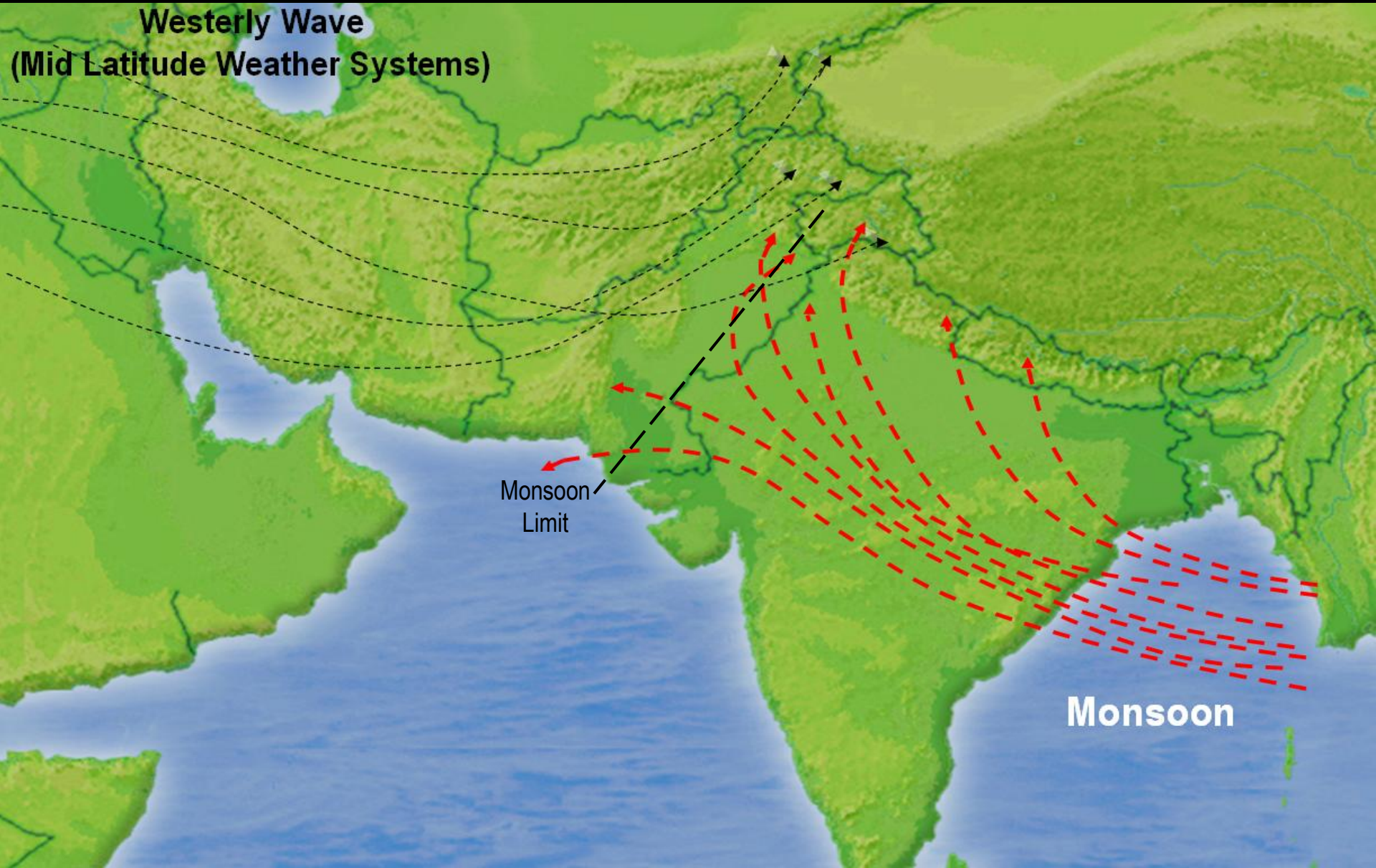
Climate of Pakistan - Extreme Weather Events

Pakistan is historically prone to Extreme Weather Events/Disasters, such as;



In Pakistan, more than 70% Extreme Weather Events are associated with Monsoon Season. So, it is very important to focus on monsoon rainfall changes and weather patterns of the region.

Monsoonal Weather Systems



Westerly Wave

(Mid Latitude Weather Systems)

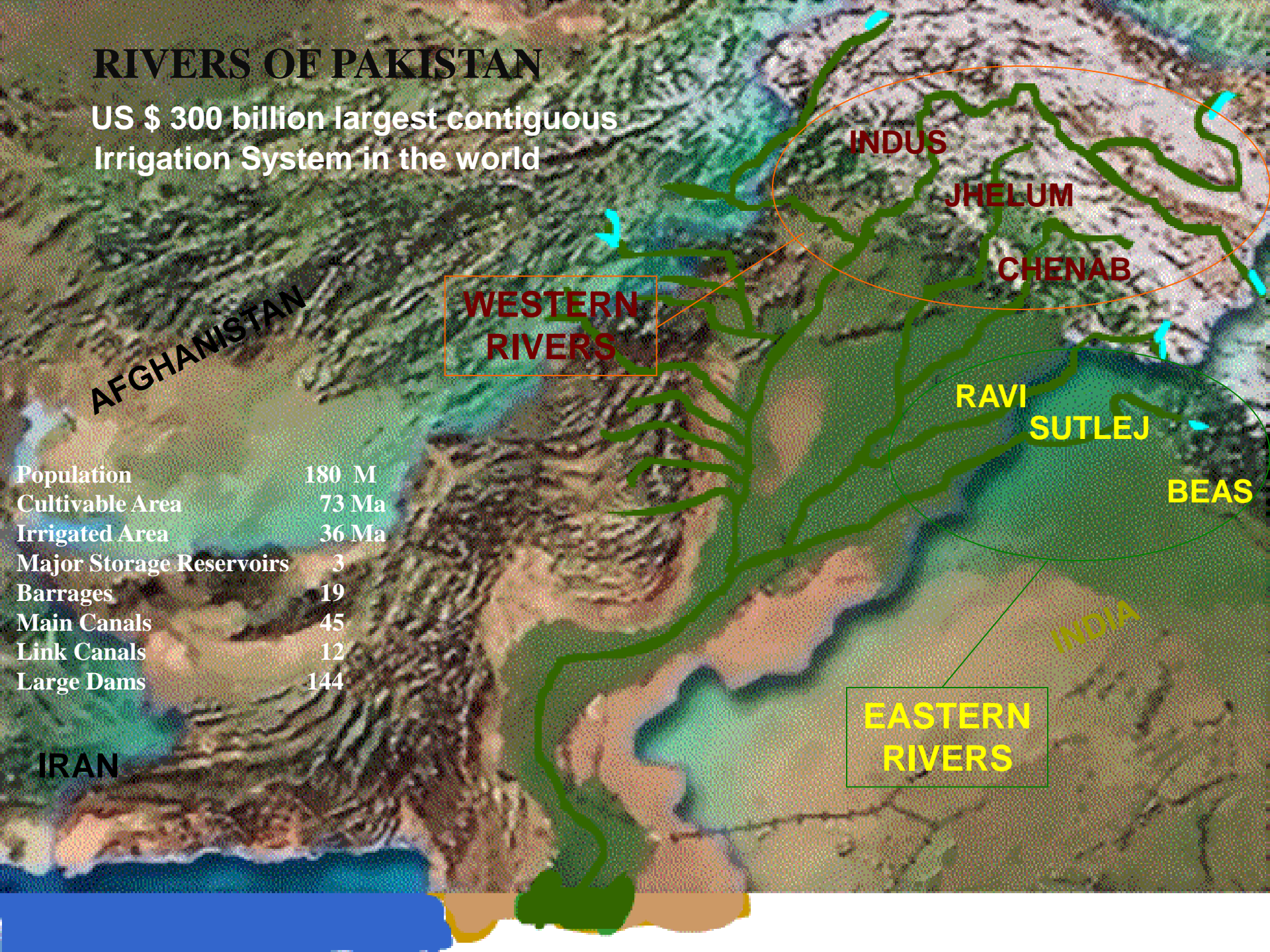
Monsoon
Limit

Monsoon

Pakistan's River System

RIVERS OF PAKISTAN

US \$ 300 billion largest contiguous
Irrigation System in the world



INDUS

JHELUM

CHENAB

**WESTERN
RIVERS**

RAVI

SUTLEJ

BEAS

**EASTERN
RIVERS**

AFGHANISTAN

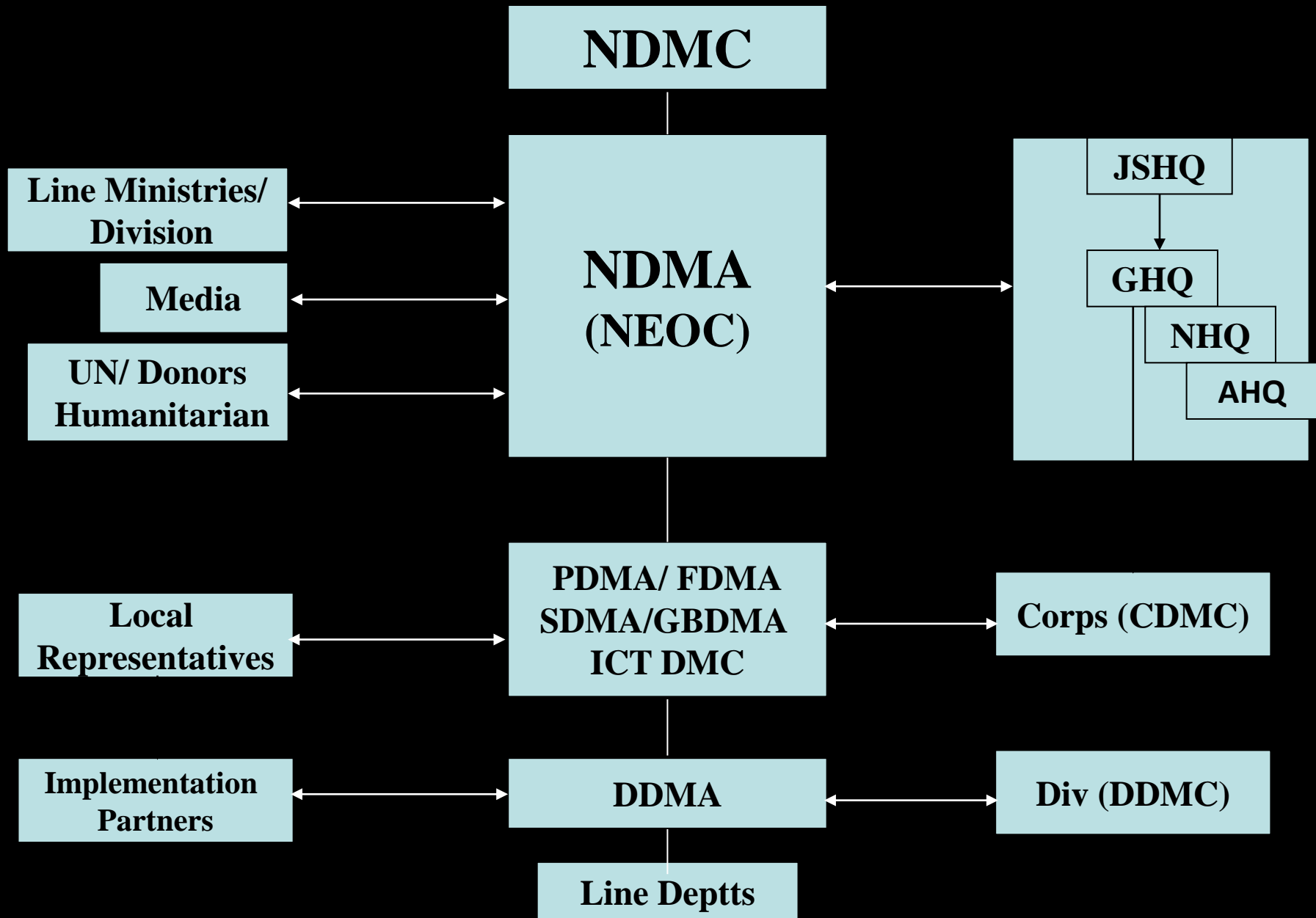
INDIA

IRAN

Population	180 M
Cultivable Area	73 Ma
Irrigated Area	36 Ma
Major Storage Reservoirs	3
Barrages	19
Main Canals	45
Link Canals	12
Large Dams	144

Flood Risk Management In Pakistan

DM Organizational Structure



Major Policies Adopted On Flood Risk Management

- Reduction of floods/ flood damages through sound & economical strategies;
- Protection of cities, vital infrastructural installations, prioritized economic areas and other areas in that order;
- Exploring more effective use of existing flood control facilities;
- Improvements in Watershed and River Management Practices;
- Improvement in Flood Forecasting & Advance Warning System;
- Minimize adverse effects on natural ecosystem/environment;
- Community participation approach for effective flood preparedness, fighting and rehabilitation;
- Flood adaptability

Flood Risk Management Measures

Structural Measures

These Include:

- **Construction of Embankments**
- **Construction of Spurs/Battery Of Spurs**
- **Construction of Dikes/Gabion Walls/Flood Walls**
- **Construction of Dispersion/Diversion Structures**
- **Channelization of Flood Waters**
- **Construction of Delay Action Dams**
- **Construction of Bypass Structures**

Flood Mitigation Measures (Structural)

Province	Embankment (KM)	Spurs (No.)
Punjab	3,334	496
Sindh	2,424	46
KP	352	186
Balochistan	697	682
Total:	6,807	1,410

Flood Risk Management Measures

Non-Structural Measures

Improved Flood Forecasting System through :

- **Effective Data Collection and Dissemination System**
- **Real Time Rain-Fall and River Flow Data Collection**
- **Weather Radar Prediction**
- **Modern System of Transmission of Flood Forecasts.**

Improved Early Flood Warning System :

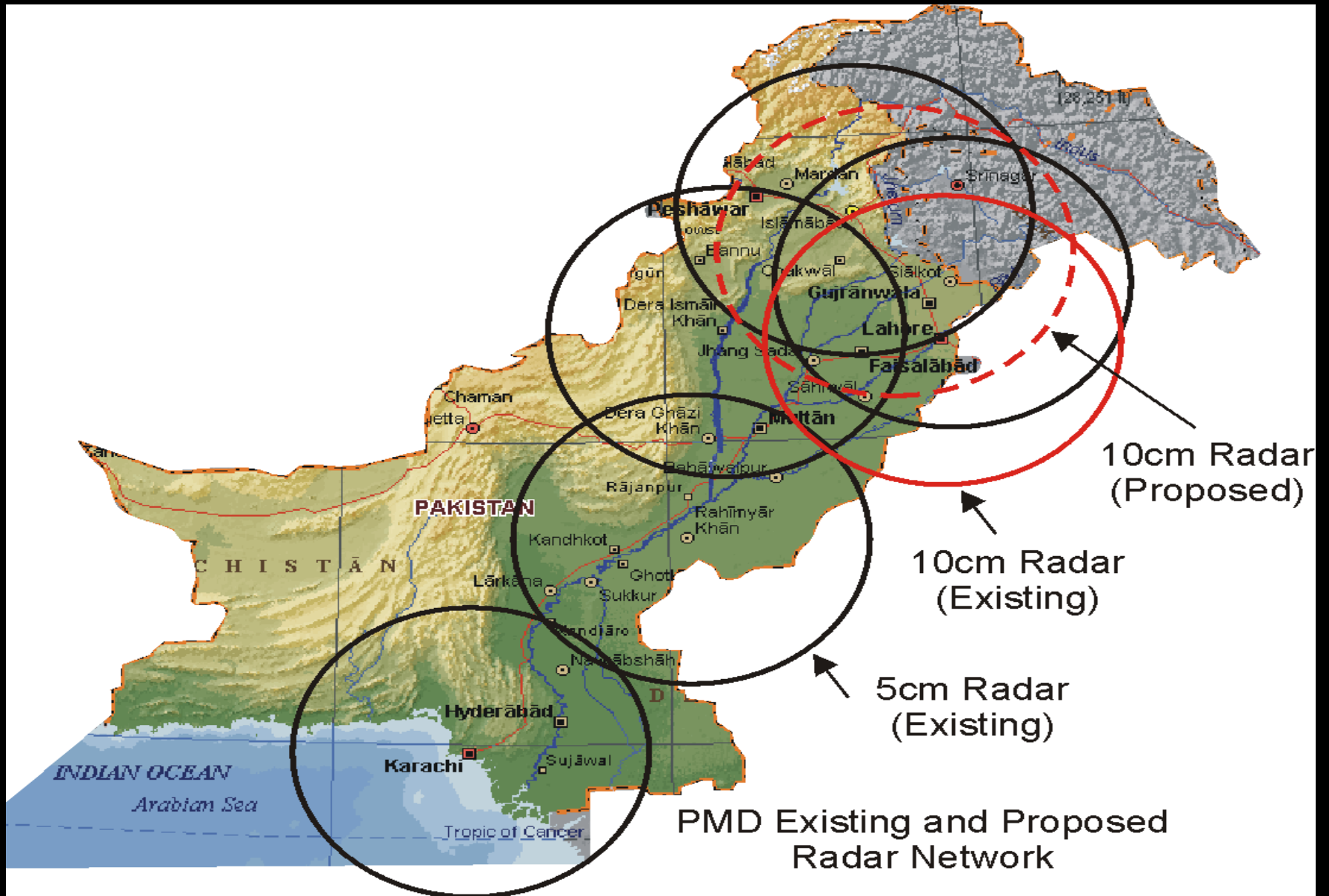
- **Based on effective Flood Forecasts, early Flood Warning is issued**
- **Reliable interaction between all related Flood Control and Relief Agencies.**
- **In-time warning and evacuation arrangements by Provincial Relief Departments, District Administrations etc.**

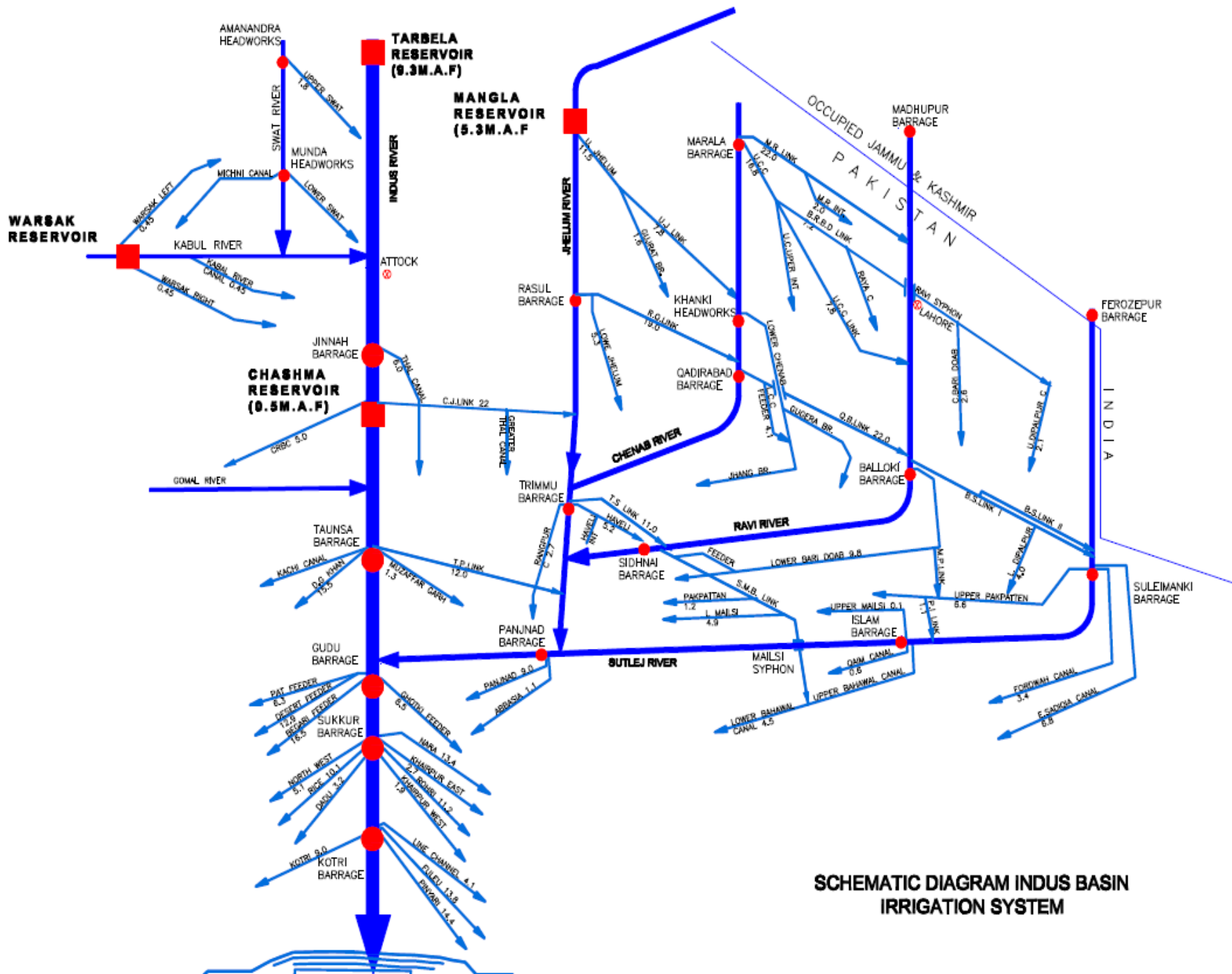
Flood Mitigation Measures

(Non-Structural)

- **Flood Forecasting Division (FFD), at Lahore;**
- **10-CM QPM Weather Radar Systems at Sialkot, Lahore & Mangla, 5 CM Weather Radars at Karachi, Rahim Yar Khan, D. I.Khan and Islamabad;**
- **HF Radio Communication system for effective rainfall, river flow/stream flow data receipt and transmission;**
- **Meteoro-burst Telecommunication System for improved flood gauging & telemetry through collection of real time hydro-met from remote sites and its dissemination;**
- **Flood Plain maps;**
- **Indus Basin Flood Forecasting System (FFS) through Rainfall-Runoff Computer modeling.**
- **Wireless Network**

Existing & the Proposed Weather Radar Network





SCHEMATIC DIAGRAM INDUS BASIN IRRIGATION SYSTEM

FLOOD FORECASTING DIVISION,(FFD), LAHORE

(H.F.RADIO NETWORK)

TARBELA

MANGLA

Besham, Jaglot

Skardu, Daggar

Phulra, Oghi

Shinkiari, Khairabad

Nowshera

Kallar, G.H.Ullah

Muzaffarabad, Domel

Kotli, Kohala

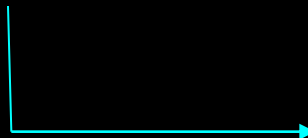
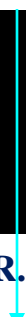
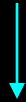
Plandri, Azadpatan

CHASMA

W.R.M.D.

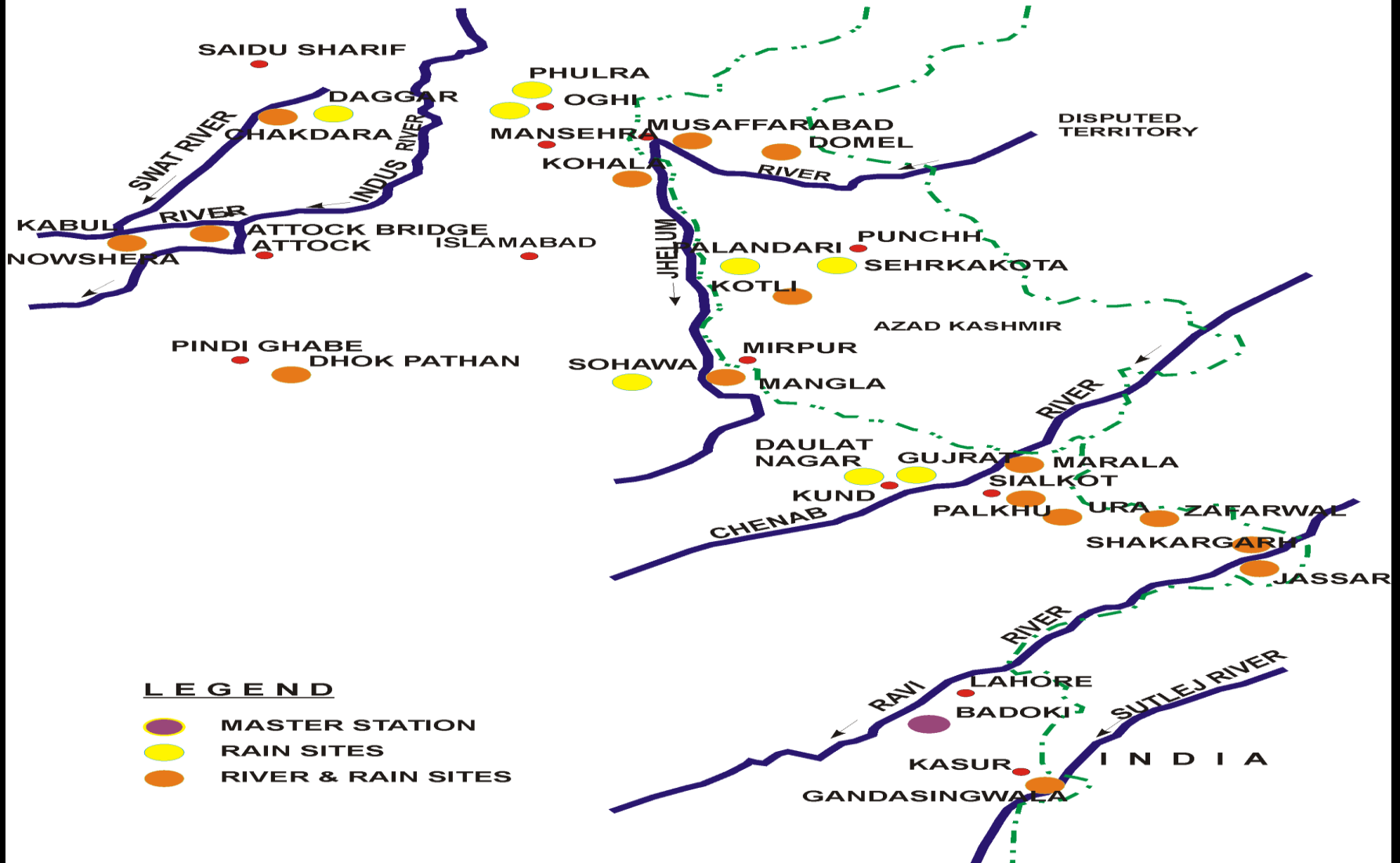
SUNNY VIEW LAHORE

**FLOOD FORECASTING DIVISION
LAHORE**



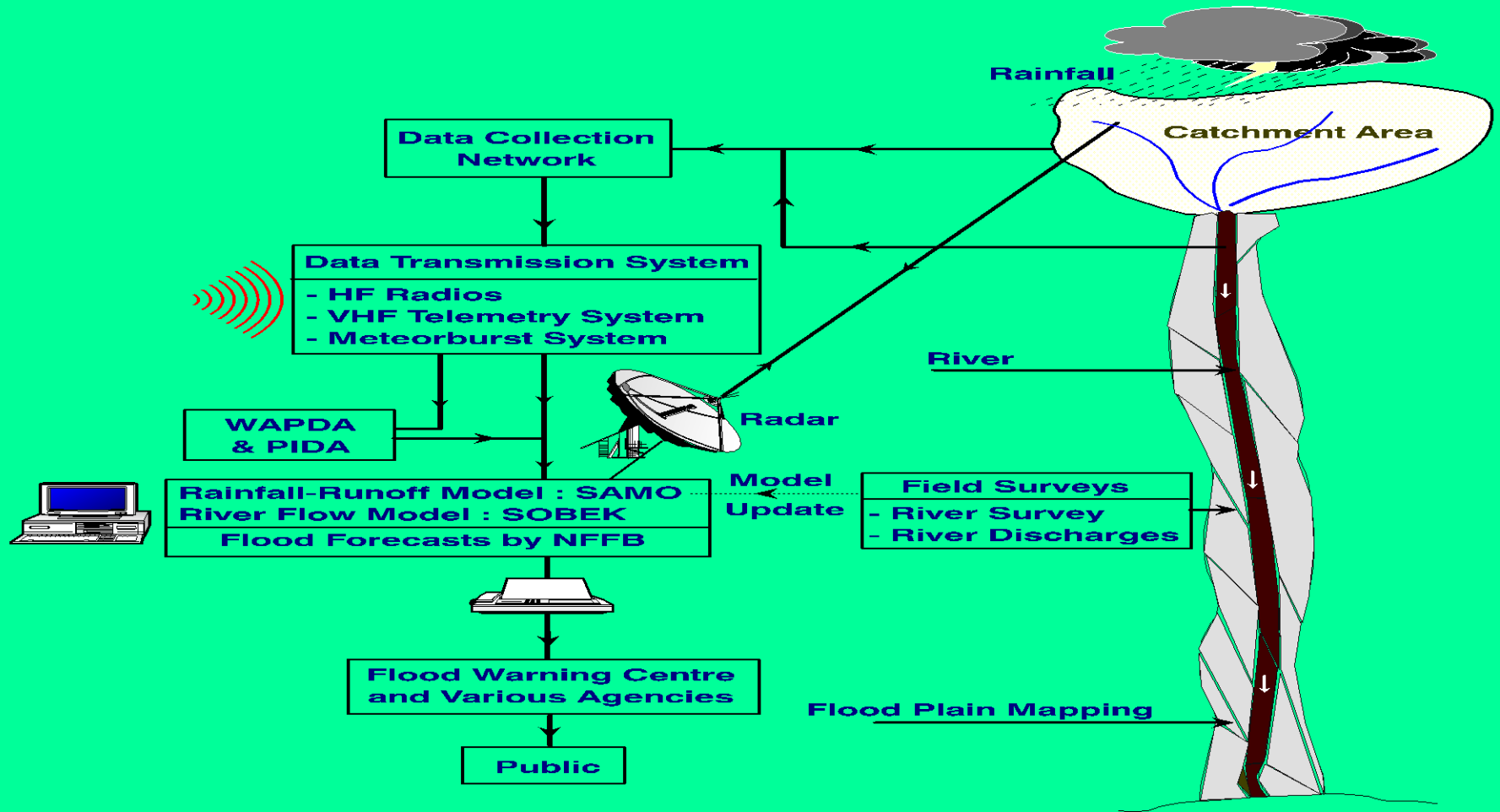
Meteoroburst Telecommunication System

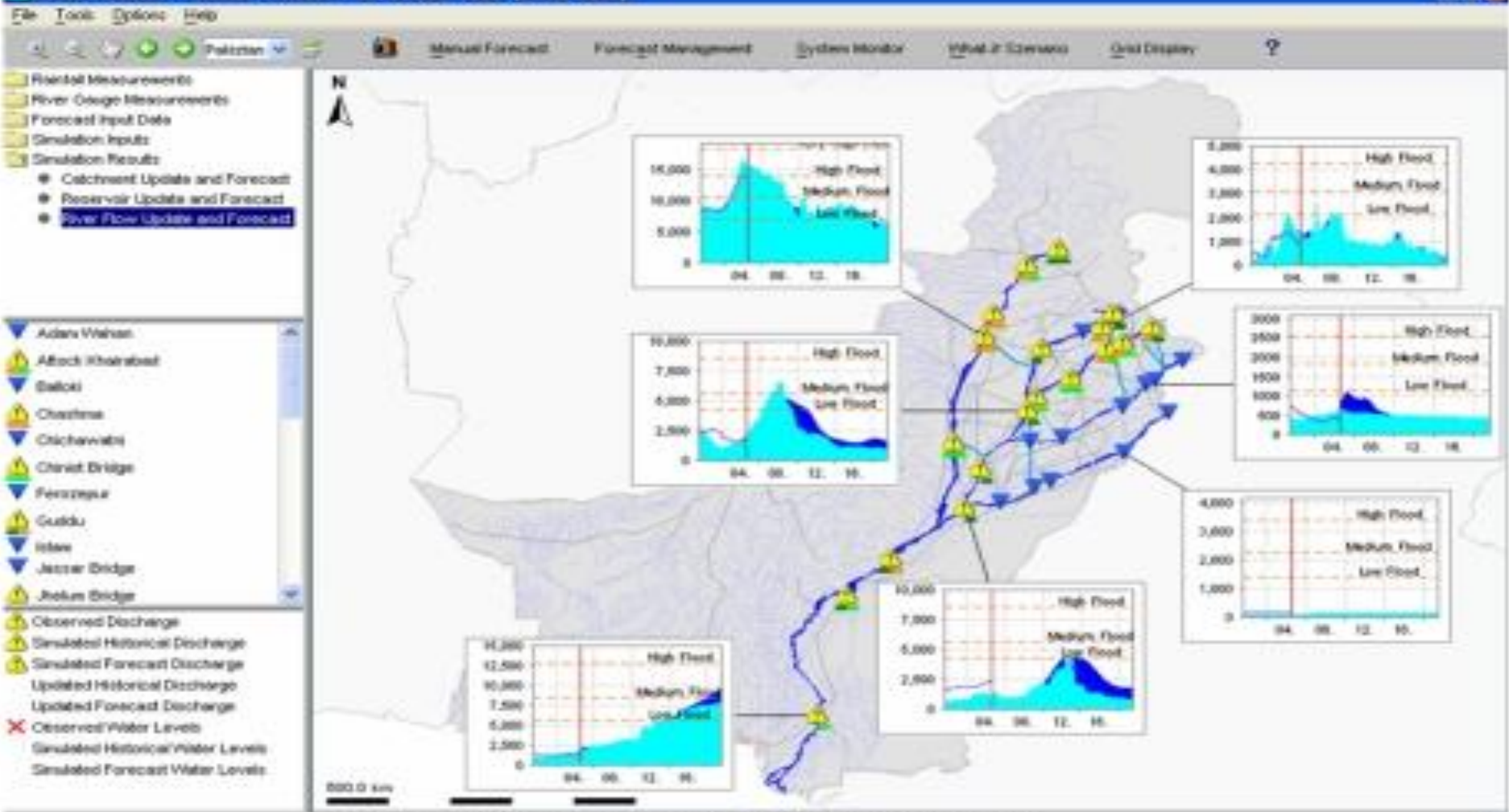
WAPDA'S FLOOD FORECASTING TELEMETRY NETWORK (METEORBURST COMMUNICATION)



Computer Based Flood Forecasting System

FLOOD FORECASTING SYSTEM FOR INDUS BASIN





06.10.2006 08:34:05 INFO - RollingBarrel.Info Rolling barrel completed
 06.10.2006 08:33:37 INFO - RollingBarrel.Info Rolling barrel started
 06.10.2006 08:33:35 INFO - Application.Startup.Finished The application finished starting up.
 05.10.2006 08:33:35 INFO - GUI.Initialized Graphical user interface initialized.



Government of Pakistan
 Ministry of Water & Power



FLOOD FORECASTING DIVISION,(FFD), LAHORE

(WIRELESS NETWORK)

RAVI

KOT NAINA, JASSAR, RAVI
SYPHON
SHAHDARA, BALLOKI, SIDHNAI
BEIN NULLAH AT CHAK AMRU
BEIN NULLAH AT SHAKARGRAH
DEG NULLAH AT Q.S.SINGH
BASSANTAR NULLAH

SUTLEJ

G.S.WALA, BAKARKE,
SULEMANKI, ISLAM,
MELSI SYPHON

CHENAB

MARALA, KHANKI
QADIRABAD, CHINOT BRIDGE
TRIMU, RAWAZ BRIDGE
PUNJNAD
AIK NULLAH AT URA
PALKU NULLAH

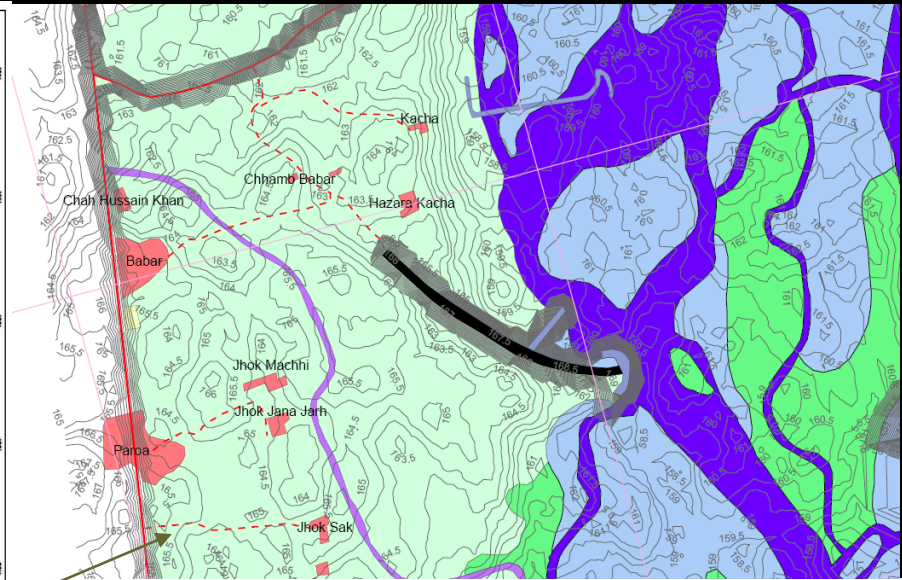
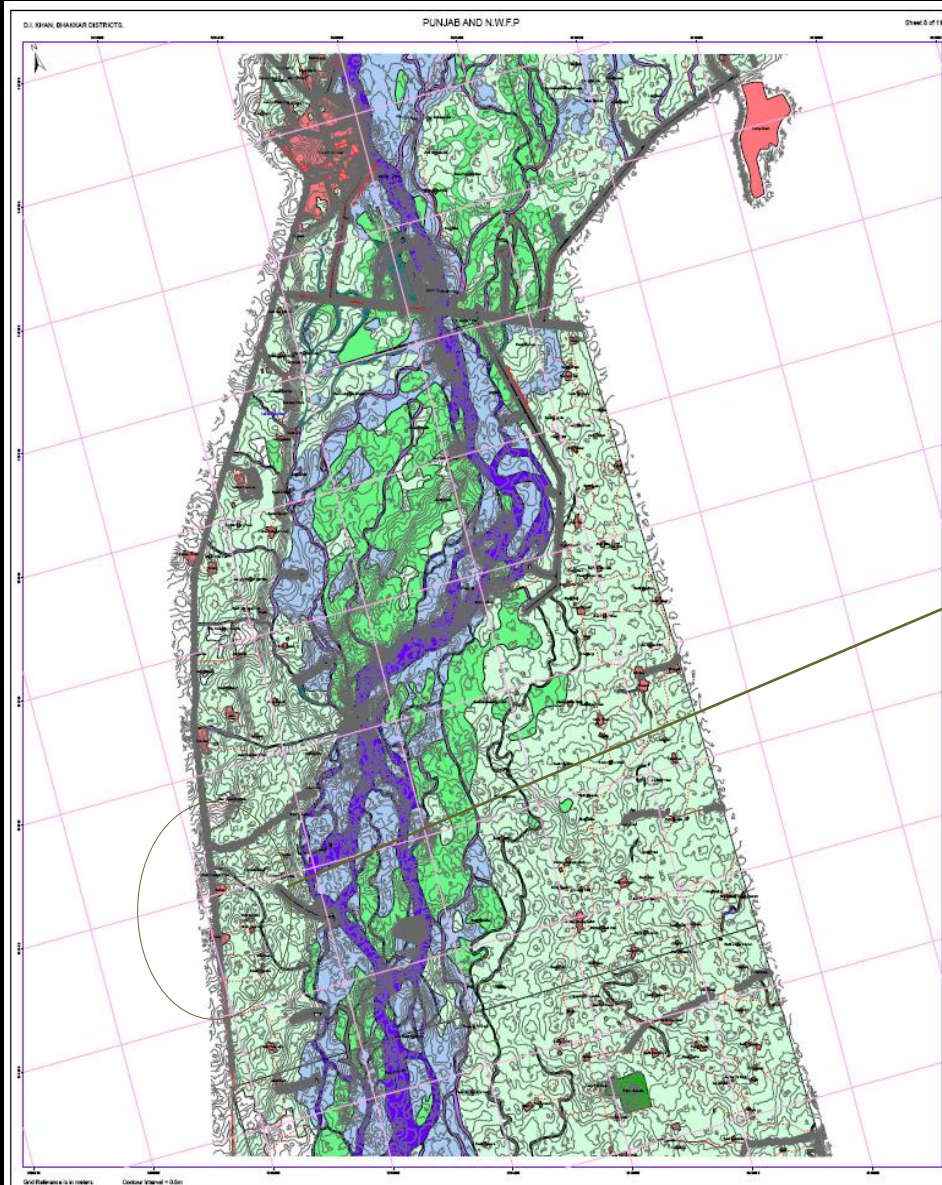
JHELUM

NEW RASUL,
KHUSHAB BRIDGE

INDUS

KALABAGH, TAUNSA,
MITHANKOT,
GHAZIGHAT, CHACHRAN
SHRAIF

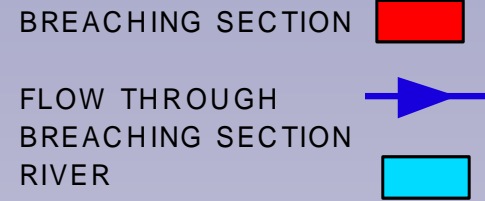
INDUS RIVER SYSTEM – Flood Risk Maps



Legend

- | | | | |
|--|------------------------|--|-----------------------------------|
| | International Boundary | | Barren Area |
| | District Boundary | | Bund |
| | Metalled Road | | Cultivated Area |
| | Un-metalled Road | | Main/Link Canal, Escape, Spillway |
| | Cart Track | | Grass |
| | Railway Line | | Graveyard |
| | Canal | | Hill |
| | Branch | | Nallah (active) |
| | Drain | | Nallah (dry) |
| | Distributary | | River |
| | Minor | | Range Forest |
| | Nallah | | Sand Dunes |
| | Wah | | Spur |
| | Contours | | Town/Village/Settlement |
| | | | Water Body |
| | | | Flood Plain |

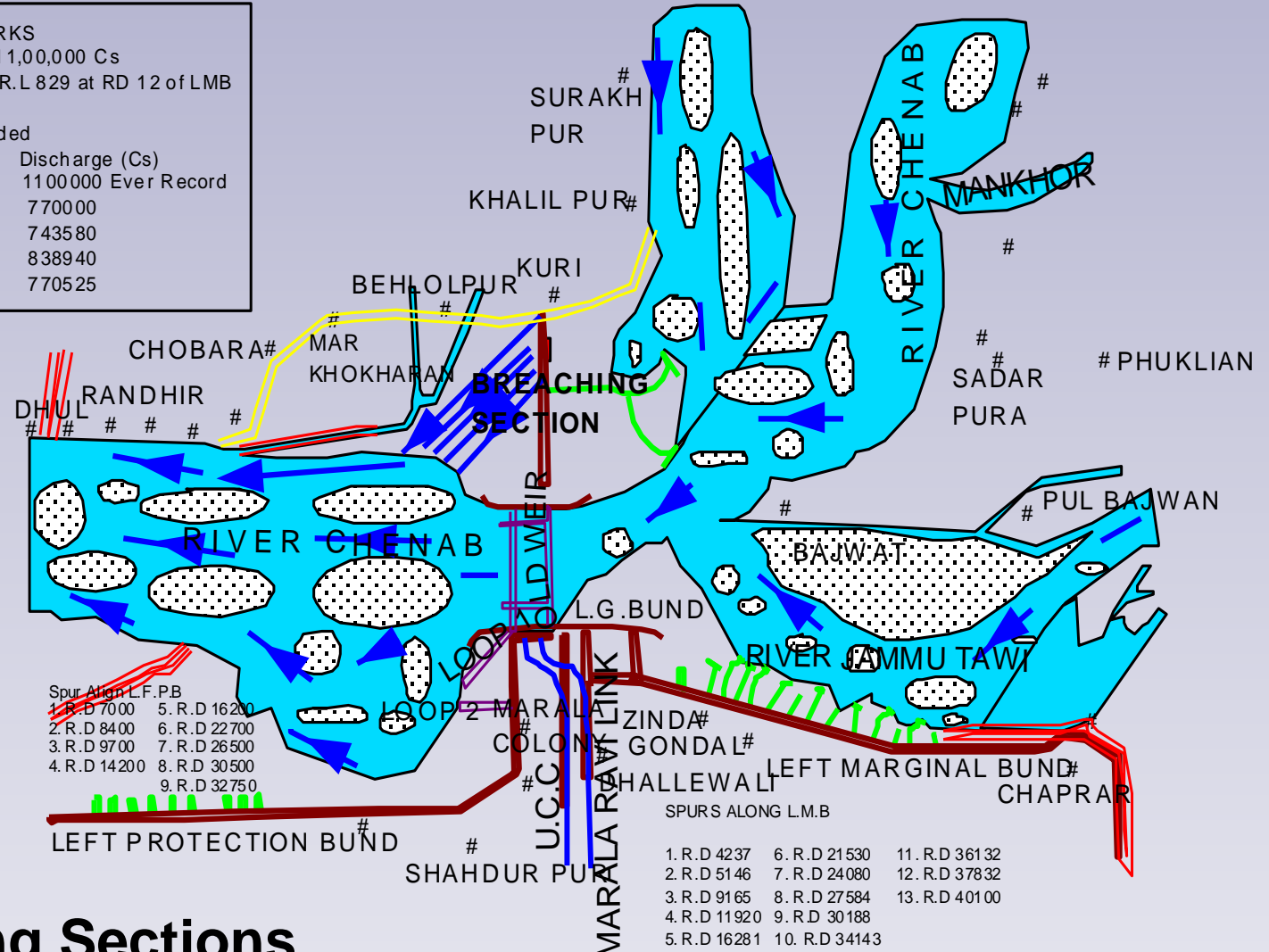
INDEX PLAN OF MARALA BARRAGE



MARALA HEADWORKS
 Design Capacity = 11,00,000 Cs
 Critical Level = R.L 829 at RD 12 of LMB

Highest Flood Recroded

Date	Guage	Discharge (Cs)
26.08.57	816	1100000 Ever Record
09.08.73	812	770000
25.09.88	808.8	743580
10.09.92	809.4	838940
28.08.97	808.2	770525



Spur Align L.F.P.B

1. R.D 7000	5. R.D 16200
2. R.D 8400	6. R.D 22700
3. R.D 9700	7. R.D 26500
4. R.D 14200	8. R.D 30500
	9. R.D 32750

SPURS ALONG L.M.B

1. R.D 4237	6. R.D 21530	11. R.D 36132
2. R.D 5146	7. R.D 24080	12. R.D 37832
3. R.D 9165	8. R.D 27584	13. R.D 40100
4. R.D 11920	9. R.D 30188	
5. R.D 16281	10. R.D 34143	

Breaching Sections

Dams Flood Management Committees

Tarbela & Mangla Dam Flood Management Committees exist for reservoir operation and flood routing to take immediate and on the spot decisions as per SOPs.

Coordination Committee At Federal Level

For coordinating the Flood Management and Forecasting Activities with specific reference to avoid flood peak synchronization during flood season following Coordination Committee exists at the federal level

Critical Flood Management at Mangla Reservoir on River Jhelum



FLOOD WARNING STATION AT MANGLA CATCHMENT

RIVER	NAME OF STATION	LAG TIME (HRS)
NEELUM	Muzaffarabad	8.25 hrs.
KUNHAR	Talhata	8.75 hrs.
U. JHELUM	Domel	8 hrs.
L. JHELUM	Chattar Kalas	6.5 hrs.
L. JHELUM	Azad Pattan	2.5 hrs

RAIN GAUGE STATIONS

U. JHELUM	Domel
L. JHELUM	Palandari
POONCH	Kotli
KANSHI	Kallar Syedian
LOCAL	Mangla

TELEMETRIC STATIONS

NEELUM	Muzaffarabad
U. JHELUM	Domel
L. JHELUM	Chattar Kalas
L. JHELUM	Palandari
POONCH	Kotli

Cross Border Hyd-data

RIVER

CHENAB at Akhnoor

JAMMU TAWI at
Jammu

RAVI below Madhopur

SUTLEJ below Rupar, Harike,
Ferozpur

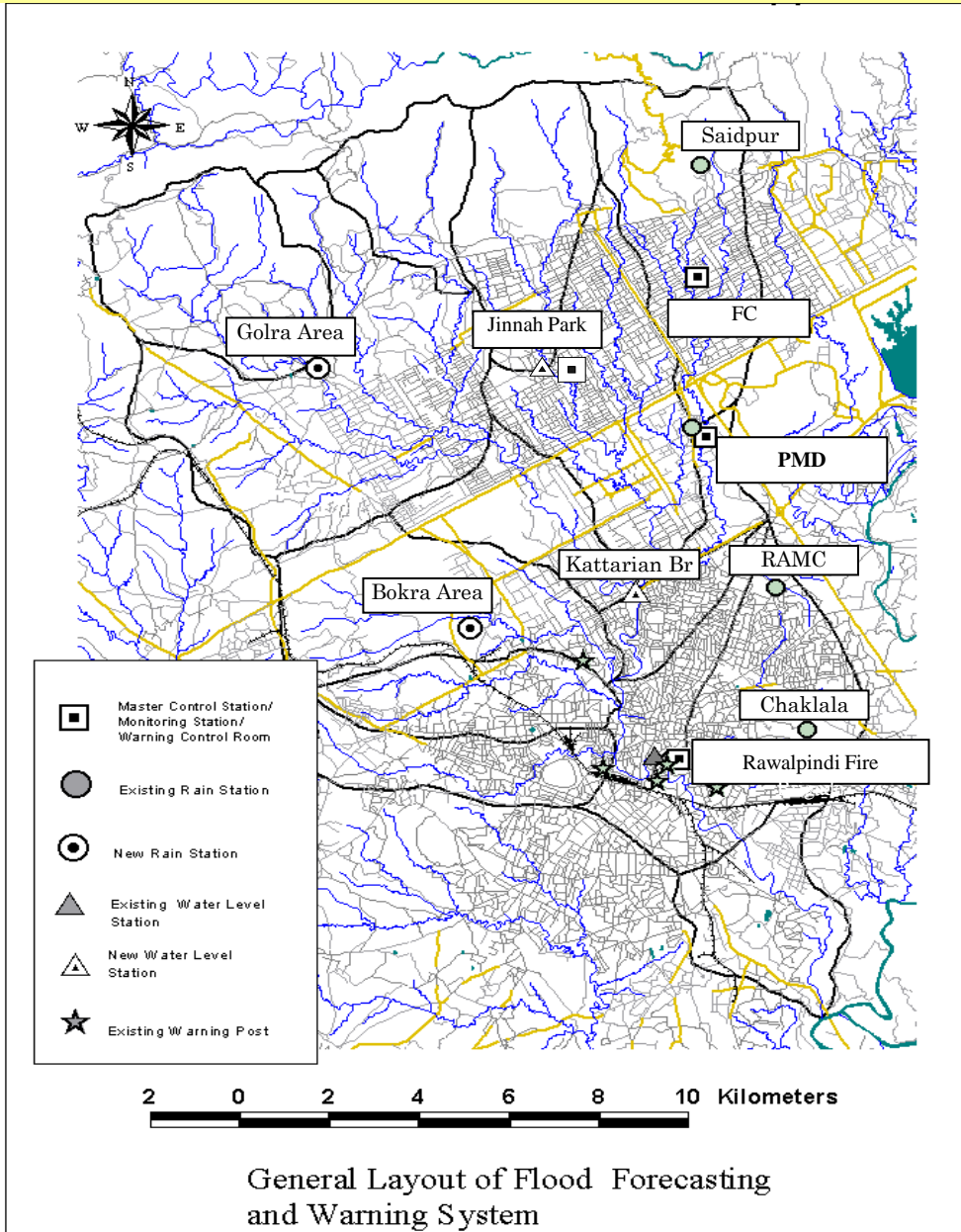
**DAILY RADIO JAMMU
BROADCAST**

0930, 1430, 2240 Hours

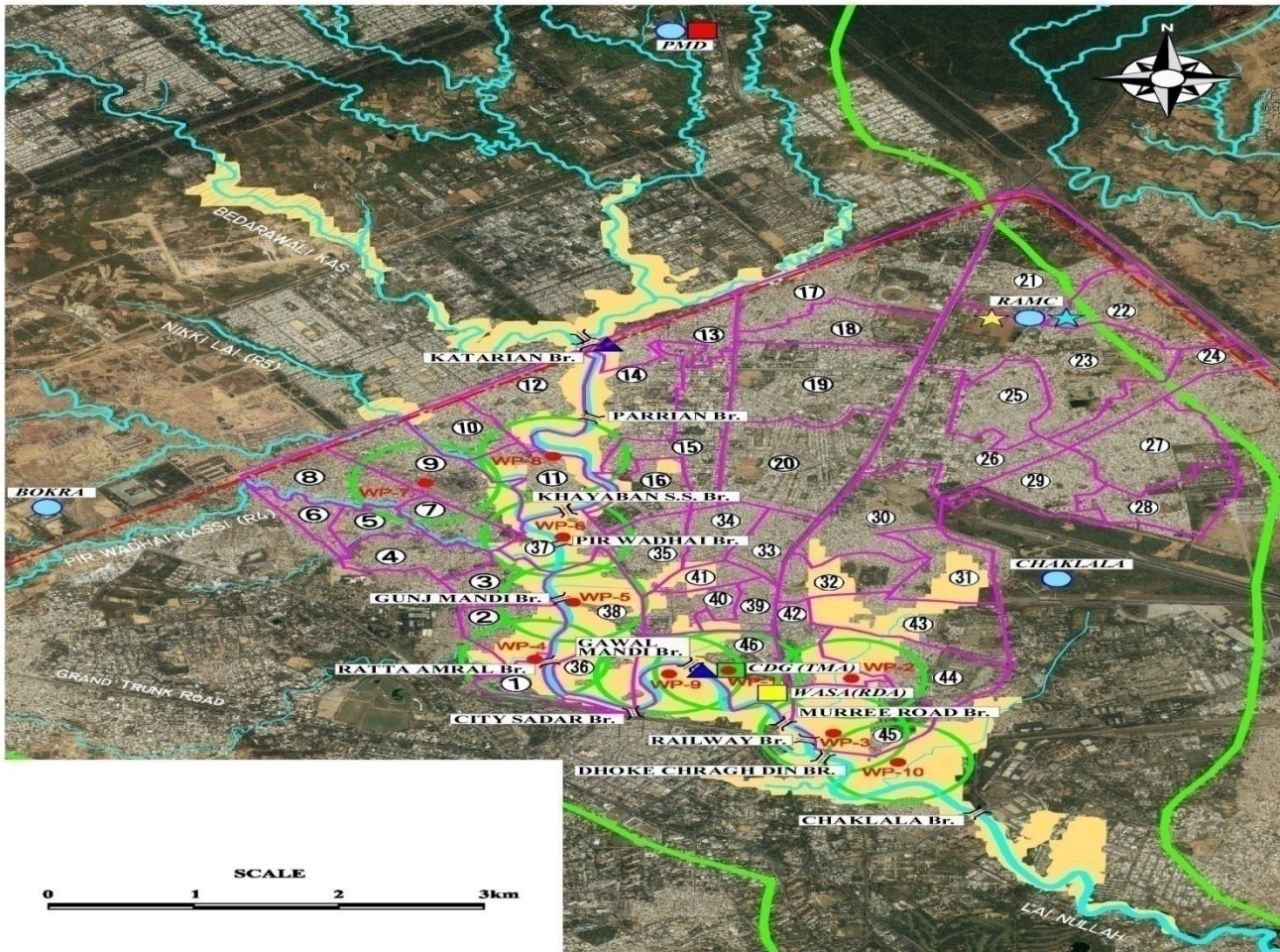
0400, 1800, 2400 Hours

(on telephone)

Urban Flood Management



Item	Nos.
Rainfall Station	6 Stations
Water Level Station	5 Stations
Master Control Station	PMD
Monitoring Stations	3 Stations
Executive Warning Control Room	1 Room
Warning Post	10 Stations



LIST OF UNION COUNCILS

S No.	Name Union Council
1	Ratta Amral
2	Dhoke Ratta
3	Hazara Colony
4	Dhoke Matkal
5	Dhoke Hassu North
6	Dhoke Hassu South
7	Pir Wadahi
8	Fauji Colony
9	Bangash Colony
10	Khyaban-e-Sir Syed
11	Khyaban-e-Sir Syed
12	Dhoke Najjo
13	New Katarian
14	F-Block Satellite Town
15	Said Pur Scheme
16	Mohallah Eid Gah
17	Dhoke Babu Urfan
18	Pindora
19	Satellite Town
20	Asghar Mall Scheme
21	Dhoke Kala Khan
22	Qayyum Abad
23	Dhoke Kashmirian
24	Dhoke Ali Akbar
25	Sadiq Abad
26	Afandi Colony
27	Muslim Town East
28	Muslim Town West
29	Khurram Colony
30	Cha Sultan
31	Dhoke Hukamdad
32	Amer Pura
33	Kartar Pura
34	Banni
35	Mohallah Imam Bara
36	Mohin Pura
37	Dhoke Dalal
38	Ganjmandi
39	Waris Khan
40	Purana Qilla
41	Shah Chan Chirag
42	Millat Colony
43	Dhoke Khabba
44	Dhoke Farman Ali
45	Chaman Zar Colony
46	City

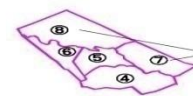
*10, 11
Both Union Councils
have same name
(should be 1 & 2)

LEGEND

- Lai Nullah Boundary
- Administrative Boundary
- River
- Monitoring Station
- PMD Master Control Station
- Rainfall Gauging Station
- ▲ Water Level Gauging Station
- Executive Warning Control Station
- ★ Repeater Station (Wireless LAN)
- ★ Repeater Station (Telemeter)
- Warning Post



100 Year Flood Area

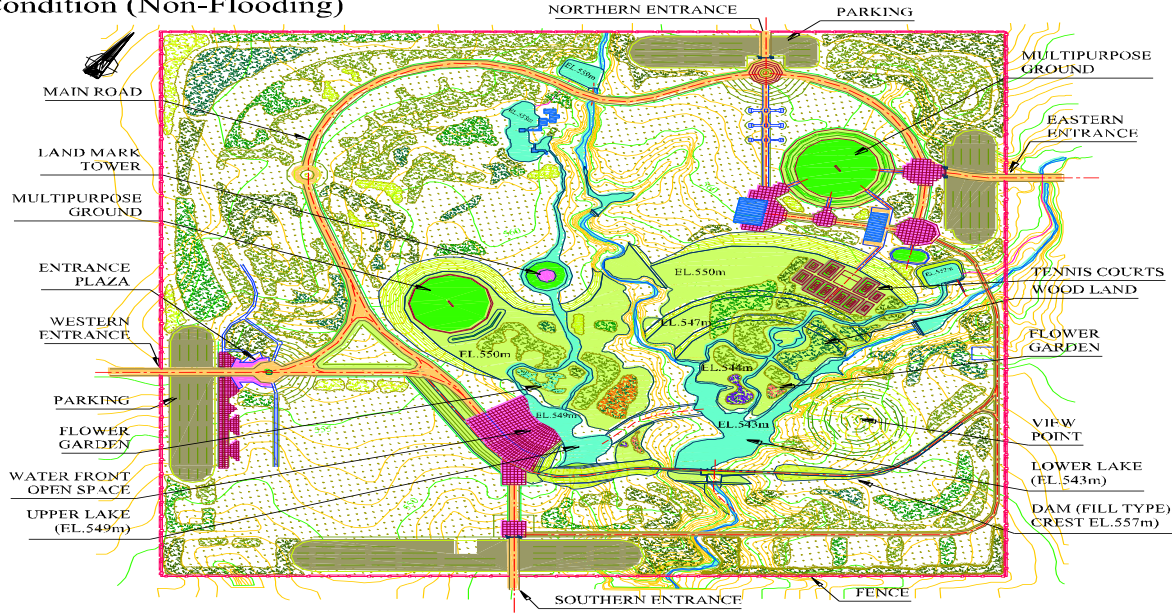


Union Councils Boundary

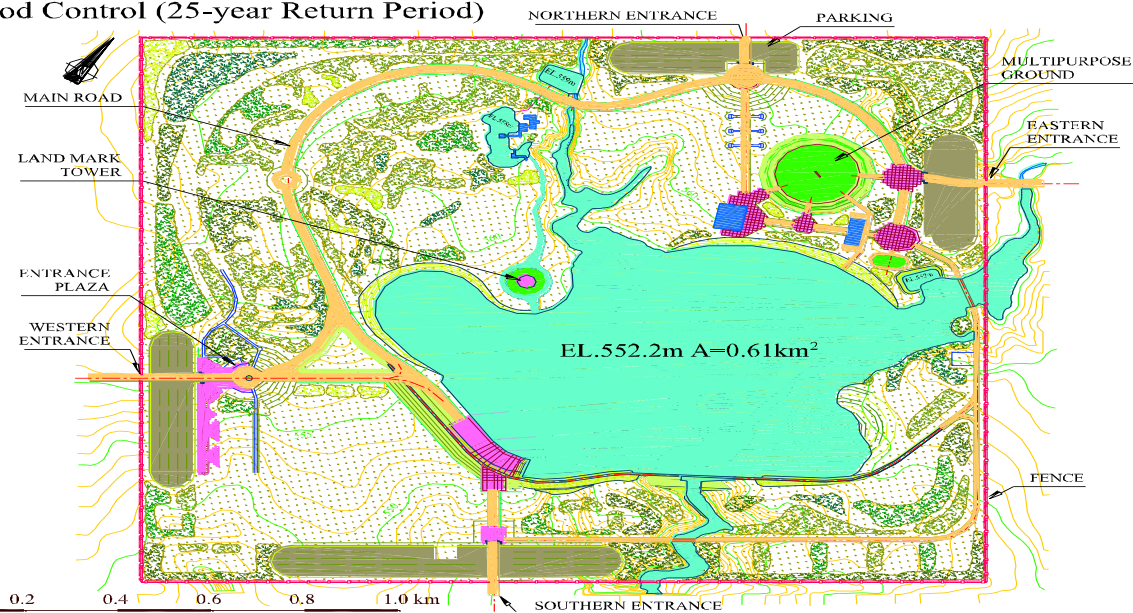
these numbers correspond to
name of union councils.
(See above List).

Urban Flood Hazard Map For Lai Nullah Basin In Rawalpindi

Normal Condition (Non-Flooding)



During Flood Control (25-year Return Period)

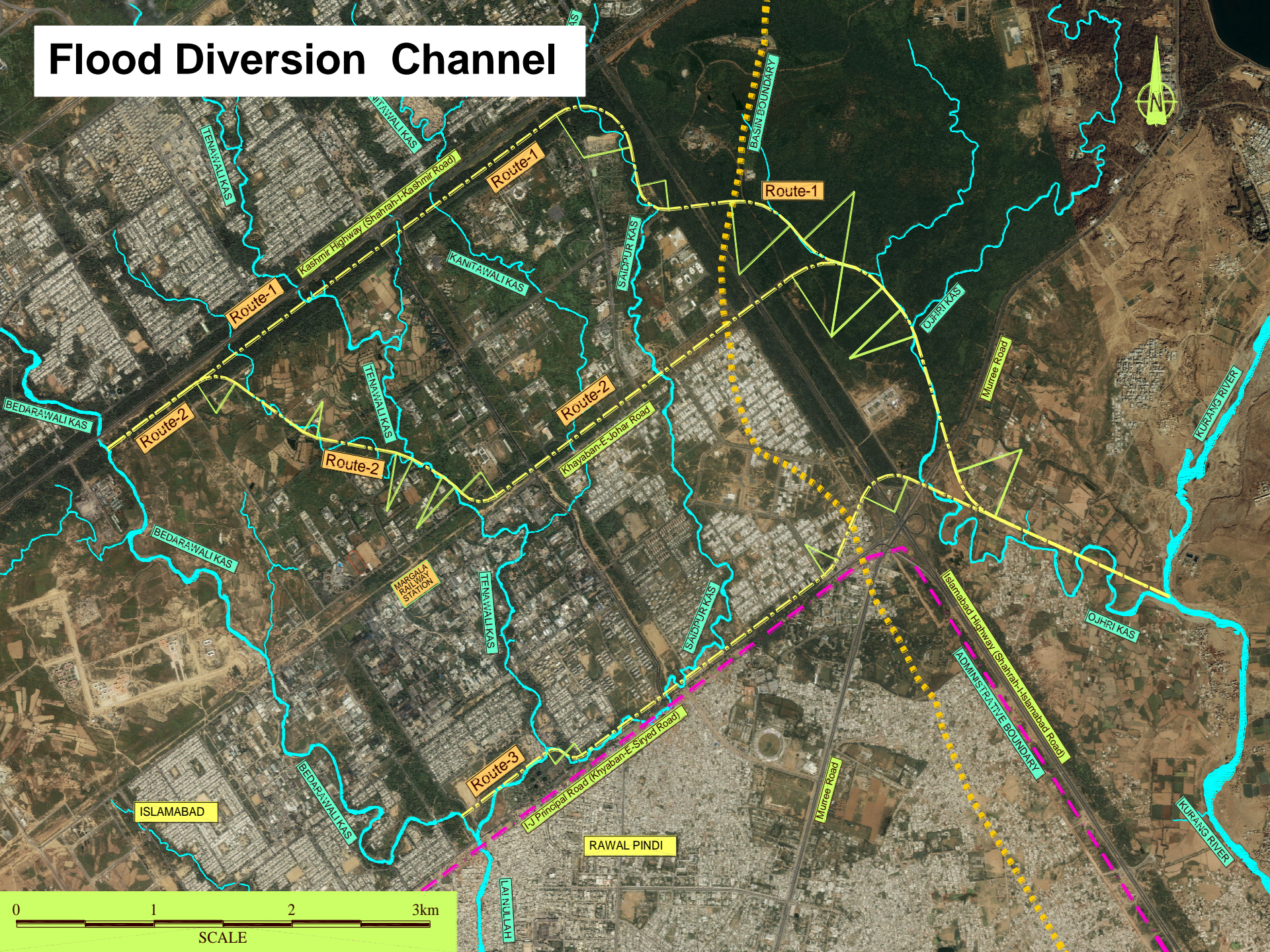


SCALE 0 0.2 0.4 0.6 0.8 1.0 km

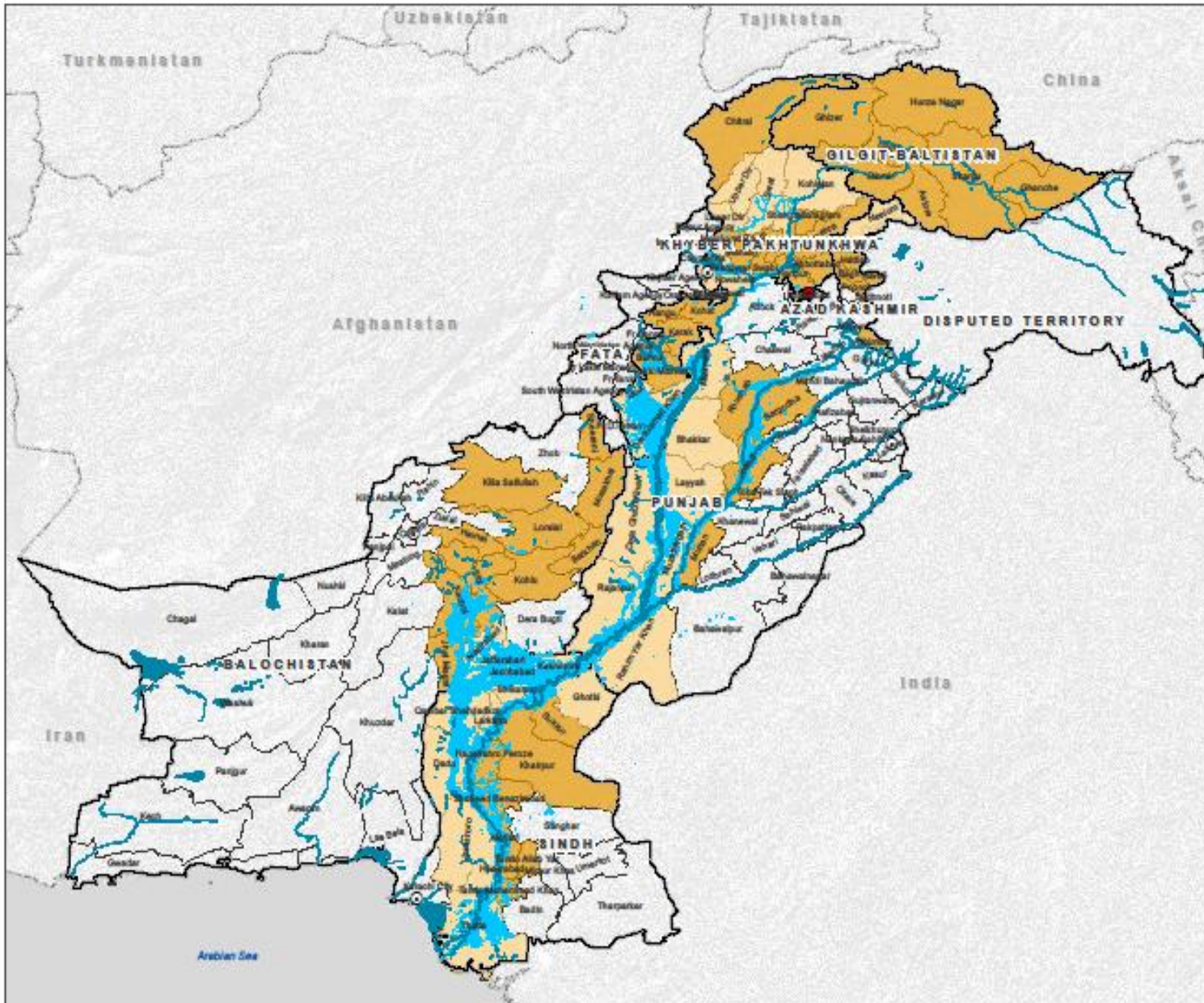
Community Pond/Delay Action Dam

Community Pond

Flood Diversion Channel



PAKISTAN - Floods 2010



Legend

- Major Cities
- Capital
- Inland Water
- Flood Extent (Oct-Nov 2010)
- Affected Districts**
- Moderately Affected
- Severely Affected
- District boundary
- Province boundary
- Neighboring country boundary



Information Management Unit
National Disaster Management Authority of Pakistan

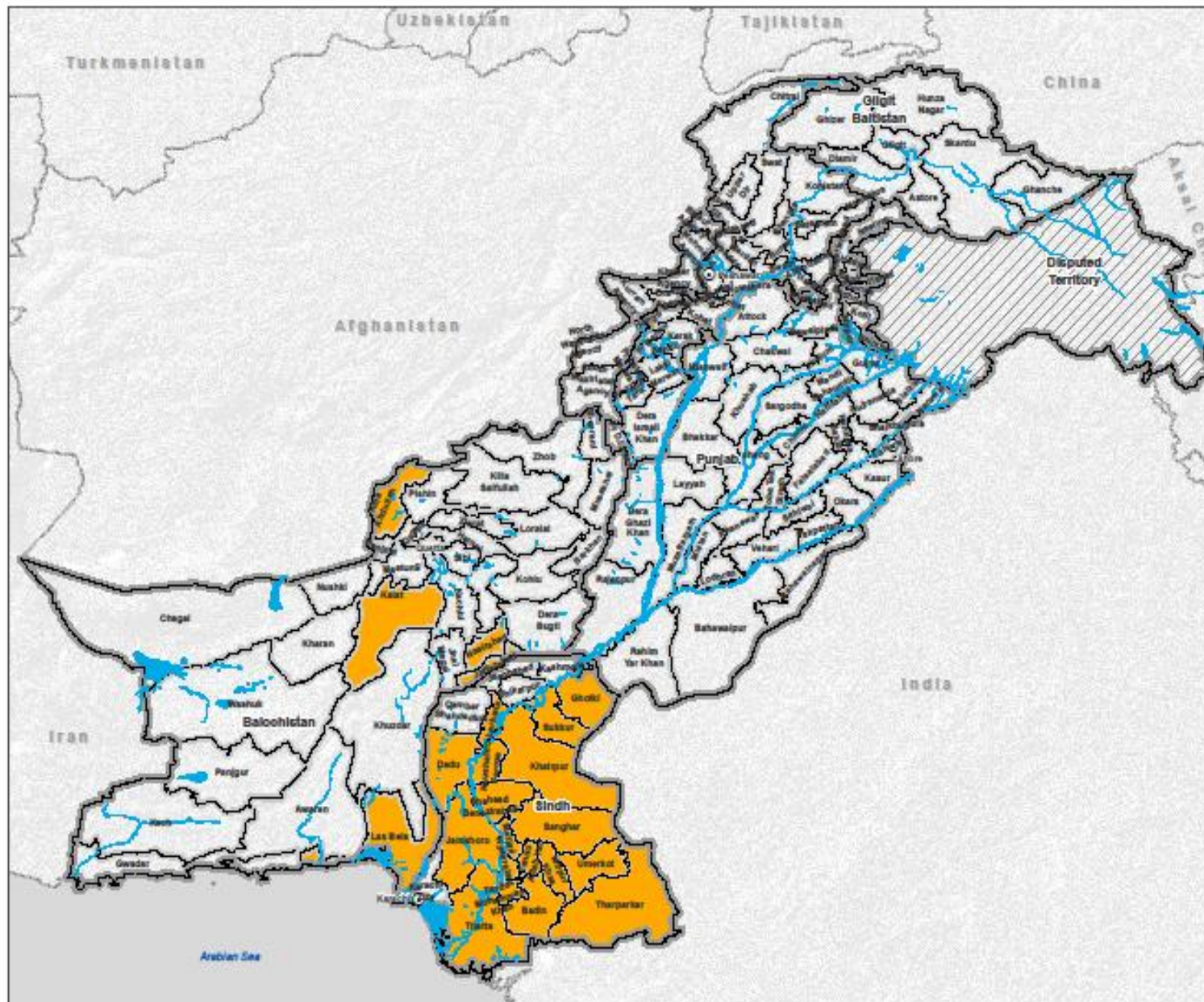
Map Doc Name: [IMAP_Floods_2010_Map_Aug_2011_080111](#)
 Creation Date: August 20, 2011
 Project/Doc ID: 080814
 Web Resources: <http://www.ismap.org>

Map data sources:
 Flood Affected Districts (NDMA), Administrative boundaries (POC),
 Maximum Flood Water (Oct-Nov 2010) (JRC/CIAT), Inland Water
 (USGS)

Disclaimer:
 The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of ISMAP, USAID and the NDMA concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its boundaries.



PAKISTAN - Flood Affected Districts (2011)



Legend

- Major Cities
- Inland Water
- Affected Districts
- District boundary
- Province boundary
- Country boundary



Information Management Unit
National Disaster Management
Authority of Pakistan

Map Date: 2011
 MAP_PAK_FloodAffectedDistricts Map_Alt_01_2011

Creation Date: September 23, 2011
 Projection: UTM
 Web Resolution: 100000
 Web Resource: <http://www.inmap.org>

Map data sources:
 USGS, PCD

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Relief Flow System

Managed By
Consignment Handling Team

MOB
Islamabad

FOB
Karachi/Sukkar
Hyderabad

FOB
Lahore/Multan

FOB
Gilgit/Skardu

FOB
Quetta

FOB
Peshawar

Employing helicopters and road transport

DIST

DIST

DIST

DIST

DIST

Employing helicopters, boats, trucks and mule trains

VILL

VILL

AFFECTED AREAS

VILL

VILL

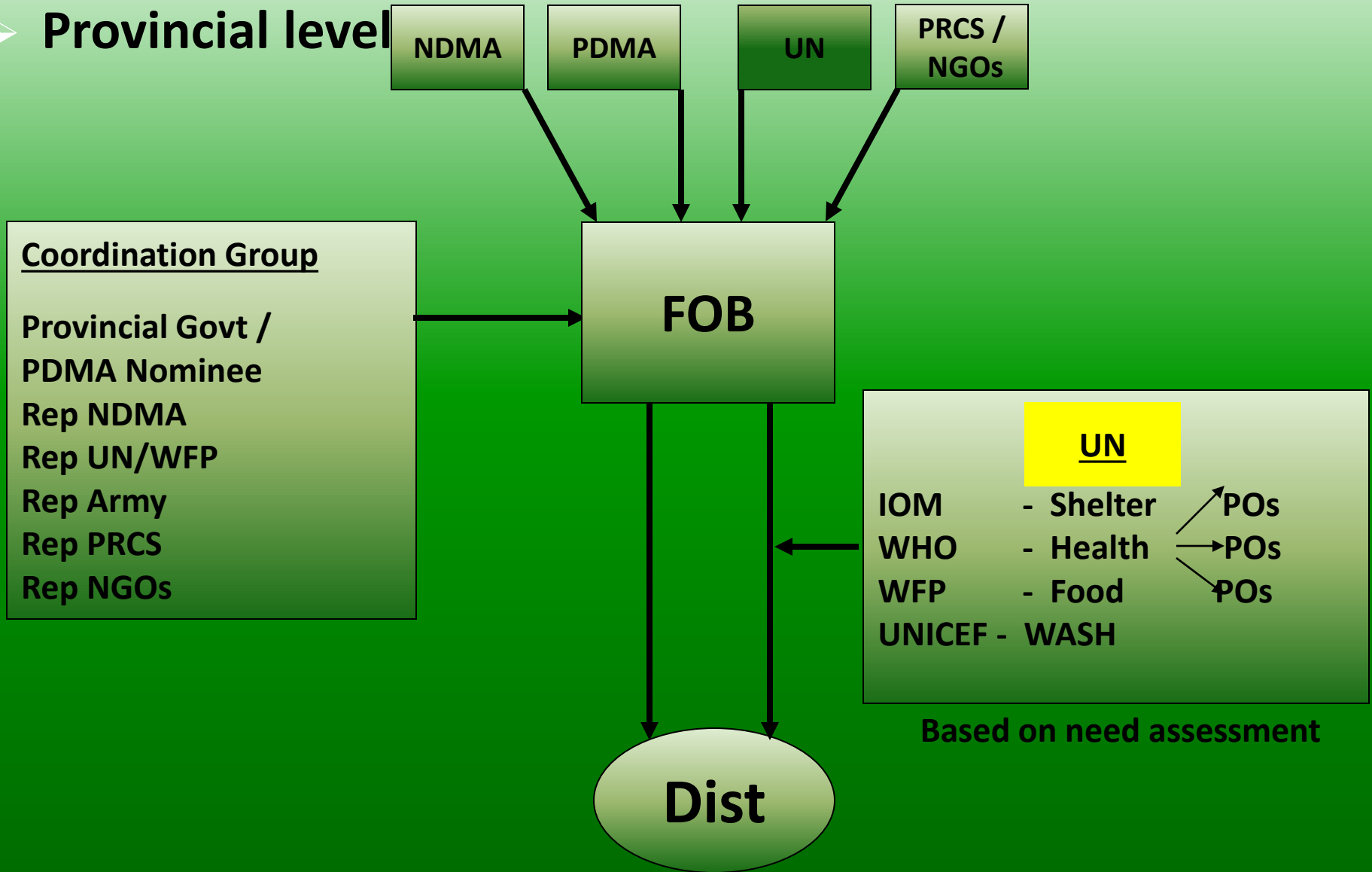
Coordination - Relief Activities

Federal Level

- **Operational Coordination Group**
- **Strategic Leaders Forum**

Coordination - Relief Activities

➤ Provincial level



Future Flood Threats In Pakistan

- **Recent trend of Climate Change in Pakistan based on last 70 years climatic data indicates:**
 - i) **Rise in mean daily temperature of 0.6 to 1.0 degree centigrade in arid coastal areas, arid western/northwestern mountains etc;**
 - ii) **10-15% decrease both winter & summer rainfall;**
 - iii) **18-32% increase in rainfall in monsoon zone (sub-humid and humid areas);**

Future Flood Threats In Pakistan

- iv) Further decrease of 5% in relative humidity;
- v) 3-5% decrease in cloud cover over central and southern Pakistan resulting in increase in sunshine;

The above will give rise to increase in frequency of extreme events such as heavy rains, flash floods, dust/thunderstorms, hailstorms, heat waves, density and persistence of fog.

Gaps In Flood Risk Reduction Measures

- **Inadequate coverage of flood vulnerable areas;**
- **System's deficiency in forecasting flash flood events;**
- **Coverage of Hill Torrents flood flows;**
- **Coastal area flood management needs to be given priority;**
- **Expansion of weather radar network;**
- **Urban flood control;**
- **Registering of discharges of secondary and tertiary rivers, streams, nullahs;**
- **O & M, Breaching Sections;**

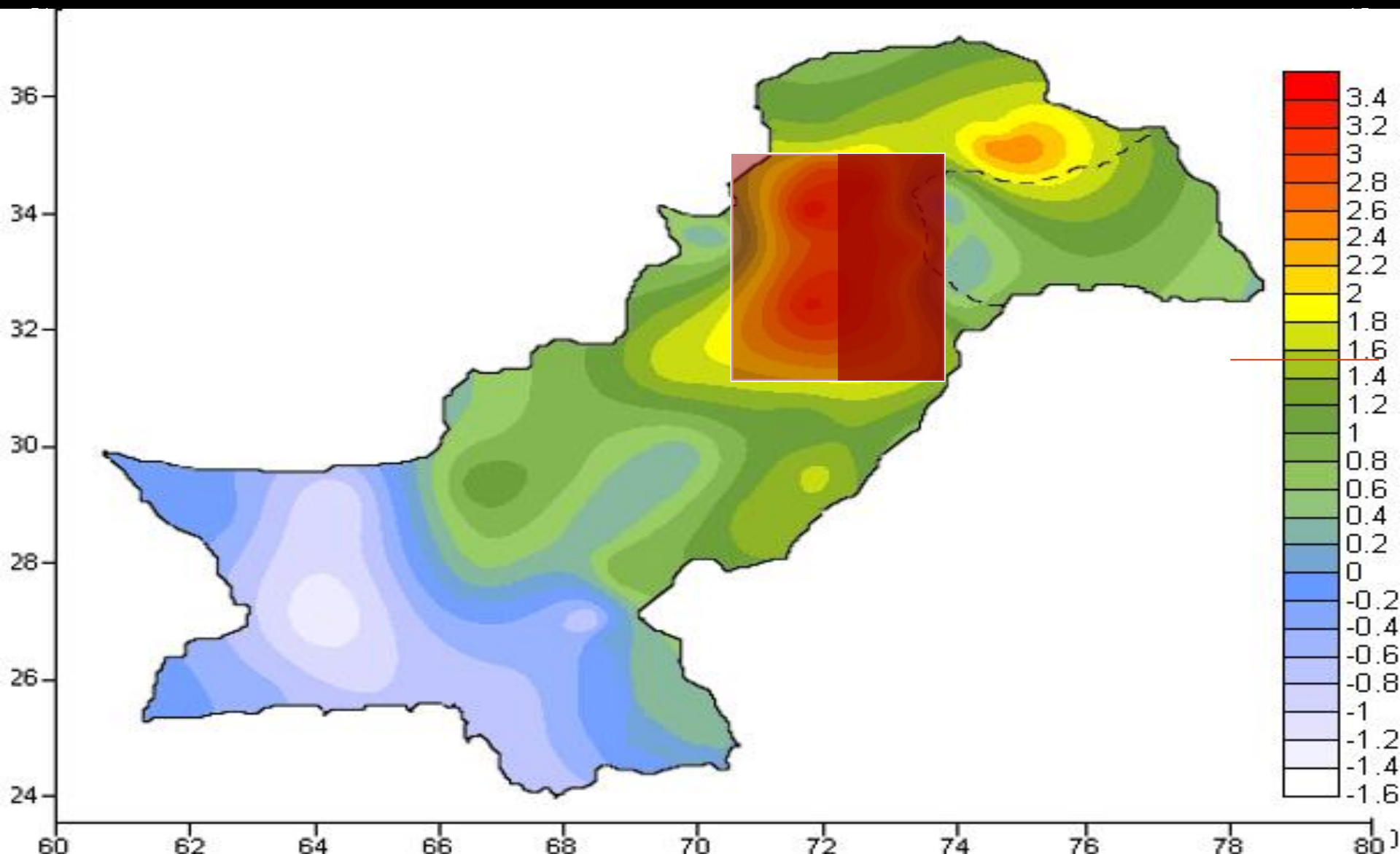
Gaps In Flood Risk Reduction Measures

- **Legislation on flood plain extent;**
- **Flood plain mapping-Secondary & Tertiary rivers;**
- **Community based flood risk management;**
- **Information dissemination from District to communities;**
- **Improvement in interagency coordination;**
- **Medium to long range flood forecasting;**
- **Unified flood risk management information system;**
- **National, Provincial, District Emergency Operation Centres;**
- **Robust Computerized Flood Forecasting**

Flash Floods Risk Management

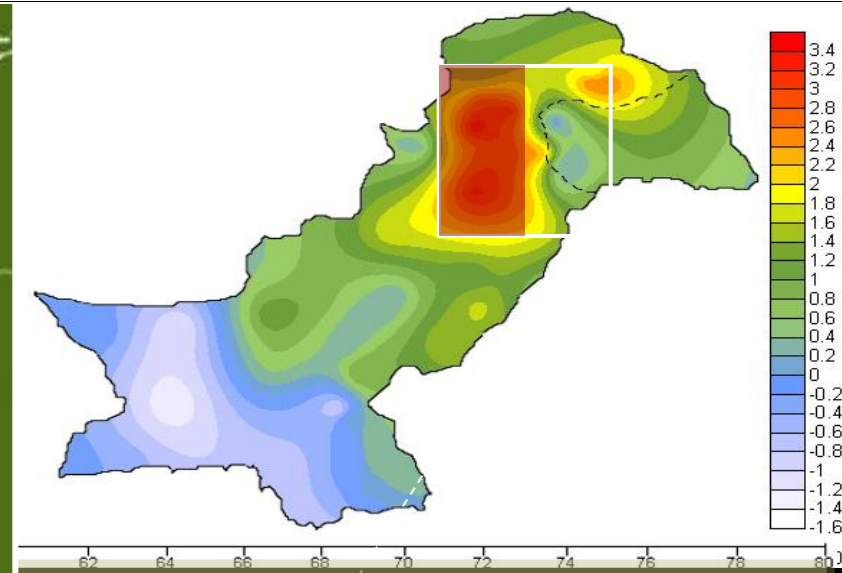
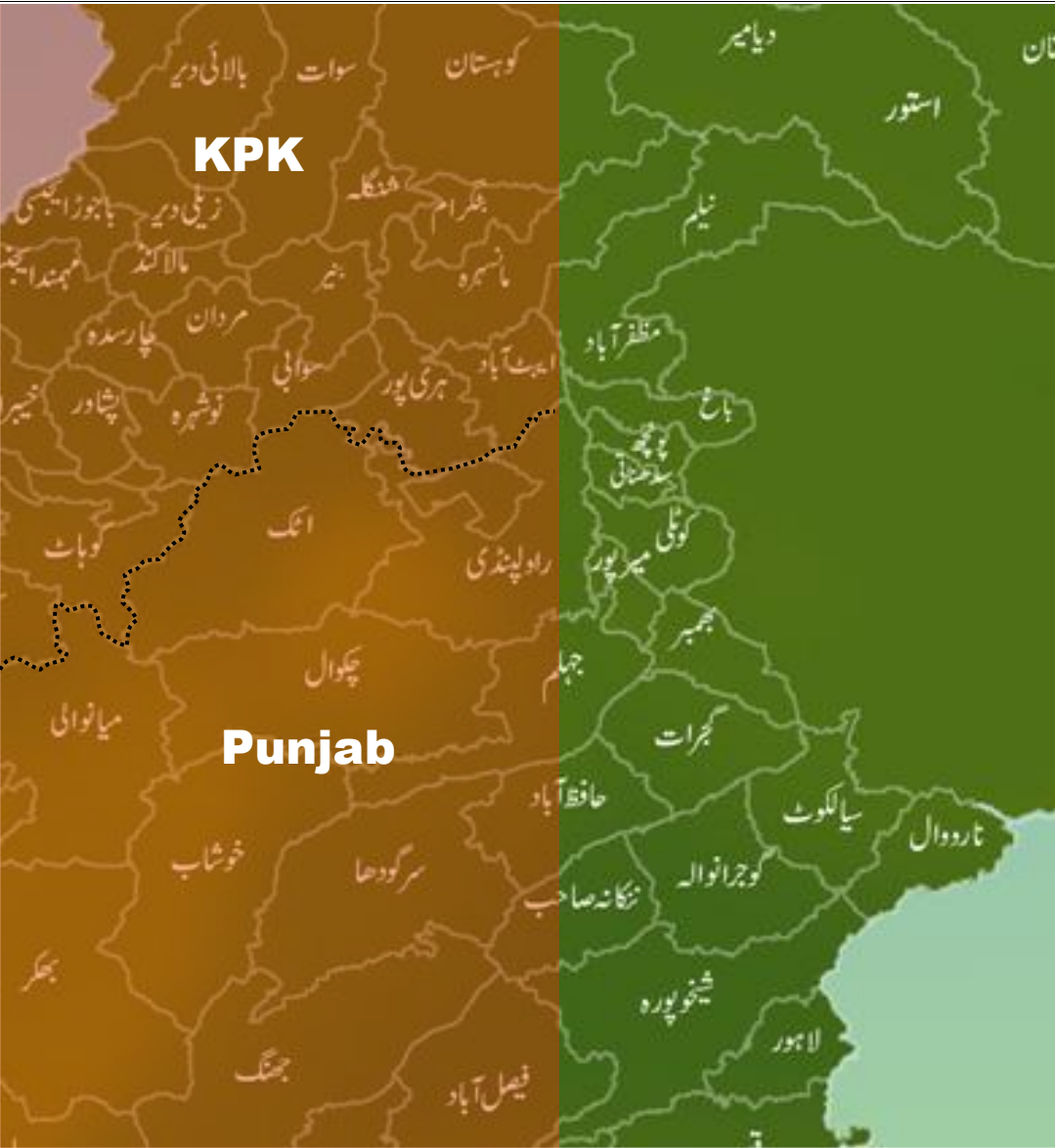
FLOOD 2010

Monsoonal Weather Systems – Rainfall Shift



FLOOD 2010

Monsoonal Weather Systems – Rainfall Shift



**25 Districts
(11 Punjab + 14 KPK)
Extremely Vulnerable to
Floods/Flash Floods**

**These areas required
more attention for water
management and to mitigate
the flood disasters
in the future**

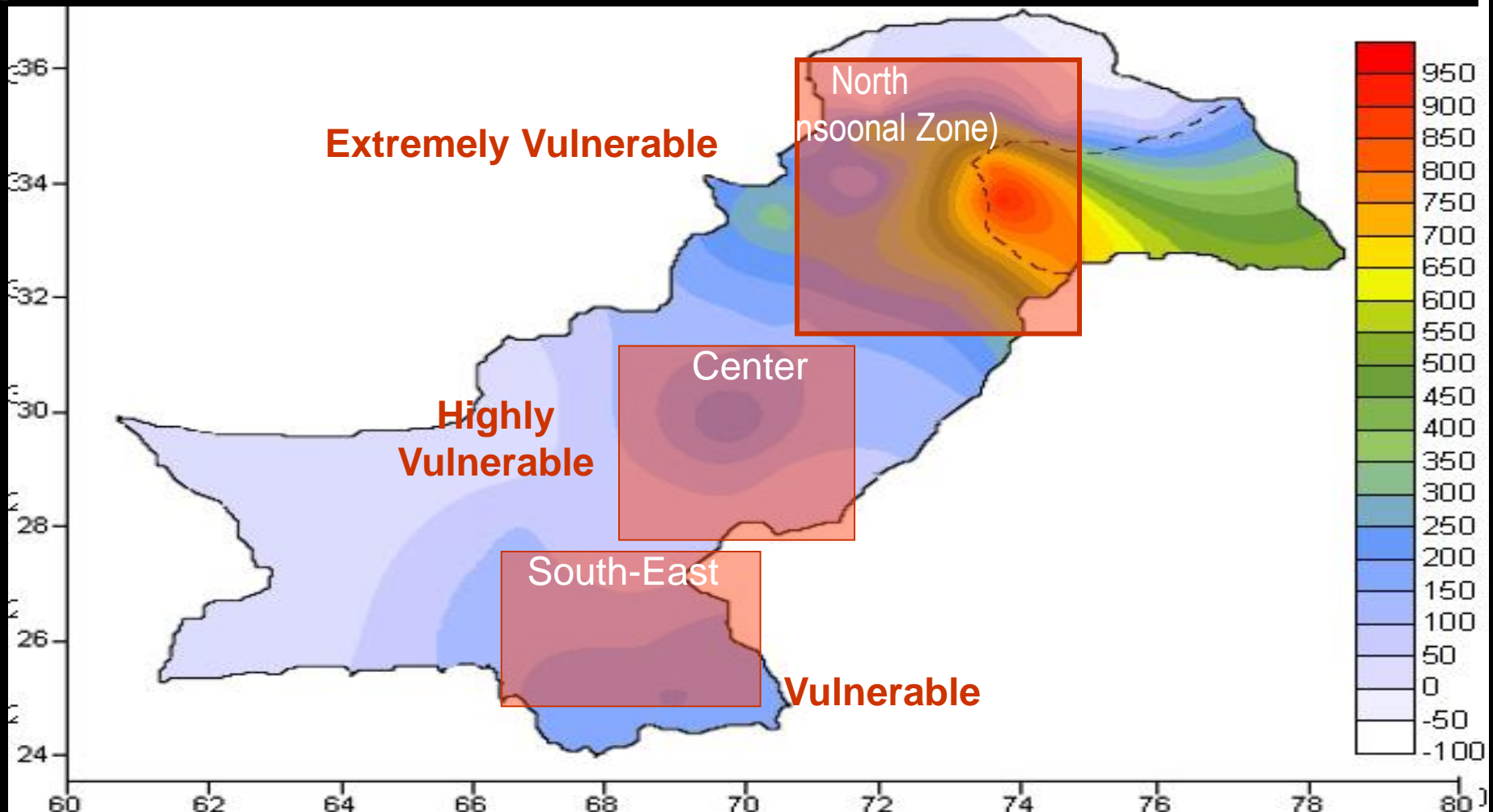
Monsoonal Weather Systems – Rainfall Shift

Based on
long-term data of last 60 years revealed that;

- **Rainfall over the Catchment Areas of Eastern Rivers has decreased (moved away).**
- **The Probability of occurrence of Heavy Rainfall Events, leading to FLASH FLOODS/FLOODS, would be HIGH over western rivers instead of eastern rivers of Pakistan in the future.**
- **Northwest Pakistan (Central parts of KPK & North-western parts of Punjab) are Extremely Vulnerable to Flash Floods/Floods.**

**The reason of Monsoonal Rainfall Shift & Increased Extreme Events
is yet unknown**

Vulnerable Areas for Floods/Flash Floods during Monsoon Season, and FOCUS must be on Extended Forecasts (2-3 weeks) instead of Seasonal Forecasts.



Milestone Actions Taken So far

- **DRR Policy**
- **National Climate Change Policy**
- **National Disaster Management Plan**
- **Multi-hazard Early Warning System Plan**
- **Establishment of NIDM**
- **Medium Range Forecasting Centres**
- **Disaster Risk Insurance**
- **IFAS/GFAS/Flash Flood Guidance System**

Future Integrated Flood Management Approach

Some Important Recommendations

- **Improved SOPs for Dams**
- **Adoption of GFAS and IFAS systems -Countrywide**
- **Accurate trans-boundary inflow measurement**
- **Capacity building of all related institutions**
- **Improvements in designs of structural measures**
- **Early warning system in cities**

Future Integrated Flood Management Approach

Some Important Recommendations

- **Reforms at the institutional level**
- **Unified River Law**
- **Well net Flash Flood Guidance System**
- **Exploitation of hill torrent flood flows**
- **Improved Early warning system (FEWS)**
- **Climate change impact properly assessed and incorporated in policy planning, implementation, monitoring, early warning stages**

Flash Floods Risk Reduction Measures

Use of Science & Technology

- **Real time rain gauging**
- **Local weather radars/Mobile radar for now-casting**
- **Flood modeling**
- **Mobile Phones**
- **GLOFs Early Warning System**



AP







AP



AP



AP



AP



AP



AP

Future Cooperation in Disaster / Flood Risk Management

To be given during presentation

Thanks a lot