

# Second Summer School on Integrated Water Resources Management

27-31 August, 2018, Islamabad

## *Overview of Watershed & Hydrology*

*Adnan Shafiq Rana*

*Meteorologist*

*Pakistan Meteorological Department*

# What is Watershed

- A watershed is a basin like landform defined by peaks which are connected by ridges that descend into lower elevations and small valleys.
- Watershed-any sloping land surface that sheds water; and refers to a particular location and a spatial extent, gravitationally draining water through that location
- It carries rainwater falling on it drop by drop and channels it into soil, rivulets and streams flowing into large rivers and in due course sea.
- It affects the people living downstream
- Watersheds provide boundaries for management
- It makes sense to manage on a watershed basis rather than a political boundaries.

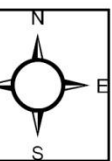
# Characteristics of Watershed



- All characteristics affect the disposal of water.
- **SIZE**: It helps in computing parameters like precipitation received, retained, drained off.
- **SHAPE**: Different shapes based on morphological parameters like geology and structure, eg. pear, elongated etc.
- **PHYSIOGRAPHY**: Lands altitude and physical disposition.
- **SLOPE**: It controls the rainfall distribution and movement:
- **CLIMATE**: It decides the quantitative approach.
- **DRAINAGE**: It determines the flow characteristics and so the erosion behavior.

# Characteristics of Watershed

- **VEGETATION**: Information of species gives a sure ground for selection plants and crops.
- **GEOLOGY AND SOILS**: Their nature determines size, shape, physiographic, drainage and groundwater conditions. Soils, derivative of rocks are the basic to greenery
- **HYDROLOGY**: Basis top assess the runoff from precipitation. It helps in quantification of water available.
- **HYDROGEOLOGY**: Availability of groundwater.
- **SOCIOECONOMICS**: Statistics on people and their health, hygiene, wants and wishes are important in managing water.



# GLACIER LAKES GLOF PROJECT SITE, BAGROT VALLEY, GILGIT

Hinarche Lake 01



Hinarche Lake 02



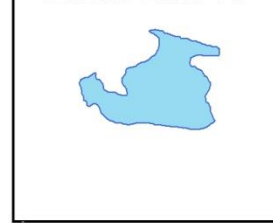
Glacier Lakes  
Bagrot



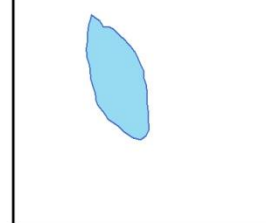
Yune Lake 01



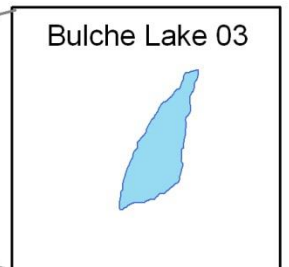
Bulche Lake 01



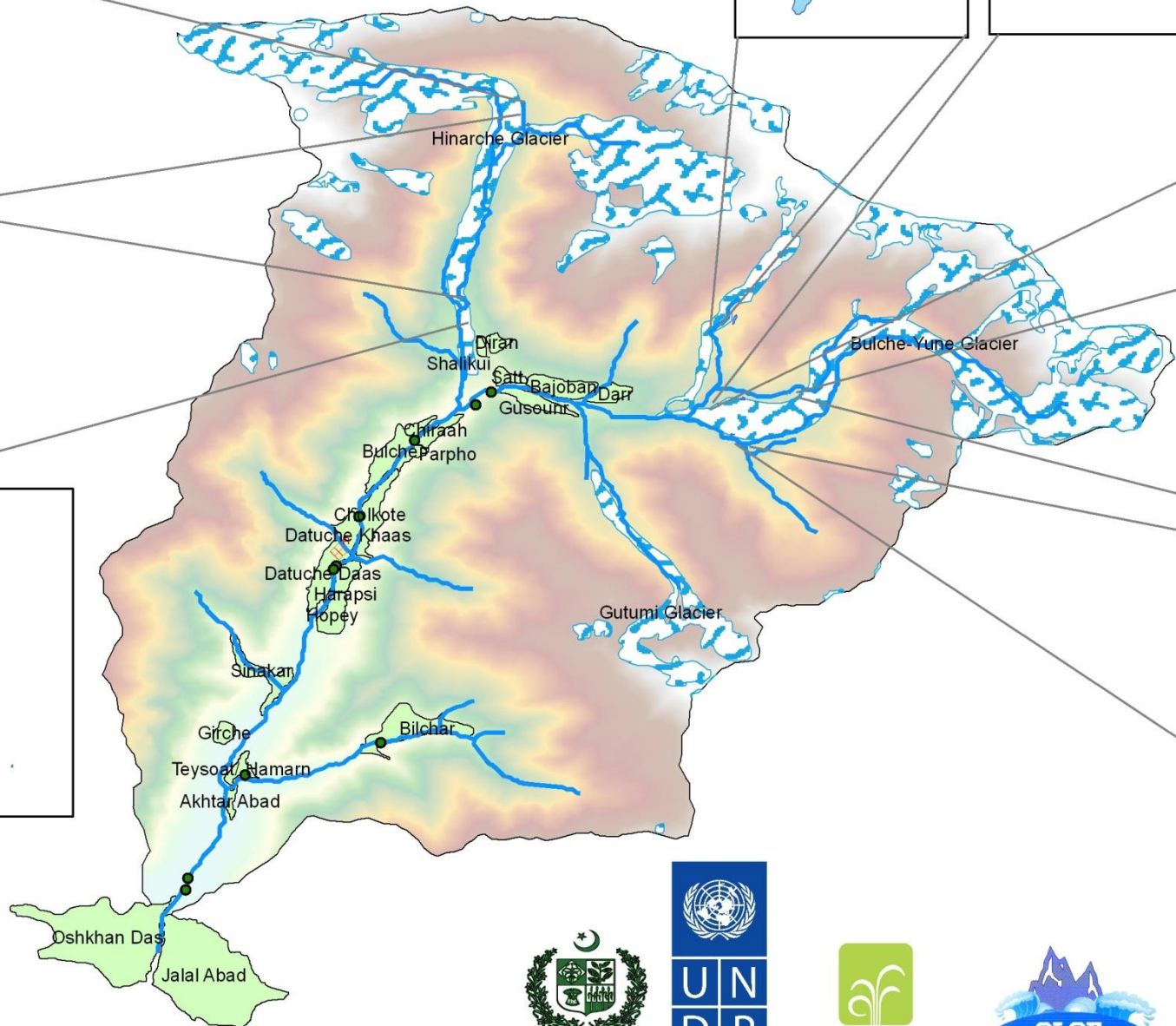
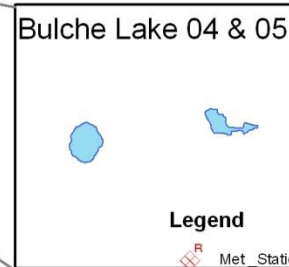
Bulche Lake 02



Bulche Lake 03



Bulche Lake 04 & 05



### Legend

- Met. Stati.
- Bridges
- Bagrot\_St
- Bagrot\_La
- Bagrot\_Vil
- Bagrot\_Gl
- Bagrot\_Bo
- bagrot\_dem**  
Value
- High: 764
- Low: 1413



# GLOF Project Site - Bindogol Valley - Chitral

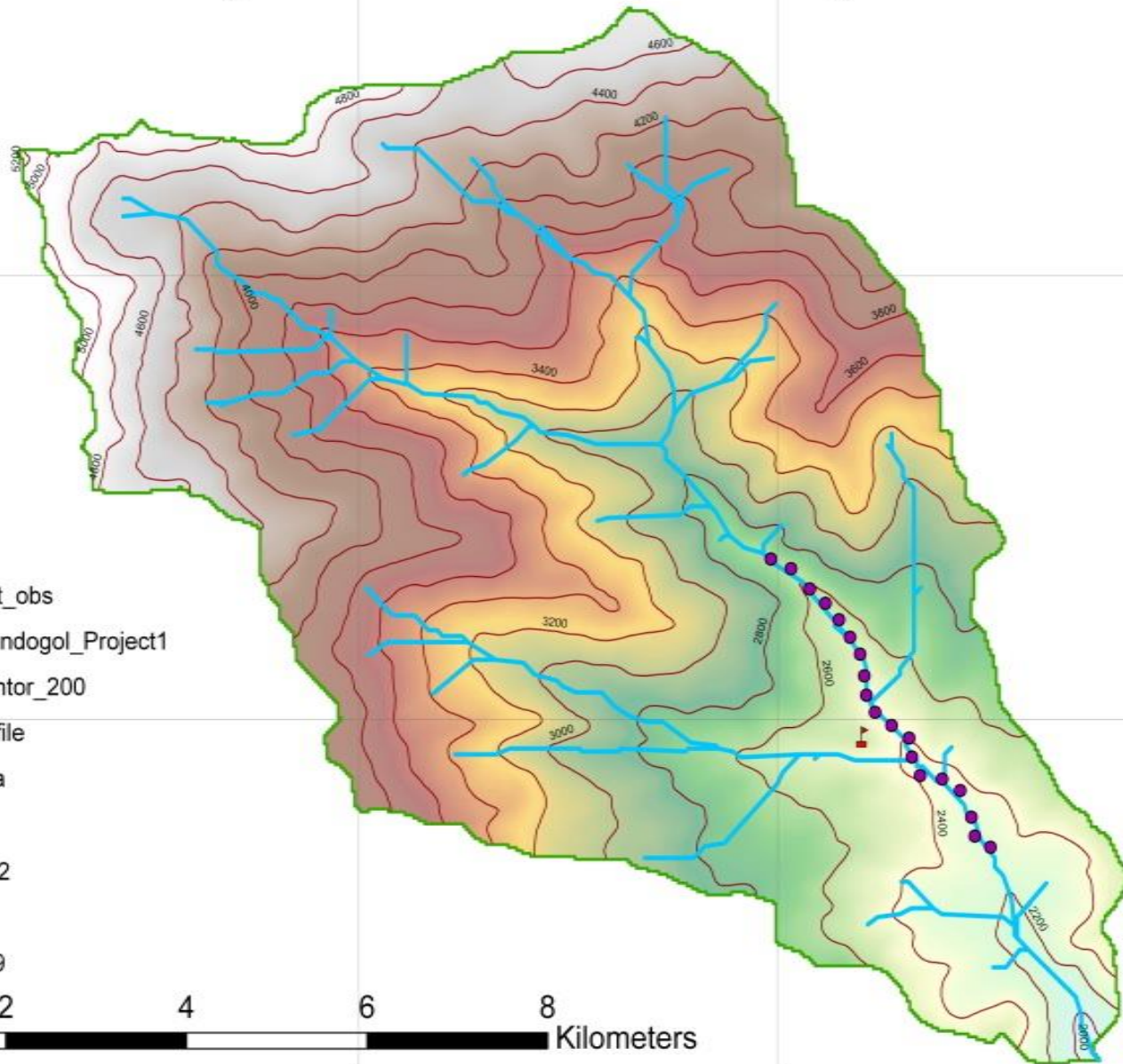


## Legend

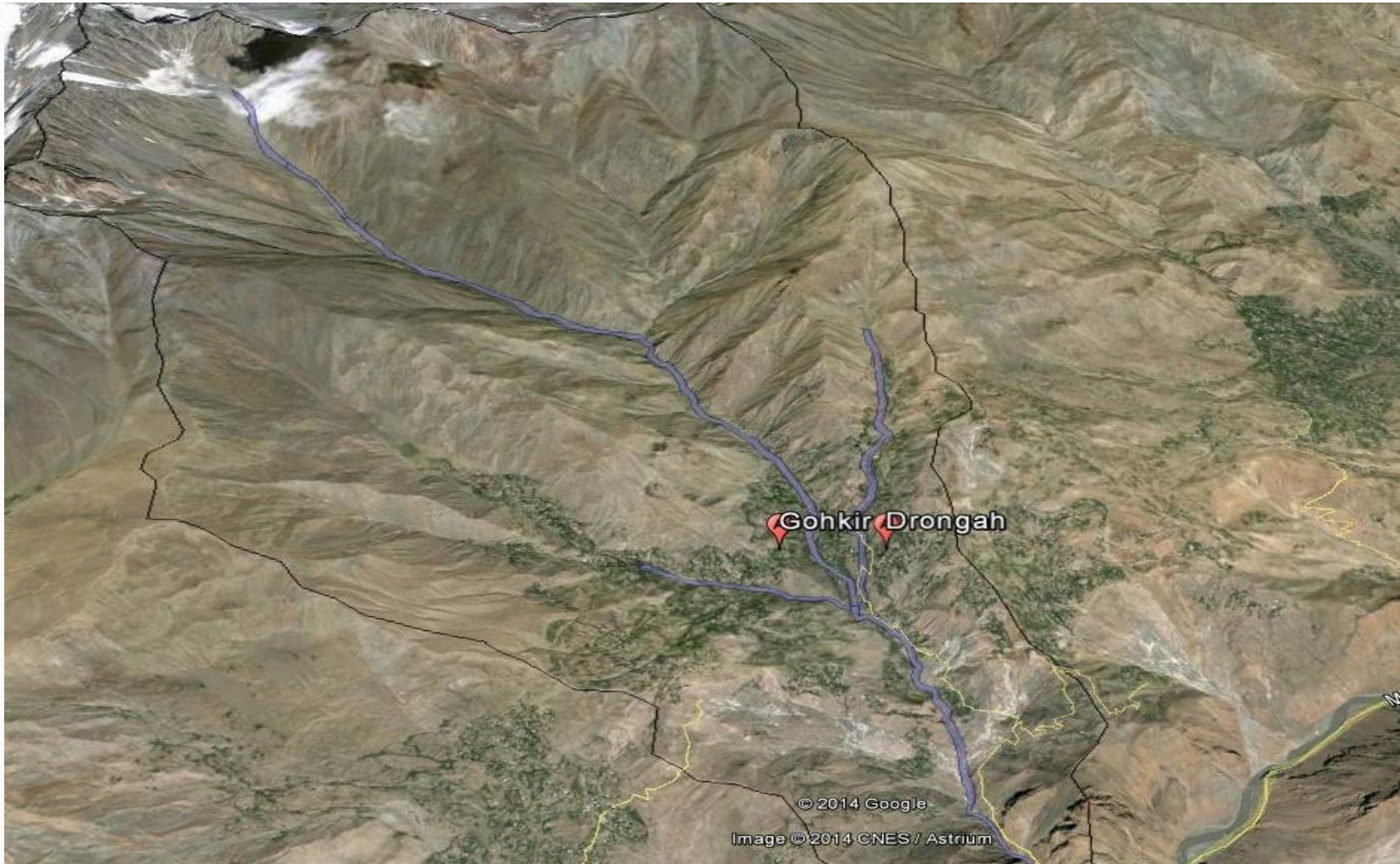
- Bindo\_Met\_obs
- Stream\_Bindogol\_Project1
- Bindo\_Contor\_200
- River\_Profile
- Bindo\_Sha

## Bindo\_DEM

- High : 5232
- Low : 1939

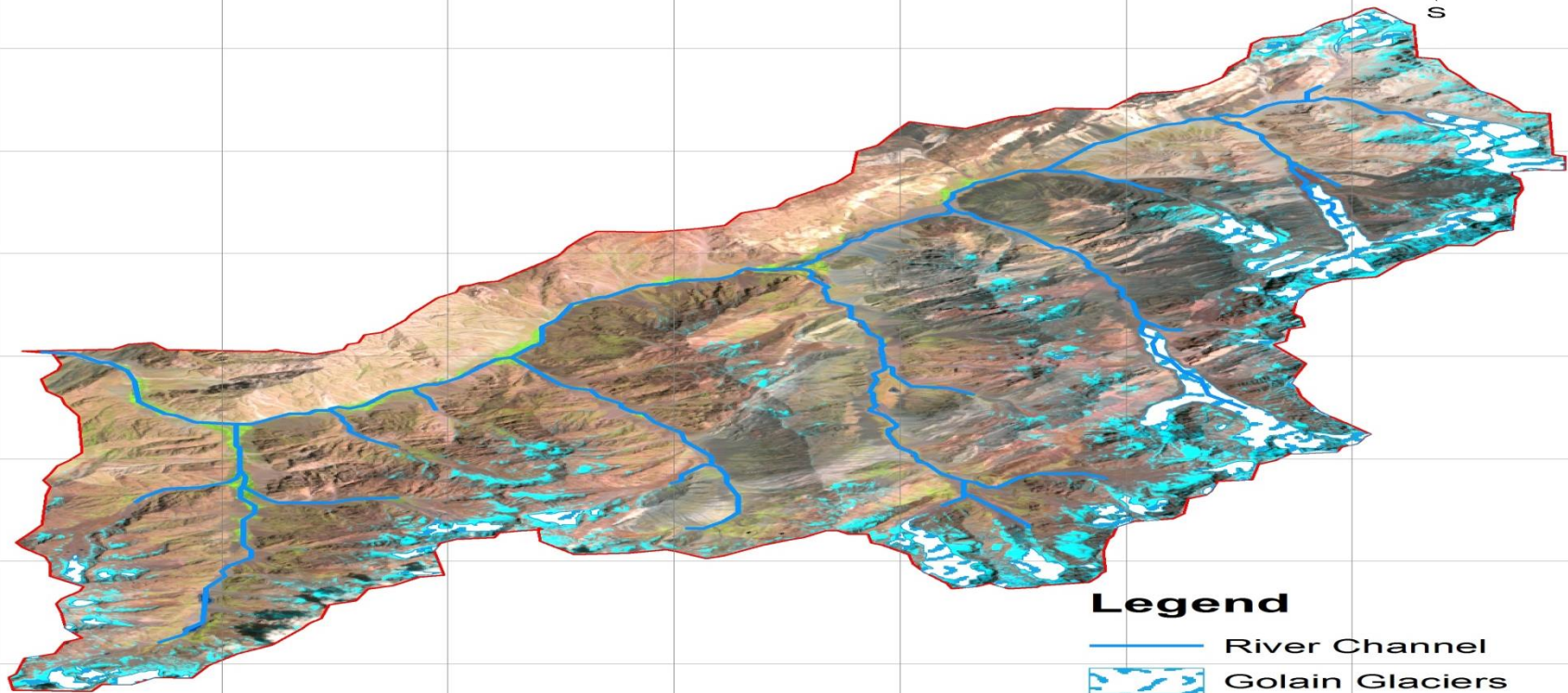
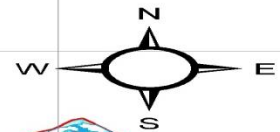


# Bindogol Valley Catchment/ Watershed displayed on Google Earth



# GIS Map of New Site

## GOLAIN CATCHMENT



### Legend

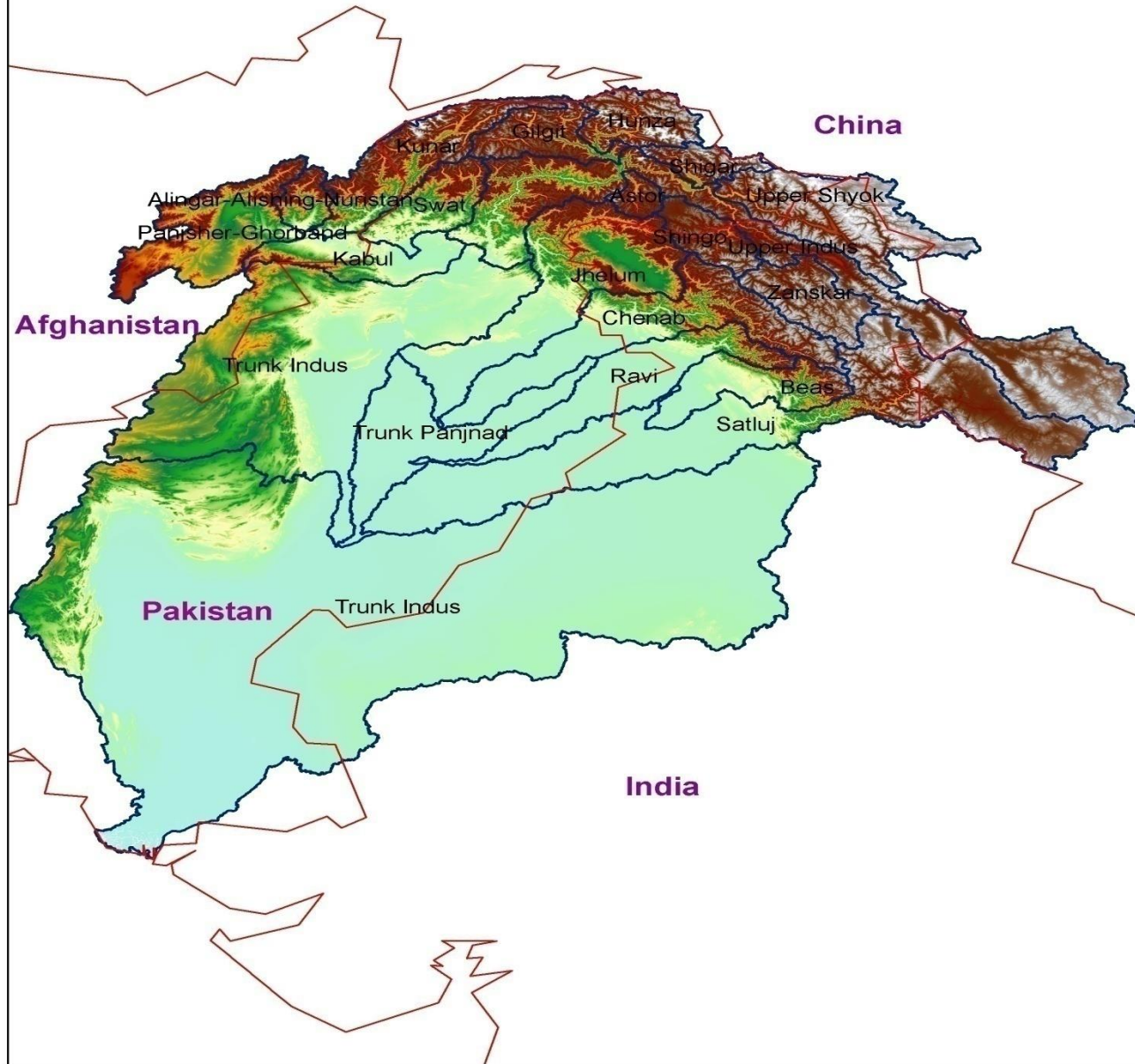
-  River Channel
-  Golain Glaciers
-  Golain Lakes
-  River Catchment

71°57'0"E 72°0'0"E 72°3'0"E 72°6'0"E 72°9'0"E 72°12'0"E 72°15'0"E 72°18'0"E

35°45'0"N 35°48'0"N 35°51'0"N 35°54'0"N 35°57'0"N 36°0'0"N 36°3'0"N 36°6'0"N 36°9'0"N



# INDUS BASIN AND SUB-BASINS



# Watershed Management

- **It involves management of land, water, energy and greenery integrating all the relevant approaches appropriate to socioeconomic background for a pragmatic development of a watershed.**
- **Process of guidance and organization of resources in watershed mainly soil and water but ensuring Environmental gradation.**
- **Human actions concerning development and conservation.**
- **Best use of Resources through Prevention and Restoration.**

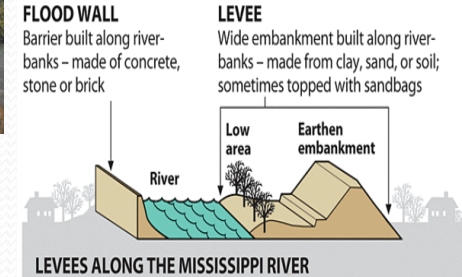
# Watershed Management-Real World

- **Disaggregation and Independent Political Actions**
- **Implementation in a manner with no or little consideration of how the other areas effect.**
- **For example**
  - Water flows ignoring political or administrative boundaries**
  - Activity of upstream person effect the welfare of downstream community**

# Watershed related issues

- **Floods**
- **Unstable Slopes/ Land Slides**
- **Erosion**
- **Water Deficit**
- **Energy shortage**
- **Food shortage**
- **Quality of drinking water**
- **Pollution (Air, land and water)**
- **Sedimentation**
- **Timber shortage**

# Watershed issues and possible solutions



## ➤ Floods

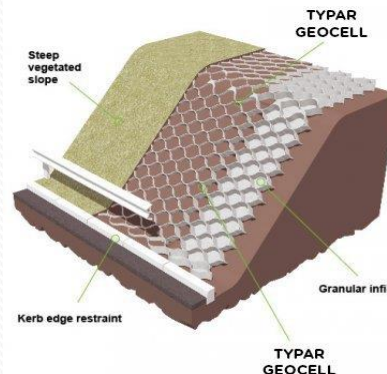
- Flood Control Reservoirs
- Construction of Levees
- Flood Management Plans
- Re-Vegetation and aforestation

## ➤ Unstable Slopes/ Land Slides

- Slope protection and Drainage Structures

## ➤ Erosion

- Erosion Control Structures
- Contour Terracing
- Re-Vegetation



# Watershed issues and Possible

## Solutions

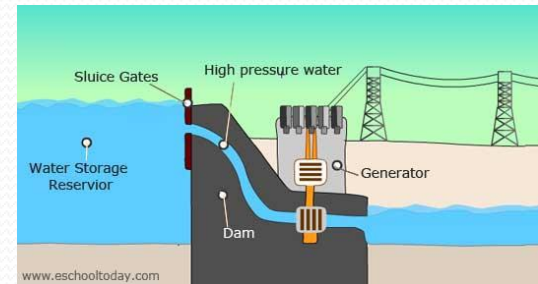
### ➤ Water Deficit

- Storage Reservoirs
- Rain Water Harvesting
- Vegetation Manipulations
- Pumping deep groundwater



### ➤ Energy shortage

- Fuel Wood harvesting
- Hydro-power Development



### ➤ Food shortage

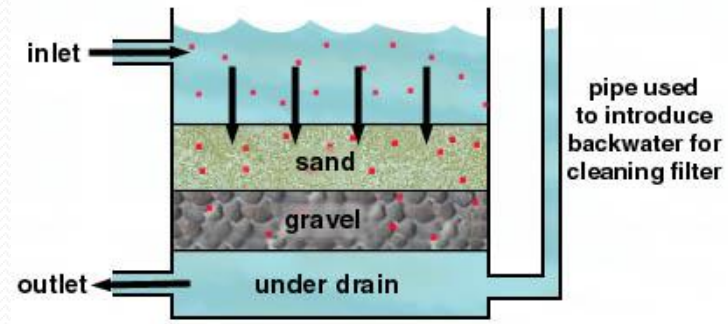
- Increase Livestock and maintaining pastures
- Develop agriculture land
- Develop agriculture practices



# Watershed issues and possible solutions

## ➤ Quality of drinking water

- Develop wells and springs
- Treat Water



## ➤ Pollution (Air, land and water)

- Control Pollutant Entry
- Treat Wastage



## ➤ Sedimentation

- Erosion Control Structures
- Dredging and mining



## ➤ Timber shortage

- Timber Forestation

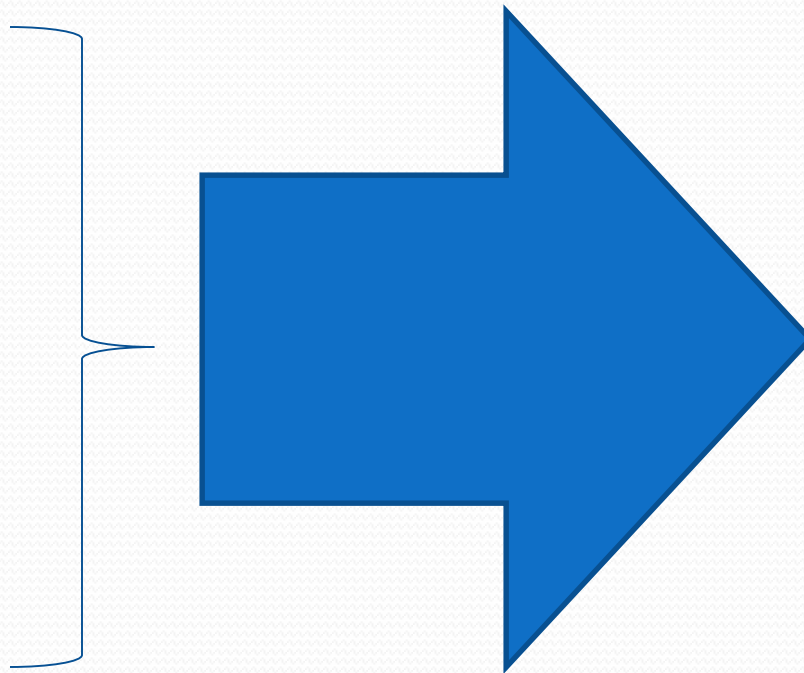
# Watershed Management

## Measures (Preservation/ Enhancement)

➤ **Water**

➤ **Vegetation**

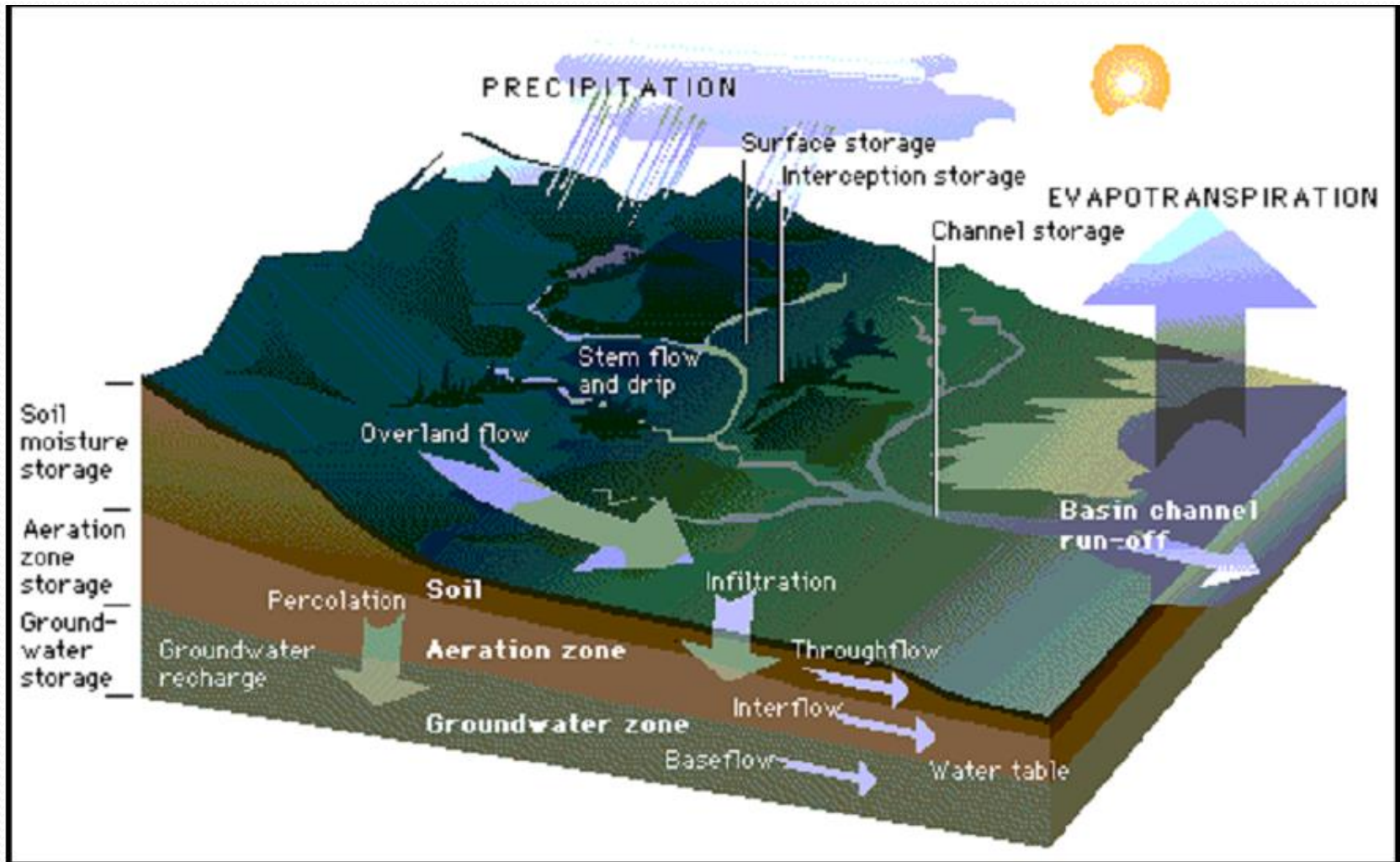
➤ **Soil**



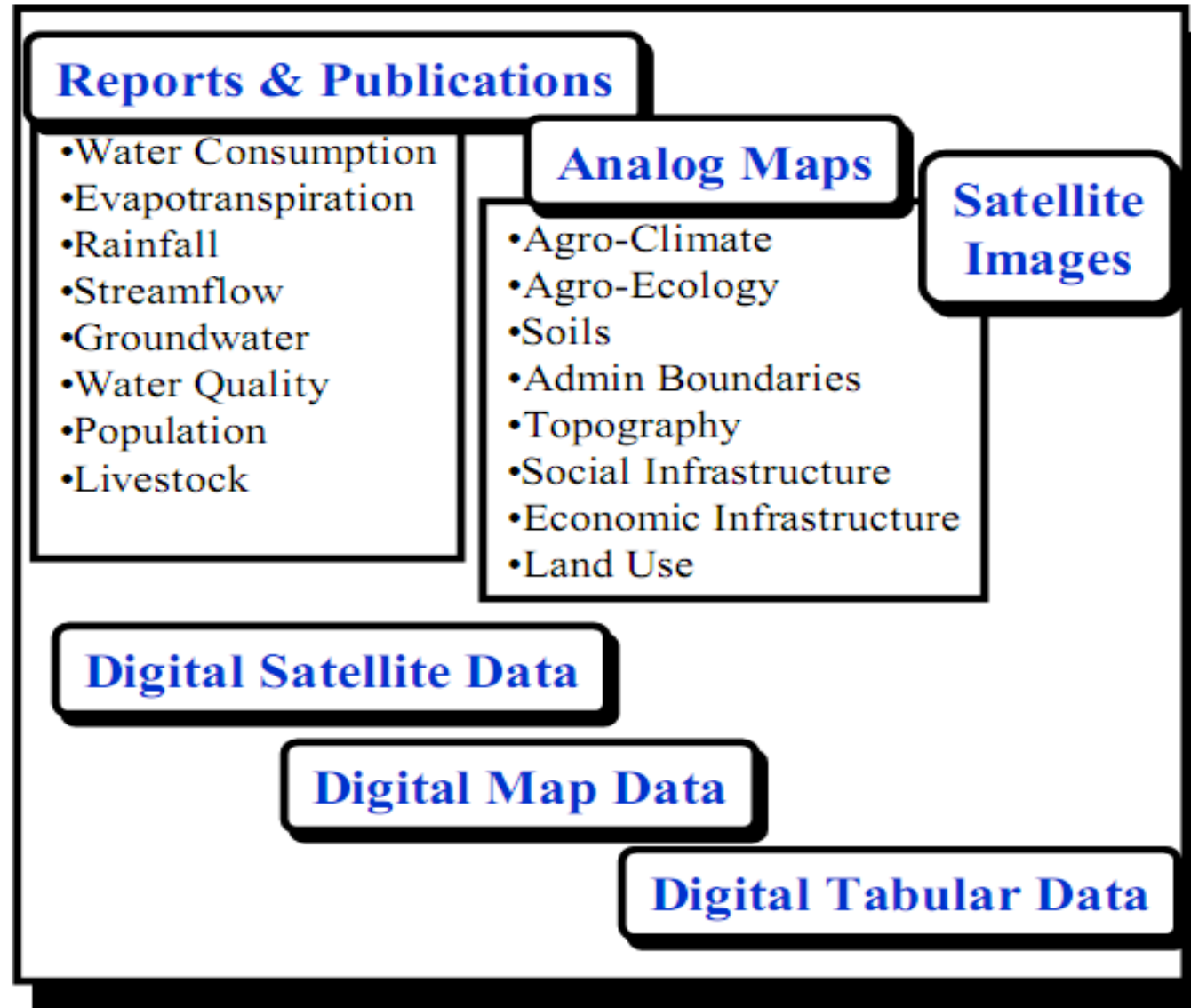
**Hydrological  
Factors**



# Water Cycle

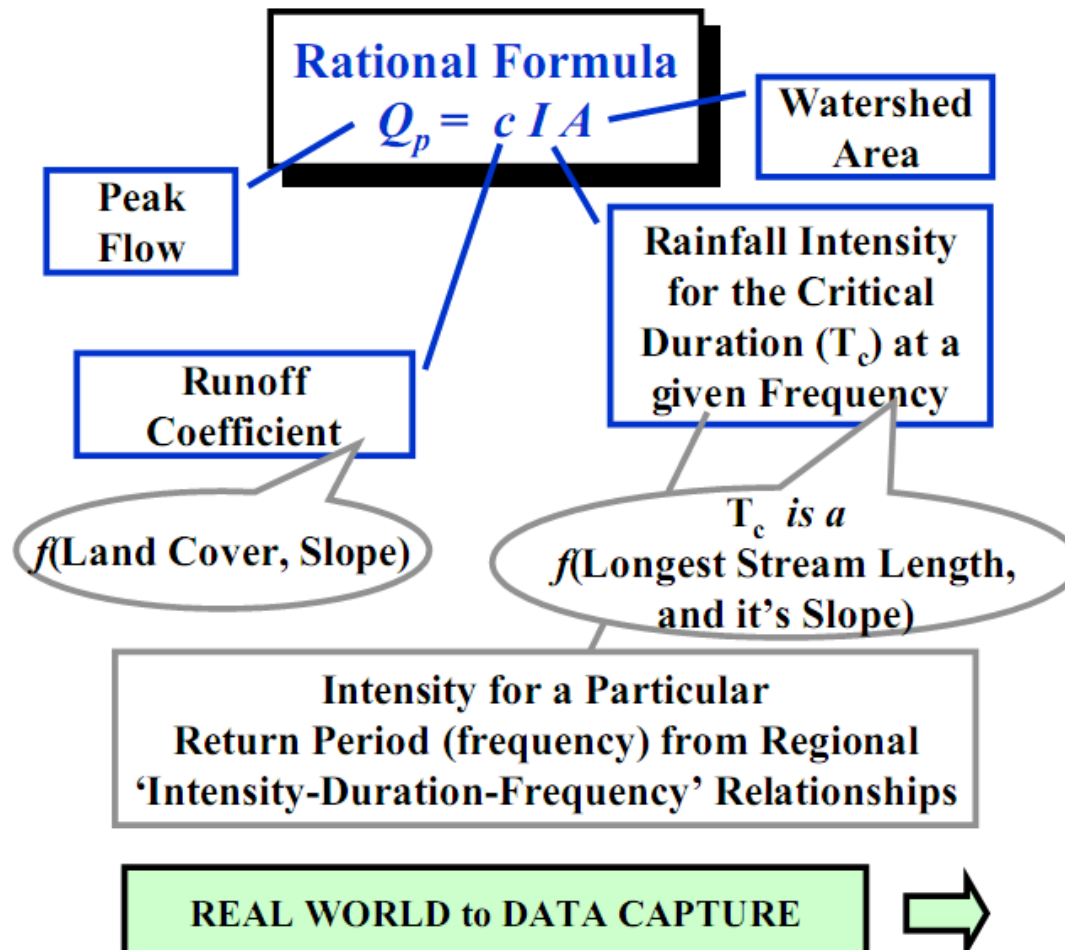


# Generalized Database for watershed management-Hydrology

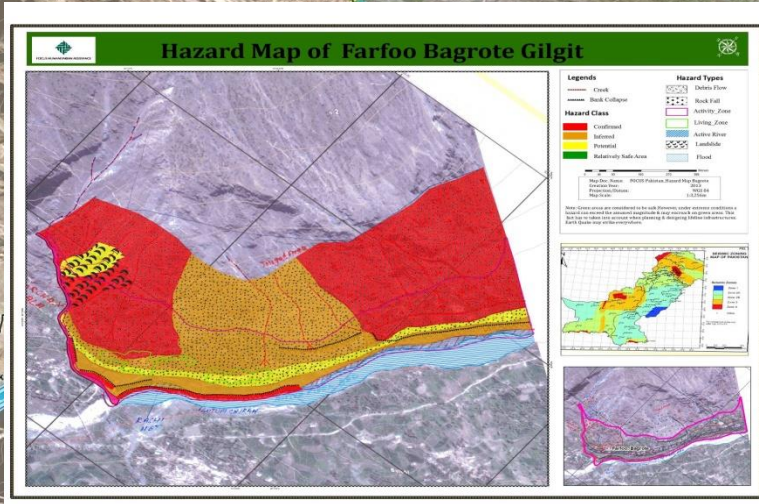
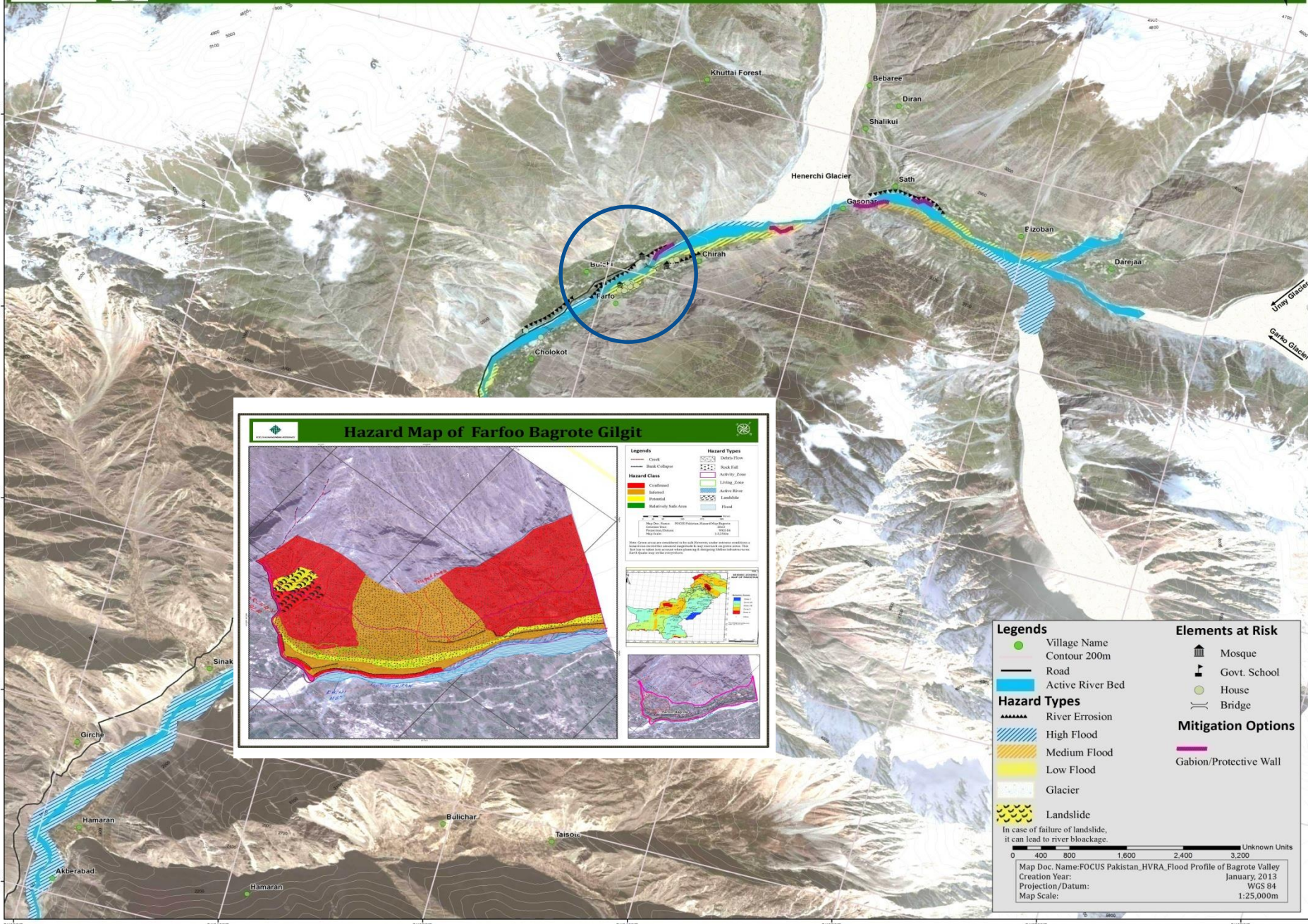


# A simple GIS model for hydrological Assessment

## A Simple GIS Model to Compute Peak Runoff from Watershed



# Flood Hazard Map of Bagrote Valley



**Legends**

- Village Name
- Contour 200m
- Road
- Active River Bed
- River Erosion
- High Flood
- Medium Flood
- Low Flood
- Glacier
- Landslide

**Elements at Risk**

- Mosque
- Govt. School
- House
- Bridge

**Mitigation Options**

- Gabion/Protective Wall

In case of failure of landslide, it can lead to river blockage.

Map Doc. Name: FOCUS Pakistan\_HVRA\_Flood Profile of Bagrote Valley  
 Creation Year: January, 2013  
 Projection / Datum: WGS 84  
 Map Scale: 1:25,000

# Flash Flood Map Of Bindagole Valley Chitral



### Hazard Types



### Legends



### Hazard Class

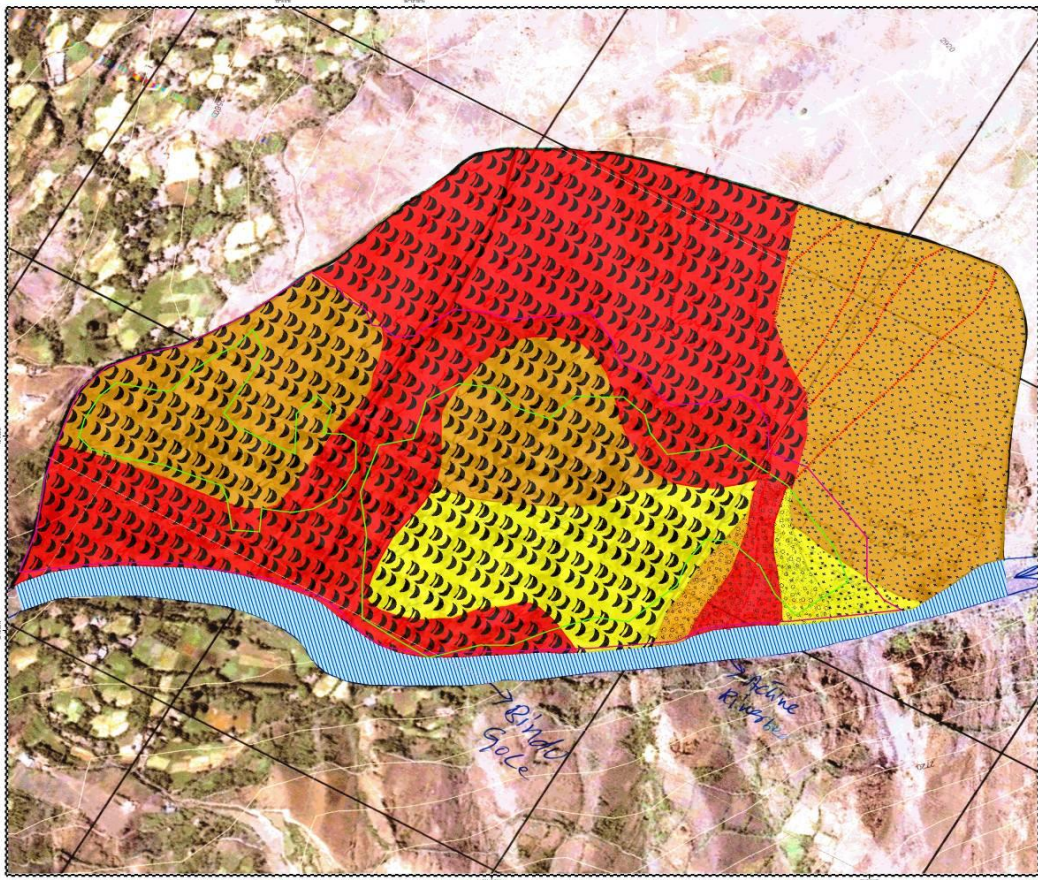


Chitral\_Hazard Map Bindagole  
2013  
WGS 84  
1:10,000m

Safe. However, under extreme conditions a hazard can exceed the assumed magnitude & may encroach on green areas. This fact has to be taken into account when planning & designing lifeline infrastructures.



# Hazard Map of Gohikir Bindagole Chitral



### Legends

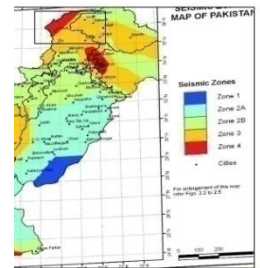
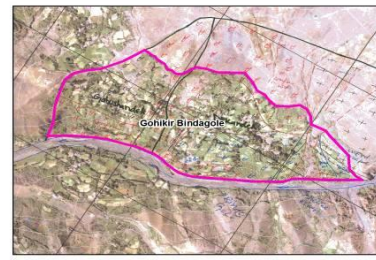
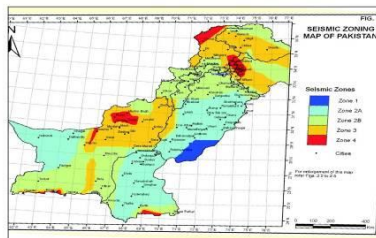


### Hazard Class



Map Doc. Name: FOCUS Pakistan\_Hazard Map Bindagole  
Creation Year: 2013  
Projection/Datum: WGS 84  
Map Scale: 1:8,810m

Note: Green areas are considered to be safe. However, under extreme conditions a hazard can exceed the assumed magnitude & may encroach on green areas. This fact has to be taken into account when planning & designing lifeline infrastructures. Earth Quake may strike everywhere.





**THANKS**