WATER AND POWER DEVELOPMENT AUTHORITY

Initiatives of WAPDA in Monitoring Upper Indus Basin

by

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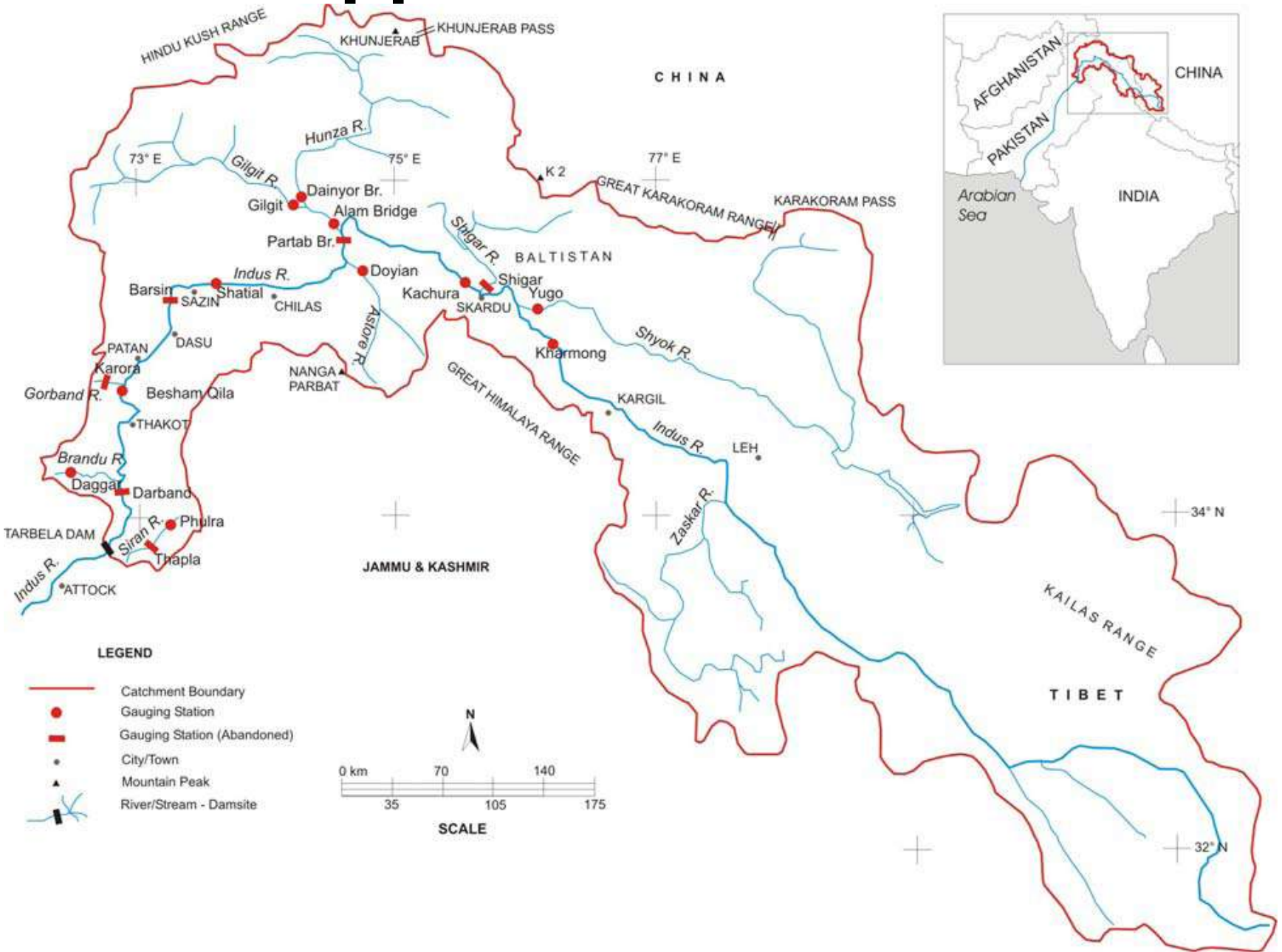
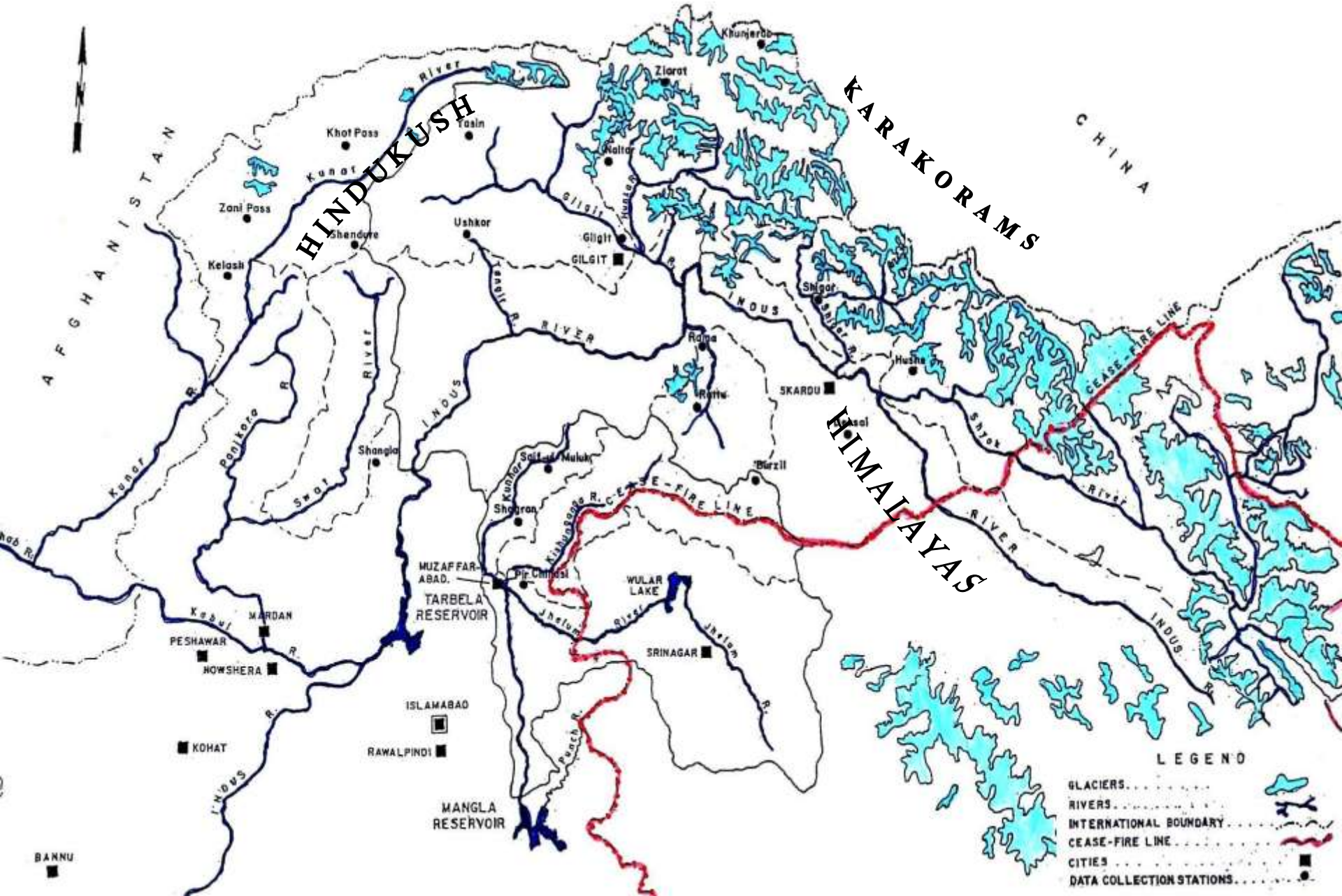
Introduction

- WAPDA - Water and power Development Authority of Pakistan was created in 1958
- Since its creation various steps to study **Upper Indus Basin** cryoshpere and establish Hydrometeorological networks in 1960's for its monitoring were taken.
- The snow surveys were carried out during 1961 to 1968 in Mangla Basin to forecast flows into the Mangla Dam.

Upper Indus Basin



Upper Indus Basin Glaciers



Studies by WAPDA in 70's and 80's

- During 1975 – 1978 Landsat imageries were used by WAPDA to investigate into the water resources of Pakistan. Very good correlation between depletion of UIB snow cover area with increasing UIB Flows during snowmelts period was established.
- During 1985-1989, to understand the cryoshpere and hydrologic conditions of UIB, ground based research was carried out by WAPDA in collaboration with Canadian and UK Universities on its Pakistan Snow and Ice Hydrology Project Phase-I.

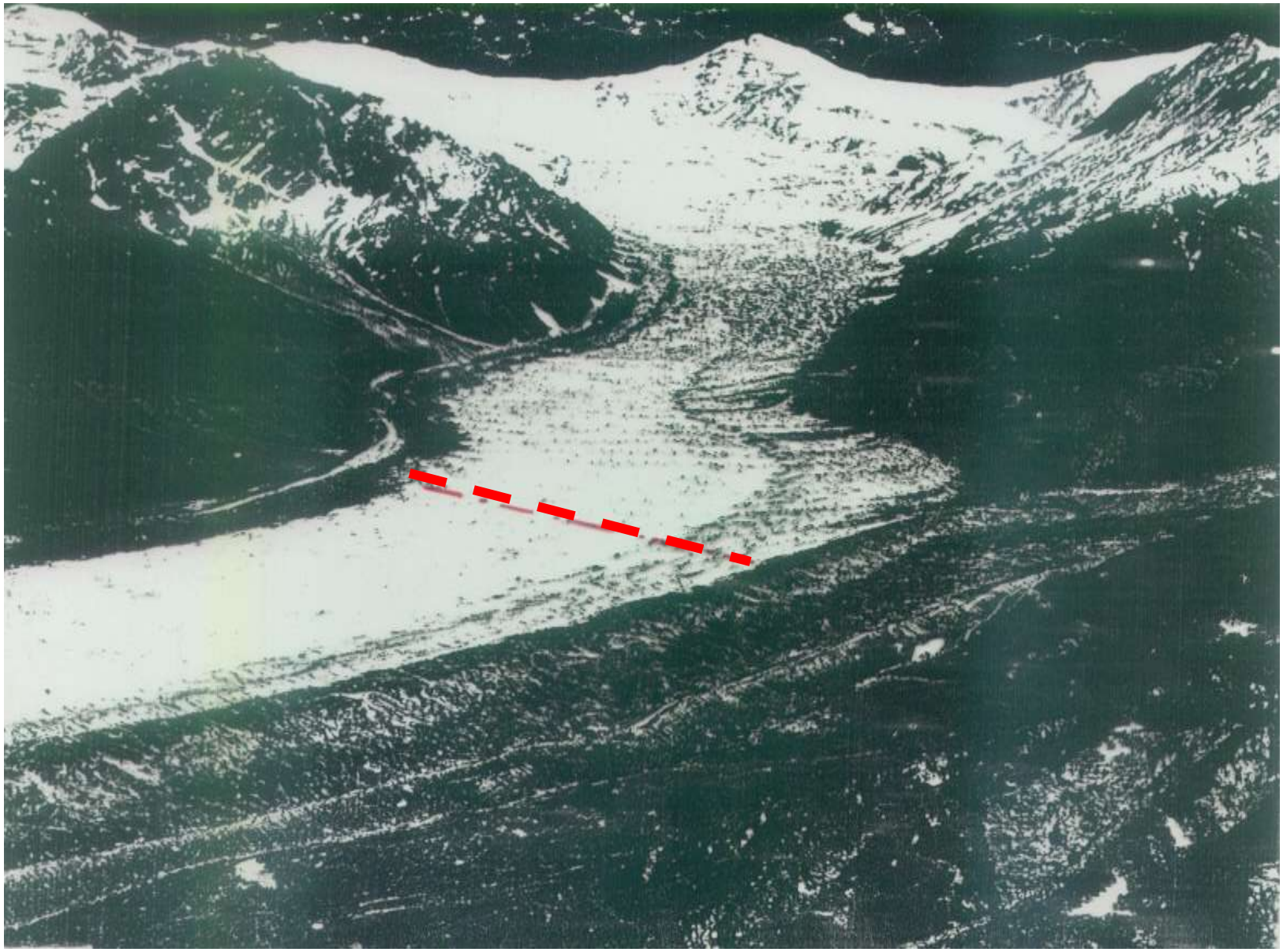
Studies by WAPDA Cont…

- Mass-Balance of selected glaciers of Karakoram and Himalayas were carried out.
- Avalanche studies in Kunhar Basin including hydrology of avalanches were also carried out.
- Ken Hewitt with WAPDA Staff studied potential Glacial Lakes sites in Upper Indus Basin
- During 1989 Dr. Gordon Young carried out sedimentation studies of Batura and Passu Glacier, Central Hunza, with the students of University of Manchester and WAPDA staff.
- Ablation gradient of Passu glacier for year 1988 and 1989 was also studied during this period.

Snow Sampling – Shark Col Snow Pit (5660 m)

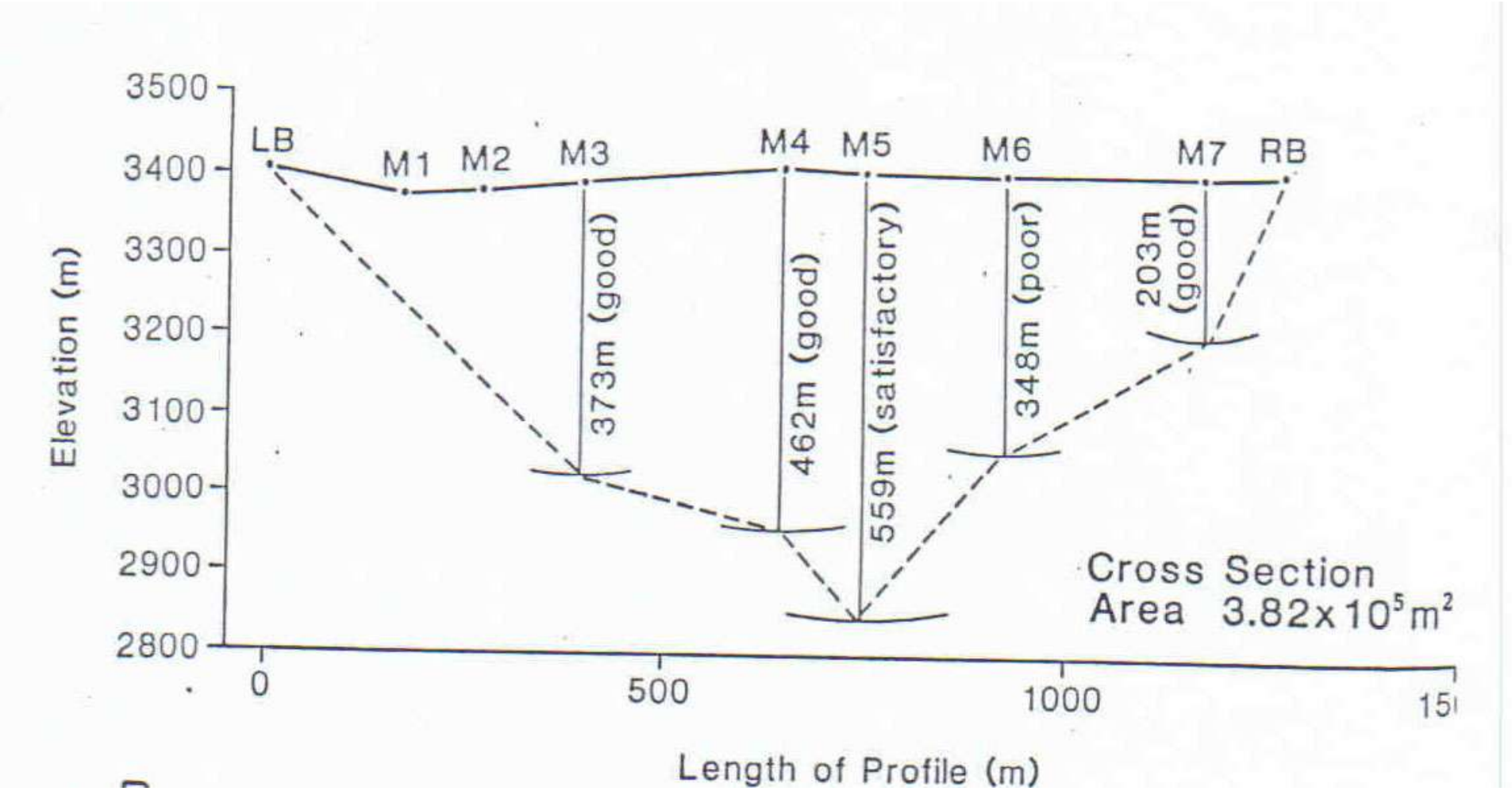
Preparation for Stake Survey

MIAR GLACIER,HUNZA-KARAKORAM



Depth Profile of Miar Glacier - 1989

(using Radio-echo soundings)



Research Studies Some outcomes

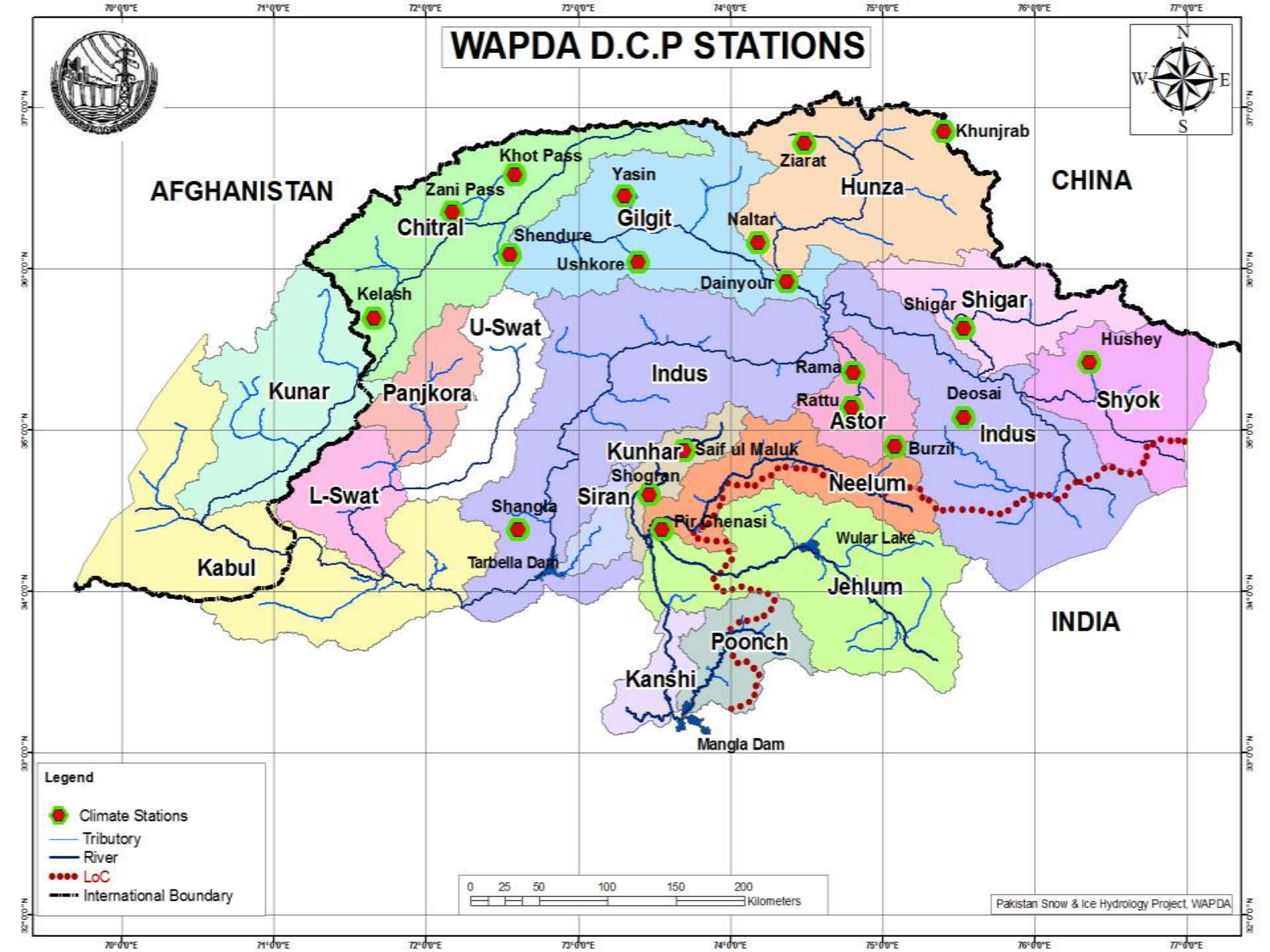
- The bulk of all UIB precipitation occurs in an altitudinal zone of 2500 – 6000 m elevation.
- The elevation of maximum precipitation is about 5000m in the Western Karakorams and 6000m in Eastern Karakorams.
- Precipitation is in the order of 1000 – 1800 mm of Snow Water Equivalent
- Most of the UIB glaciers are fed by snow avalanching and are Debris Covered
- Active melting zone of glaciers is between 3500 to 4800 meters above sea level.

Pakistan Snow and Ice Hydrology Project -II

- On the findings of 1985-1989 another Phase - I second phase of PSIHI was initiated in 1991 and continued till 1997.
- In this phase 20 High Altitude weather stations in the elevation zone of 2200 to 4800 meters a.s.l. were installed in Upper Indus Basin
- The data from these stations is being collected and transmitted to Lahore Forecasting Centre through Meteorburst Communication System since 1993.
- A hydrologic Model from the University of British Columbia Vancouver, Canada was obtained and calibrated for the hydrologic conditions of Upper Indus Basin.

PSIHP-II

- The UBC Watershed model is being used for developing and issuing flow forecasts to the Water Managers of the country since 2004.
- In this operational phase Seasonal (Kharif and Rabi) and Short Term (10-Daily) flow forecasts of River Indus at Tarbela Reservoir, River Jhelum at Mangla Reservoir and that of River Kabul at Nowshera are prepared and issued.
- The forecasts are used by IRSA and WAPDA Authority for water management of Indus River System and optimum production of Hydropower.


WAPDA D.C.P STATIONS
AFGHANISTAN
CHINA
INDIA
Khot Pass
Zani Pass
Chitral
Yasin
Gilgit
Shendure
Ushkore
Ziarat
Hunza
Naltar
Khunjrab
Dainyour
Kelash
U-Swat
Kunar
Panjkora
Indus
Shigar
Shigar
Hushey
Rama
Rattu
Astor
Deosai
Shyok
Indus
Burzil
Kunhar
Saif ul Maluk
Shogran
Siran
Neelum
L-Swat
Shangla
Pir Chenasi
Wular Lake
Tarbella Dam
Kabul
Jehlum
Poonch
Kanshi
Mangla Dam
N
S
E
W
Legend
Climate Stations
Tributory
River
LoC
International Boundary
0 25 50 100 150 200
Kilometers
Pakistan Snow & Ice Hydrology Project, WAPDA

TYPICAL DCP STATION

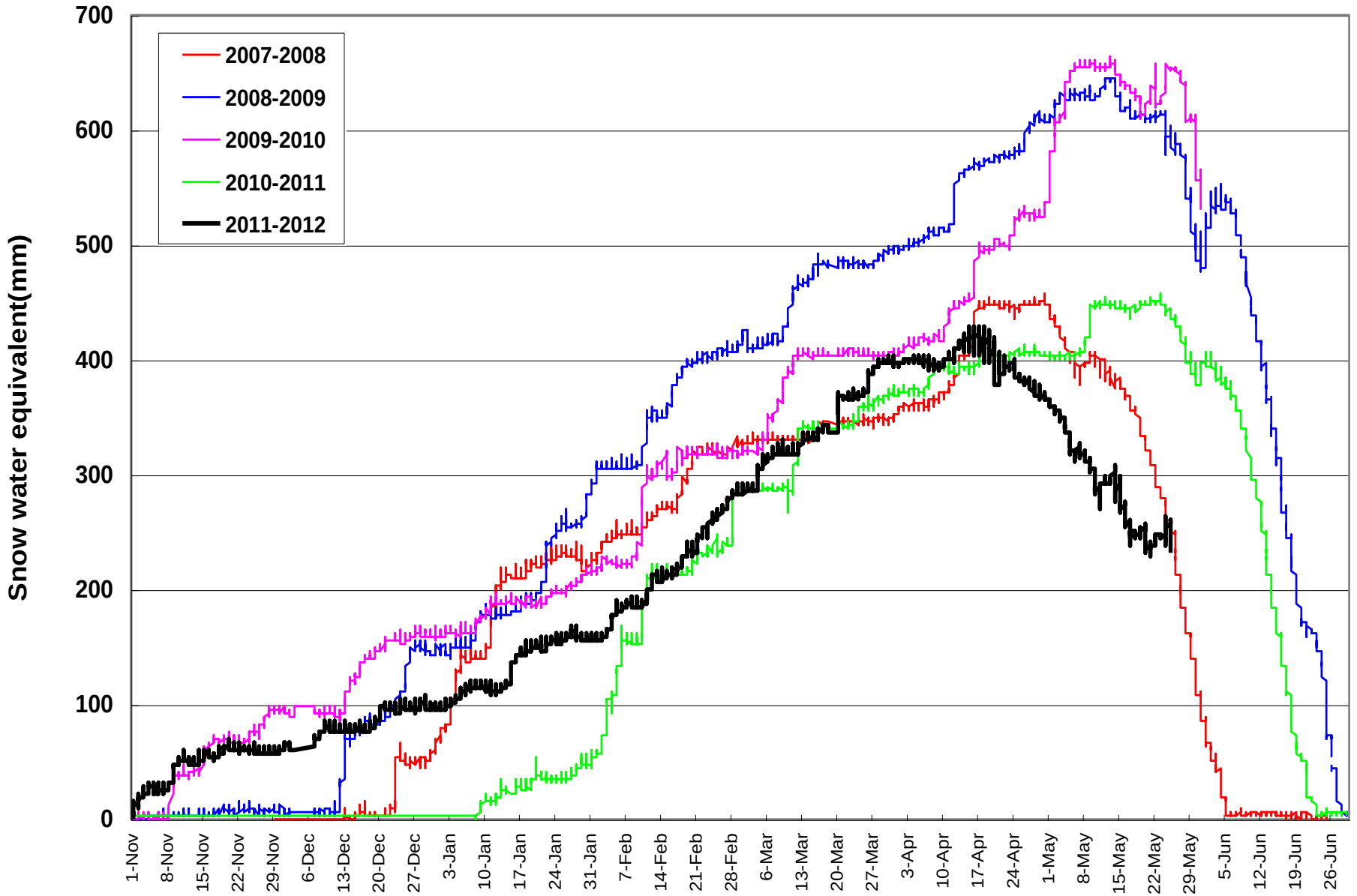
SENSORS INSTALLED

- Temperature
- Precipitation
- Relative Humidity
- Solar Radiation
- Snow Water Equivalent
- Wind (Speed; Direction)

Khunjerab (4710masl)

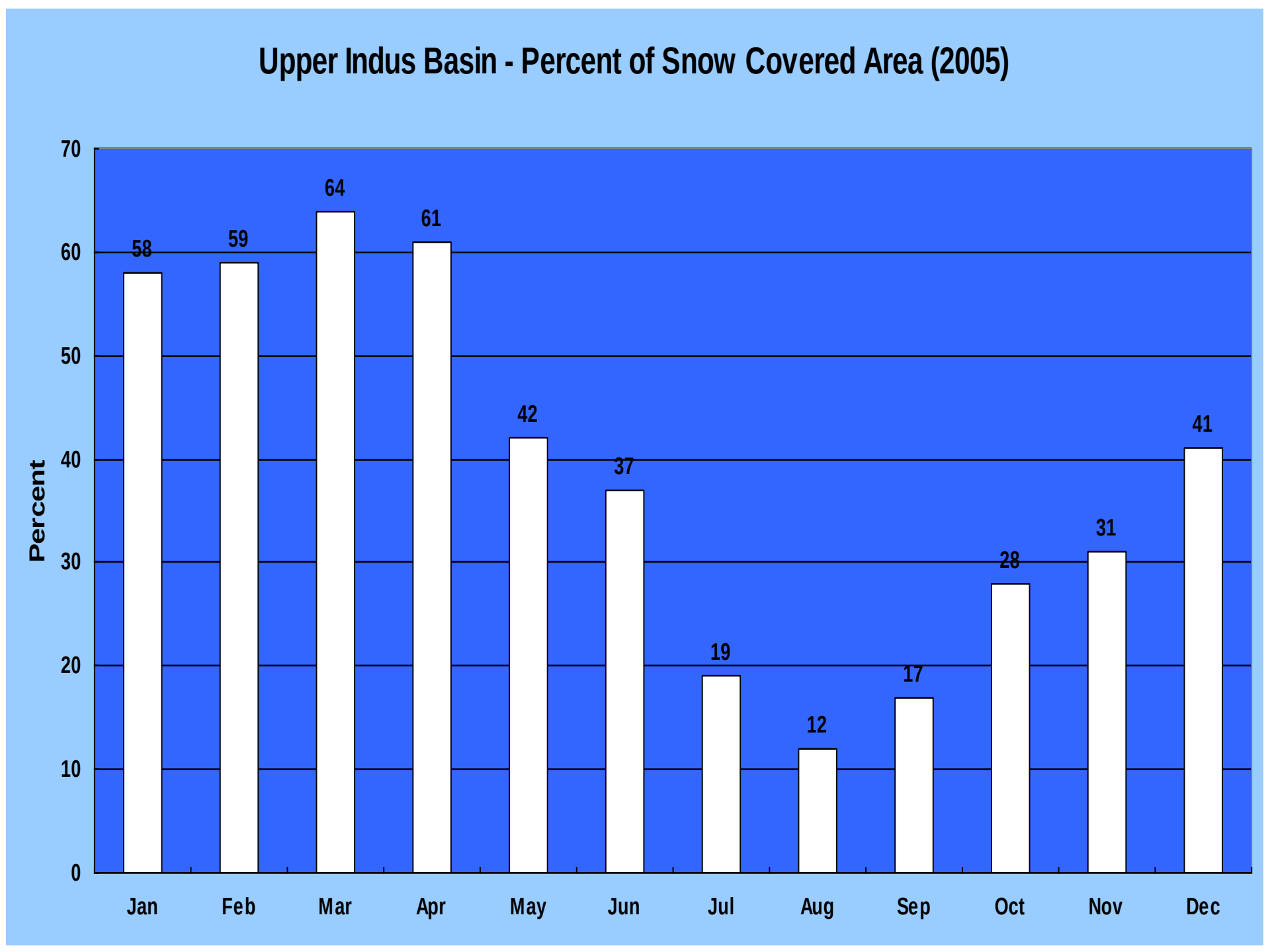
Propylene Glycol Filling in Snow Pillow

Snow Water Equivalent- DCP Station DEOSAI (3910 m.a.s.l.)



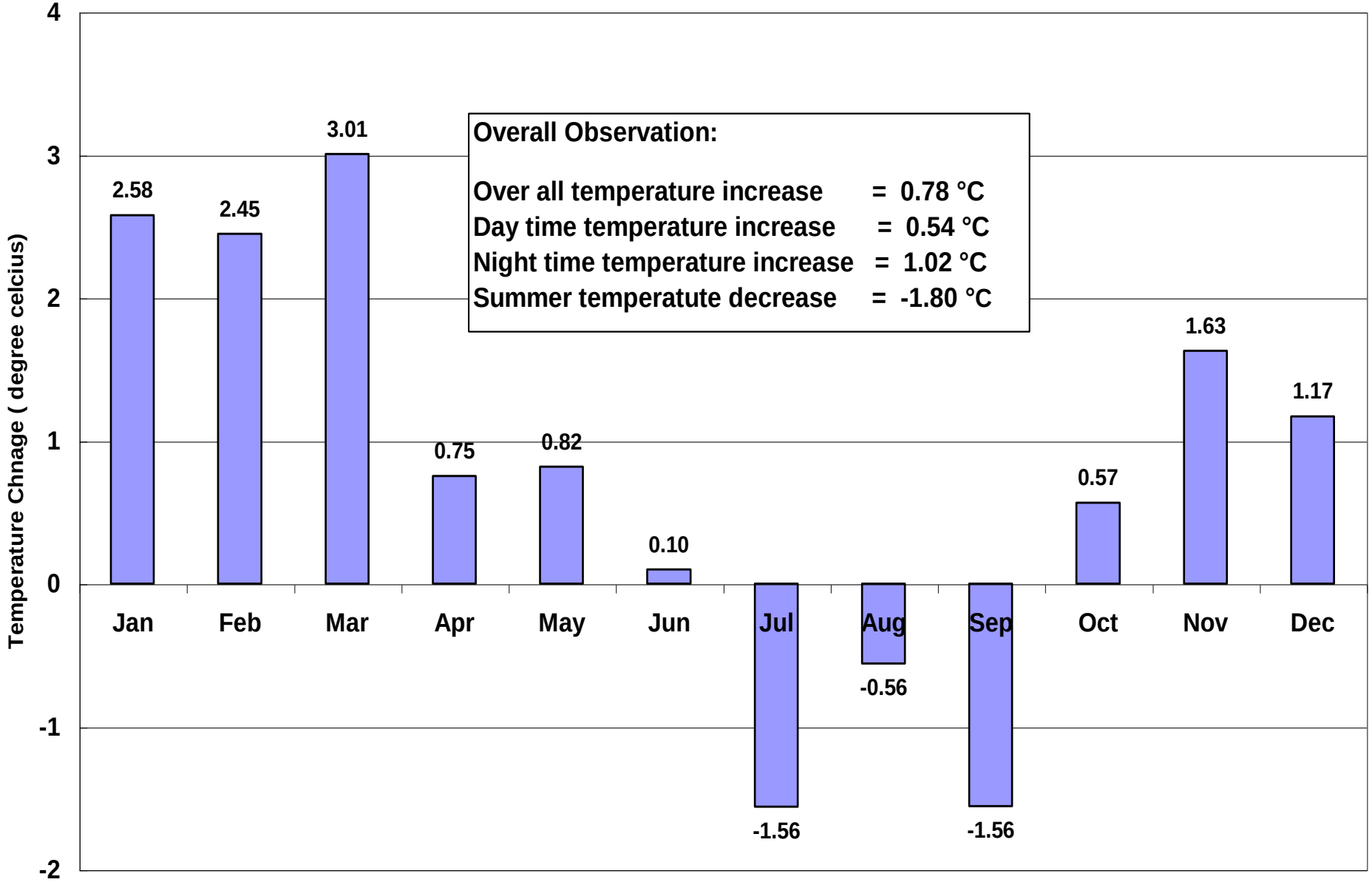
Automatic Weather Station - Shogran

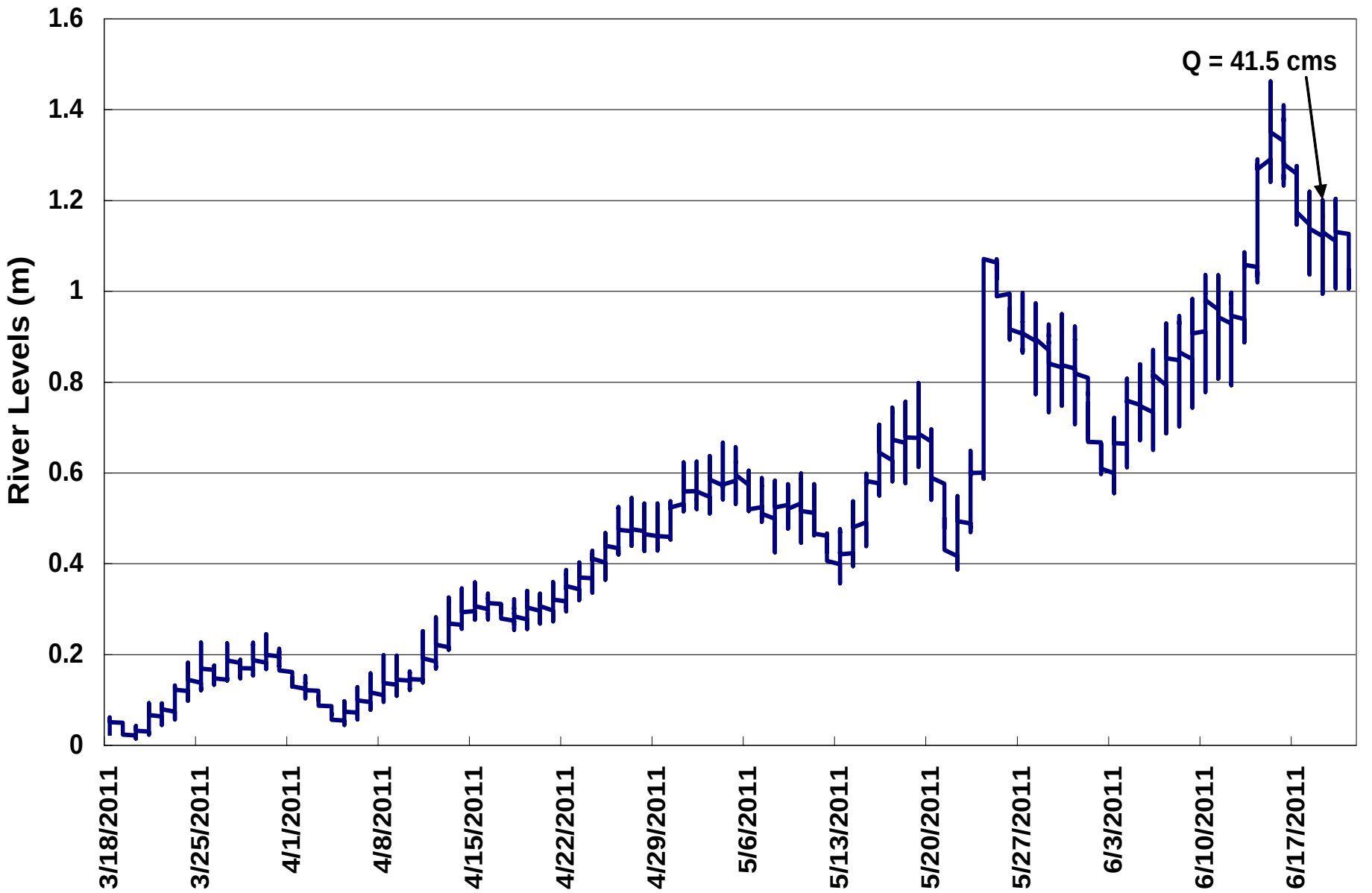
SWE confirmation at SHOGRAN


Upper Indus Basin - Percent of Snow Covered Area (2005)
Percent
70
60
50
40
30
20
10
0
58
59
64
61
42
37
19
12
17
28
31
41
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Temperature Change at WAPDA Weather Station Khunjerab

Period: 1995 - 2010 , Elevation 4710 m.a.s.l




Passu Outlet River Levels
River Levels (m)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Q = 41.5 cms
3/18/2011
3/25/2011
4/1/2011
4/8/2011
4/15/2011
4/22/2011
4/29/2011
5/6/2011
5/13/2011
5/20/2011
5/27/2011
6/3/2011
6/10/2011
6/17/2011

Climate Change Studies in WAPDA

- In Collaboration with the University of Colorado, Boulder, USA WAPDA studied Impact on the flows of River Indus due to Climate Change 1991.
- Dr. James Wescoat was the Principal investigator in this study.
- UBC Watershed Model was used to generate future flow scenarios.
- This study using GCM's from Goddard Institute of Space Sciences (GISS) and Geophysical Fluid Dynamics Lab (GFDL) predicted 3.2°C and 4.7°C increase in temperature respectively by doubling CO2 from 1991 Level shown change in total annual river inflows by 11% to 16%

WAPDA new Initiative

Monitoring of Upper Indus Basin Glaciers for Water Resources Management in Wake of Climate Change

Objectives

- Glacier Monitoring and Research Centre (GMRC) has been established within WAPDA
- Conduct Mass Balance Studies of 5 Major Upper Indus Basin (UIB) Glaciers
- Monitoring and Mapping of 52 Nos. Large and Medium size UIB Glaciers for their Snout Movement

Objective Continued….

- **Forecasting of Future Water Availability from UIB using Remote Sensing, GIS, Digital Elevation and Glacier Melt Models using different Climate Scenarios**
- **Installation of 6 New High Altitude Automatic Meteorological Stations in Upper Indus Basin**
- **Setting up of Remote Sensing and GIS Lab in GMRC Lahore.**

Project Cost & Implementation Period

- Project is C4 component of Tarbela 4th Extension Hydropower Project

- Implementation Period — Six Years (July 2012 – June 2018)

- Project Cost — USD 6.000 Million

Major Activities

- Recruitment of Additional Staff
- Hiring of Glacier Experts and Incremental Staff
- Training (Local, Foreign and On the Job) of Staff on Remote Sensing ,GIS, Digital Elevation Model and Glacier Melt Models
- Application of RS, GIS, DEM and Glacier Melt models on UIB Glaciers for Estimation of Future Water Availability
- Construction of Offices at Lahore and Skardu
- Rehabilitation of Existing High Altitude Data Collection Network and installation 6 new Stations
- Procurement of Field Investigation Equipment; AWS; ARLS; Computer Hardware, Software, Vehicles etc.

Thank You
for your kind Attention