

The Assessment of Hydrogeological and Seismic Danger in the Northern Areas and Kashmir, using GIS Techniques".


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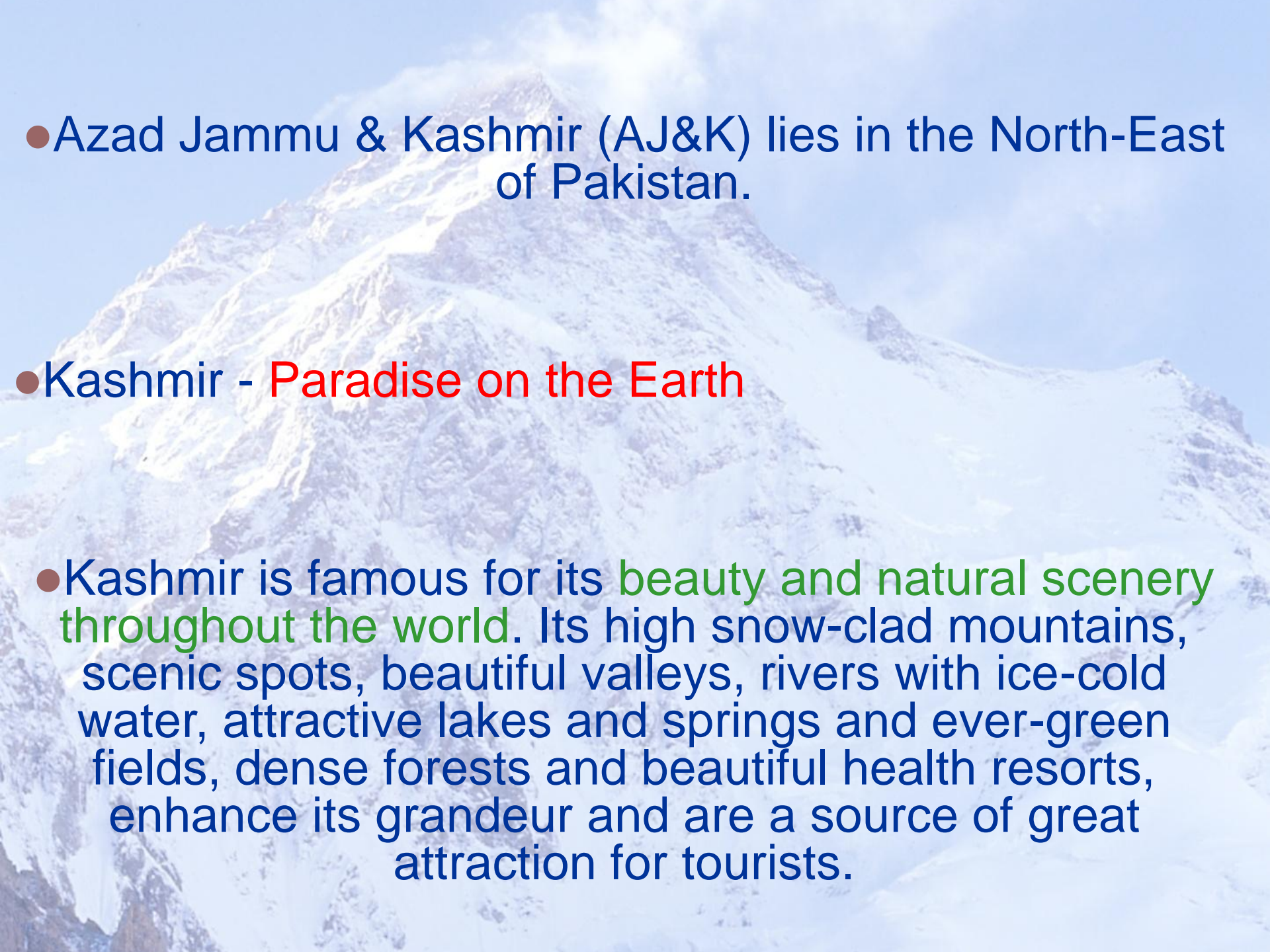
AJK University, Muzaffarabad²

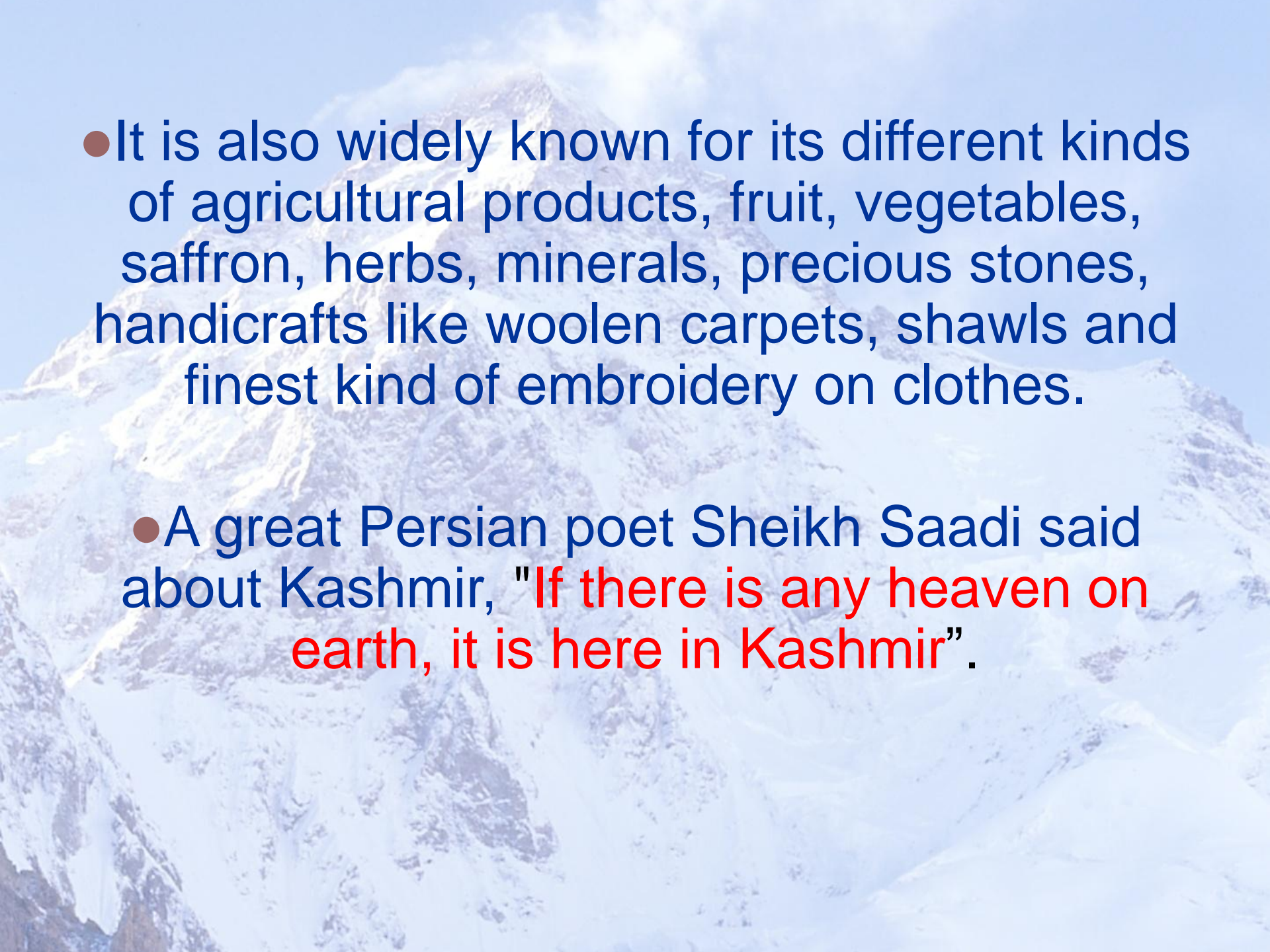
Ev-K2-CNR - Department of Mathematics and Informatics - University of Trieste, Italy³



Kashmir Earthquake

October 08, 2005

- 
- Azad Jammu & Kashmir (AJ&K) lies in the North-East of Pakistan.
 - Kashmir - Paradise on the Earth
 - Kashmir is famous for its beauty and natural scenery throughout the world. Its high snow-clad mountains, scenic spots, beautiful valleys, rivers with ice-cold water, attractive lakes and springs and ever-green fields, dense forests and beautiful health resorts, enhance its grandeur and are a source of great attraction for tourists.



- It is also widely known for its different kinds of agricultural products, fruit, vegetables, saffron, herbs, minerals, precious stones, handicrafts like woolen carpets, shawls and finest kind of embroidery on clothes.

- A great Persian poet Sheikh Saadi said about Kashmir, "If there is any heaven on earth, it is here in Kashmir".

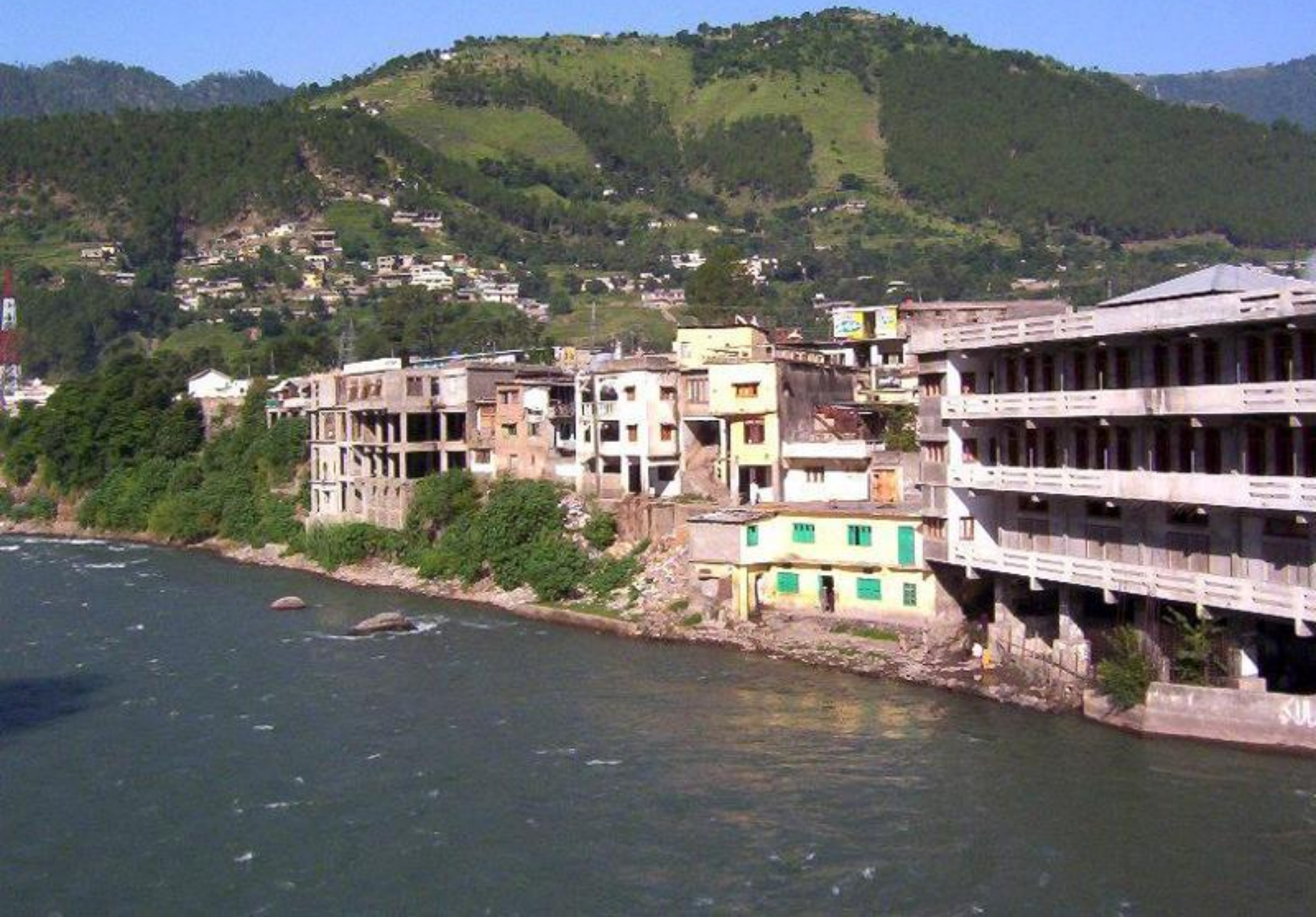
Kashmir - Before Earthquake 2005



Kashmir - Before Earthquake 2005



Kashmir - Before Earthquake 2005



Tolipir, Rawalakot



Banjosa Lake, Rawalakot



Banjosa Rest House & Lake, Rawalakot




Neelum Valley



Saturday 08 October, 2005

"A Day of Disaster"





Date 08/10/2005

Origin Time 03:50:38.63 (UTC)

Local Time 08:50:38.63 (PST)

Epicenter 34.432° N : 73.537° E

Location Epicenter lies in the Pakistan-administered Kashmir about 19 km NE of Muzaffarabad, and 100 km NNE of Islamabad

Magnitude (M_w) 7.6 on the Richter Scale

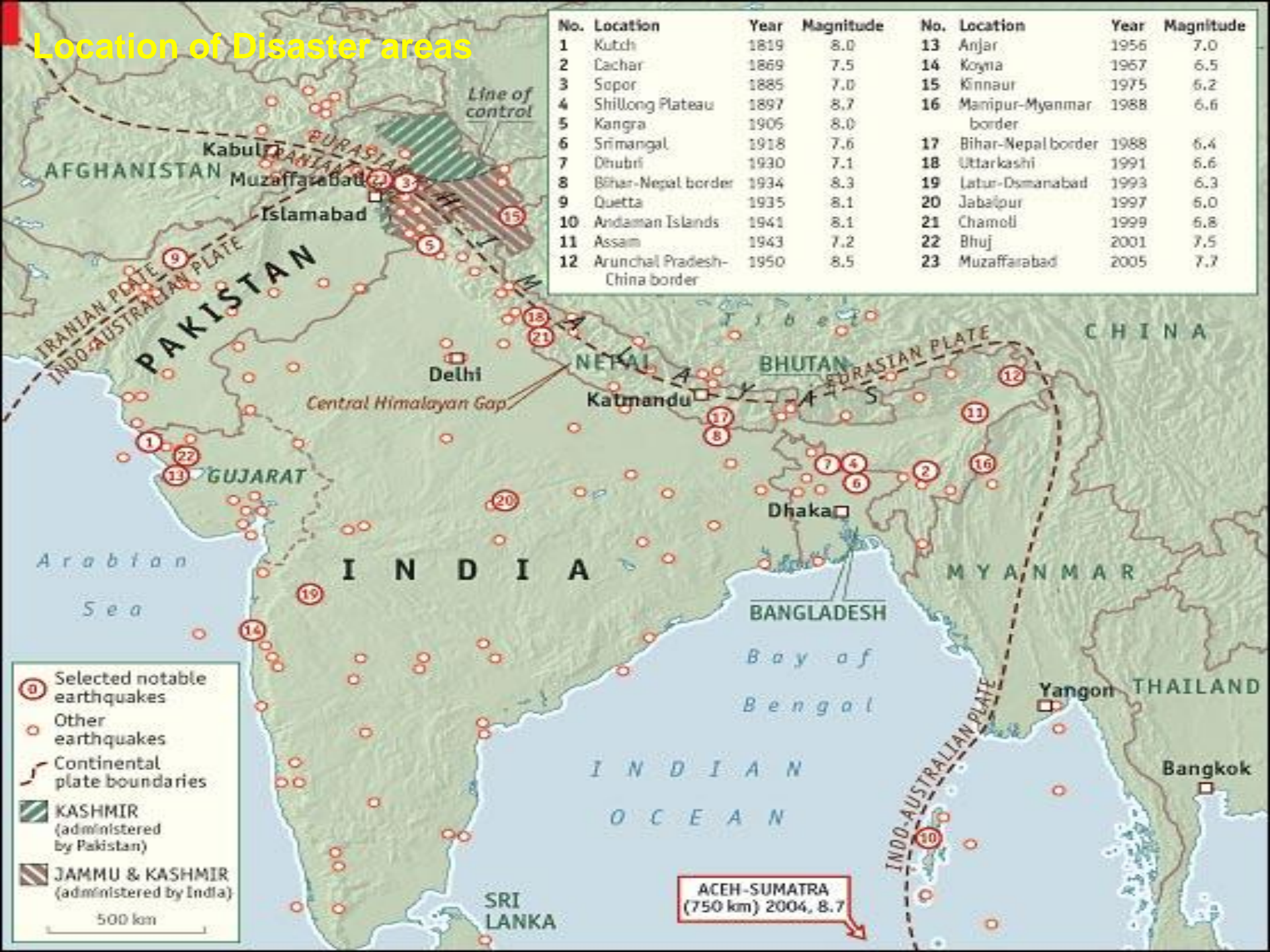
Depth 20 Km

Eartquake Type Major

Areas Affected Pakistan-administered Kashmir, NWFP.
(Some damages in [Afghanistan](#) and northern [India](#))

Location of Disaster areas

No.	Location	Year	Magnitude	No.	Location	Year	Magnitude
1	Kutch	1819	8.0	13	Anjar	1956	7.0
2	Cachar	1869	7.5	14	Koyna	1967	6.5
3	Sopor	1885	7.0	15	Kinnaur	1975	6.2
4	Shillong Plateau	1897	8.7	16	Manipur-Myanmar border	1988	6.6
5	Kangra	1905	8.0	17	Bihar-Nepal border	1988	6.4
6	Srinangal	1918	7.6	18	Uttarkashi	1991	6.6
7	Dhubri	1930	7.1	19	Latur-Damanabad	1993	6.3
8	Bihar-Nepal border	1934	8.3	20	Jabalpur	1997	6.0
9	Quetta	1935	8.1	21	Chamoli	1999	6.8
10	Andaman Islands	1941	8.1	22	Bhuj	2001	7.5
11	Assam	1943	7.2	23	Muzaffarabad	2005	7.7
12	Arunchal Pradesh-China border	1950	8.5				



- 10 Selected notable earthquakes
- Other earthquakes
- Continental plate boundaries
- KASHMIR (administered by Pakistan)
- JAMMU & KASHMIR (administered by India)

500 km

ACEH-SUMATRA
(750 km) 2004, 8.7

- 
- The USGS recorded **22** aftershocks of $M > 4.5$ in the first 18 hours of the main shock.
 - A total of **147** aftershocks were registered in the first day after the main event of 08 October 2005, of which one had a magnitude of **6.2**.
 - On October 19, a series of strong aftershocks, one with a magnitude of **5.8**, occurred about 65 km north-northwest of Muzaffarabad.
 - There have been more than **978** aftershocks with a magnitude of 4.0 and above, as of 27 October 2005.



- Causalities recorded in Pakistan and Kashmir were:

- Death toll > **90,000**
- Injured > **100,000**
- Homeless > **2 Million**

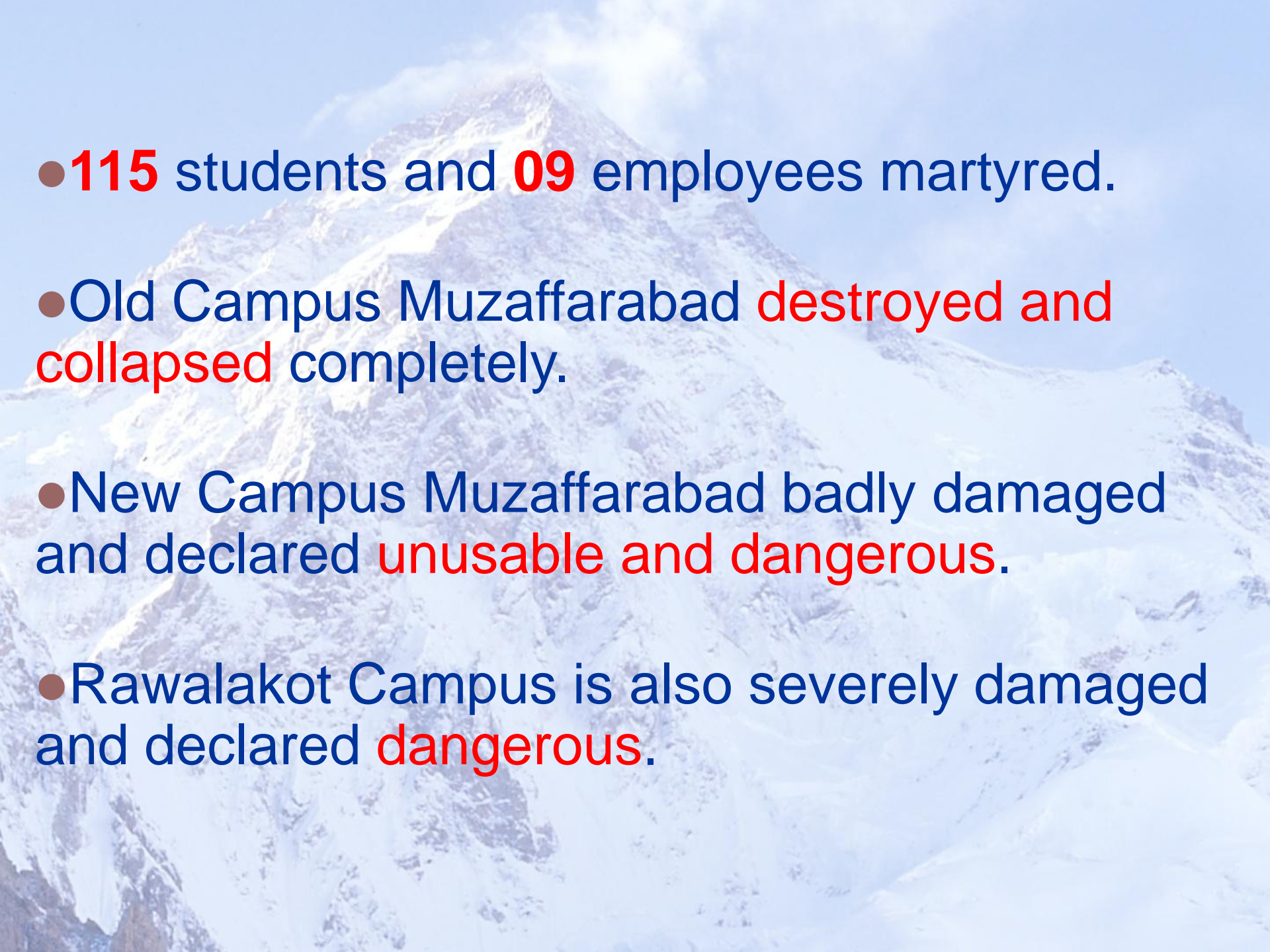
- Furthermore, nearly **1,400** people died in Indian-administered Kashmir and **14** people in Afghanistan.

UNIVERSITY OF AZAD JAMMU AND KASHMIR

Total Students at MZD Campus	= 1500
Female Students Martyred	= 45
Male Students Martyred	= 70
Total	= 115
Damage of Property	= Rs. 1 Billion

INSTITUTE OF GEOLOGY

Total Students	= 350
Martyred in Earthquake 2005	= 51
Damage of Property	= Rs. 11.400 Million
Damage of Equipments	= Rs. 100.000 Million
Total	= Rs. 111.400 Million

- 
- **115** students and **09** employees martyred.
 - Old Campus Muzaffarabad **destroyed and collapsed** completely.
 - New Campus Muzaffarabad badly damaged and declared **unusable and dangerous**.
 - Rawalakot Campus is also severely damaged and declared **dangerous**.

AJK University Auditorium



Rizwan Public High School



Tourist Inn Hotel & restaurant



WEL COME

TOURIST
INN

HOTEL & Rst
KAWAI & SHOGRAN

TOURIST INFORMATION
CENTRE

کافان منزل شو

Sangam Hotel





Central Bus Stand



Rupture on the Highway

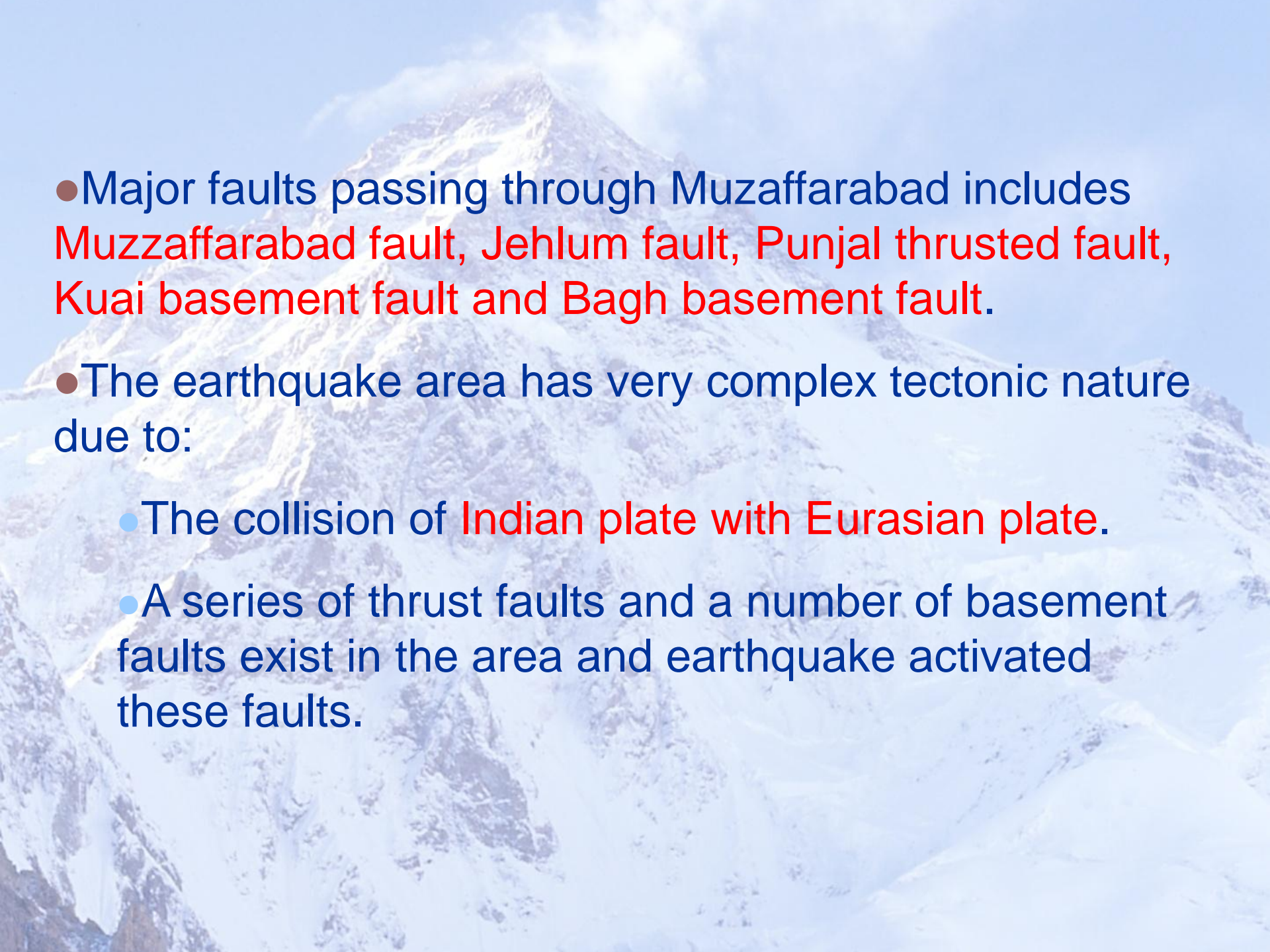


A bridge on the highway



Damages in Muzaffarabad City



- 
- Major faults passing through Muzaffarabad includes **Muzaffarabad fault, Jehlum fault, Punjal thrust fault, Kuai basement fault and Bagh basement fault.**
 - The earthquake area has very complex tectonic nature due to:
 - The collision of **Indian plate with Eurasian plate.**
 - A series of thrust faults and a number of basement faults exist in the area and earthquake activated these faults.

Fault Line passing through the Muzaffarabad



An aerial photograph of a mountain range. The mountains are characterized by steep, light-colored (tan or yellowish) rocky slopes. There are patches of green vegetation, including trees and shrubs, scattered across the slopes and along the ridges. The sky is a pale, hazy blue. The overall scene depicts a rugged, mountainous landscape.

Digital Cartography

of Kashmir & Surroundings Area

Level 1: Regional Cart. of Kashmir, NWFP & Punjab

- Provincial and Districts boundaries
- Major Cities and Towns
- Major Landmarks
- Roads, Motorways and Railways
- Rivers and its Tributaries
- Dams

Level 2: Detailed Cartography of Kashmir area

- Districts Boundaries
- Major Cities, Towns and villages
- Major Landmarks
- Major Roads
- Rivers, Kathas/Nallas and its Tributaries

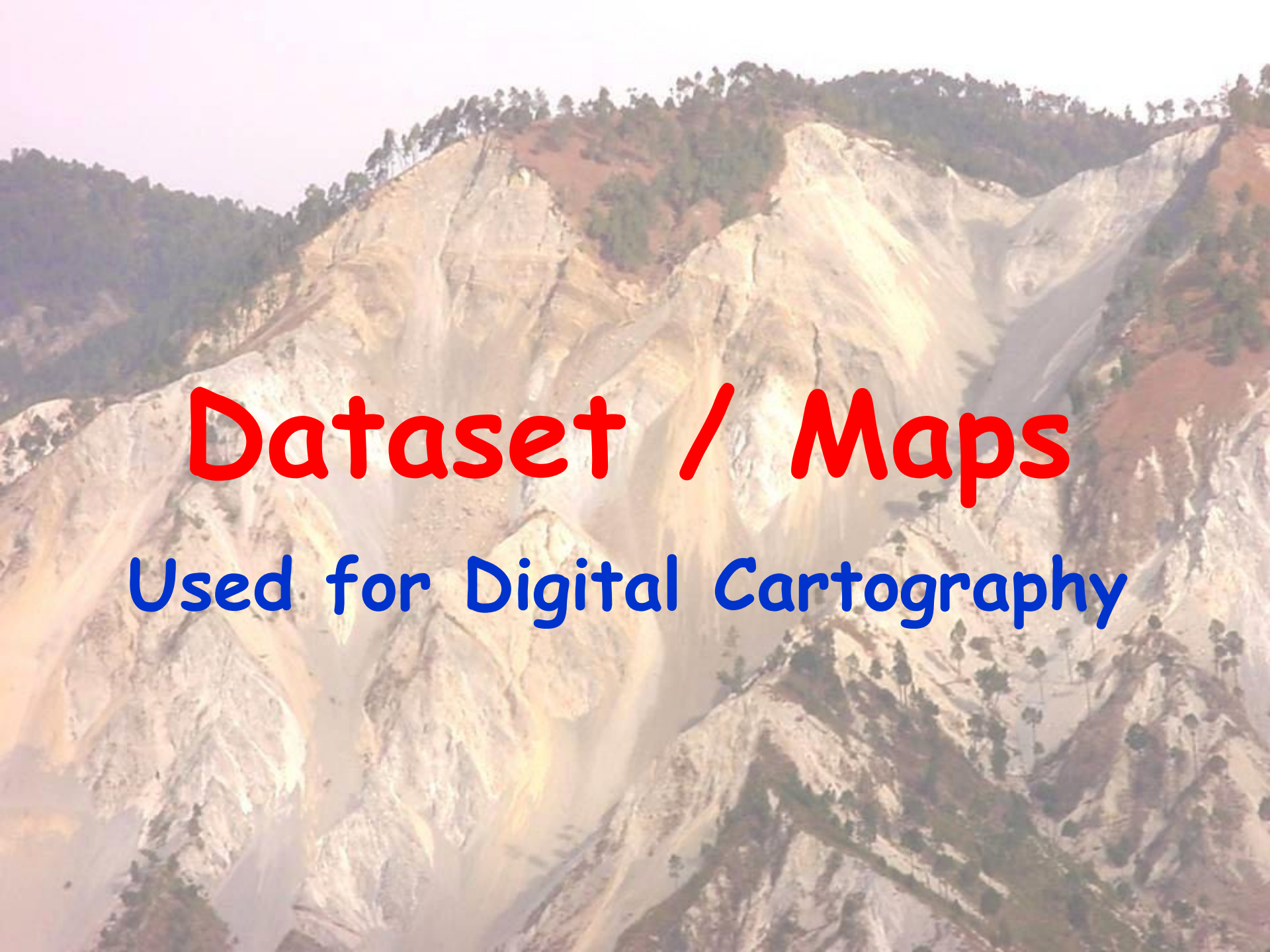
An aerial photograph of a mountainous region. A large, light blue shaded area on a steep slope indicates a landslide. The surrounding terrain is rugged and rocky, with some sparse vegetation and trees. The sky is clear and light-colored.

Level 3: Landslides Mapping & Cataloguing

- Landslides perimeter
- Graphic direction of Landslides
- Landslides Hazard
- Analysis of the risk

Level 4: Seismological Cataloguing & Hazards

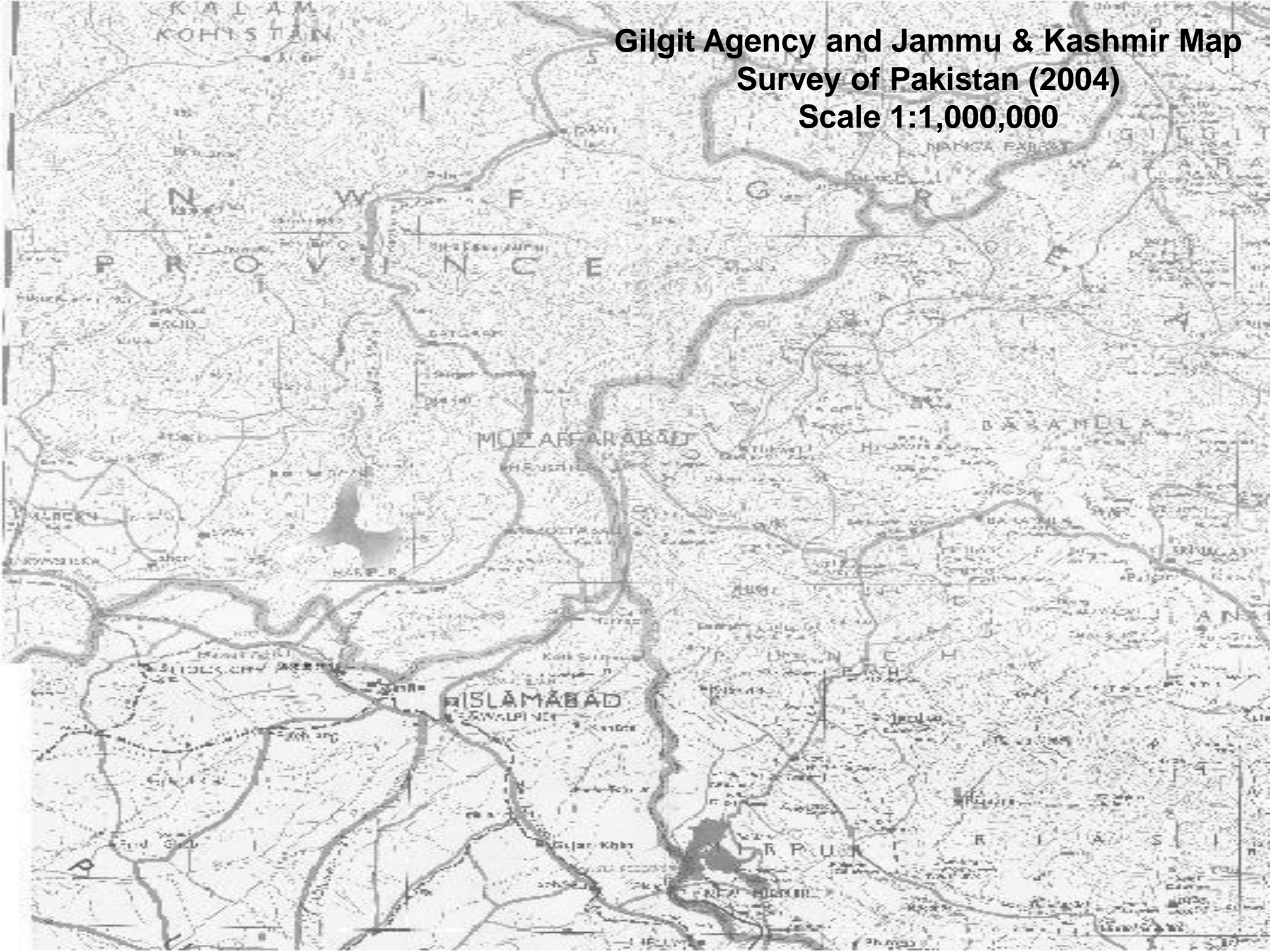
- Epicenter of main event
- Aftershocks
- Damages related to the E/Q
- Major Fault lines
- General and Local Geology
- Seismological Hazard

An aerial photograph of a mountain range. The mountains are characterized by steep, light-colored (tan or yellowish) rocky slopes with visible vertical erosion patterns. The peaks and upper ridges are covered with dense, dark green coniferous forests. The sky is a pale, hazy blue. The overall scene is rugged and mountainous.

Dataset / Maps

Used for Digital Cartography

**Gilgit Agency and Jammu & Kashmir Map
Survey of Pakistan (2004)
Scale 1:1,000,000**



Topsheet No. 43-F/7
Survey of Pakistan
Scale 1:50,000



Topsheet No. 43-F/8
Survey of Pakistan
Scale 1:50,000



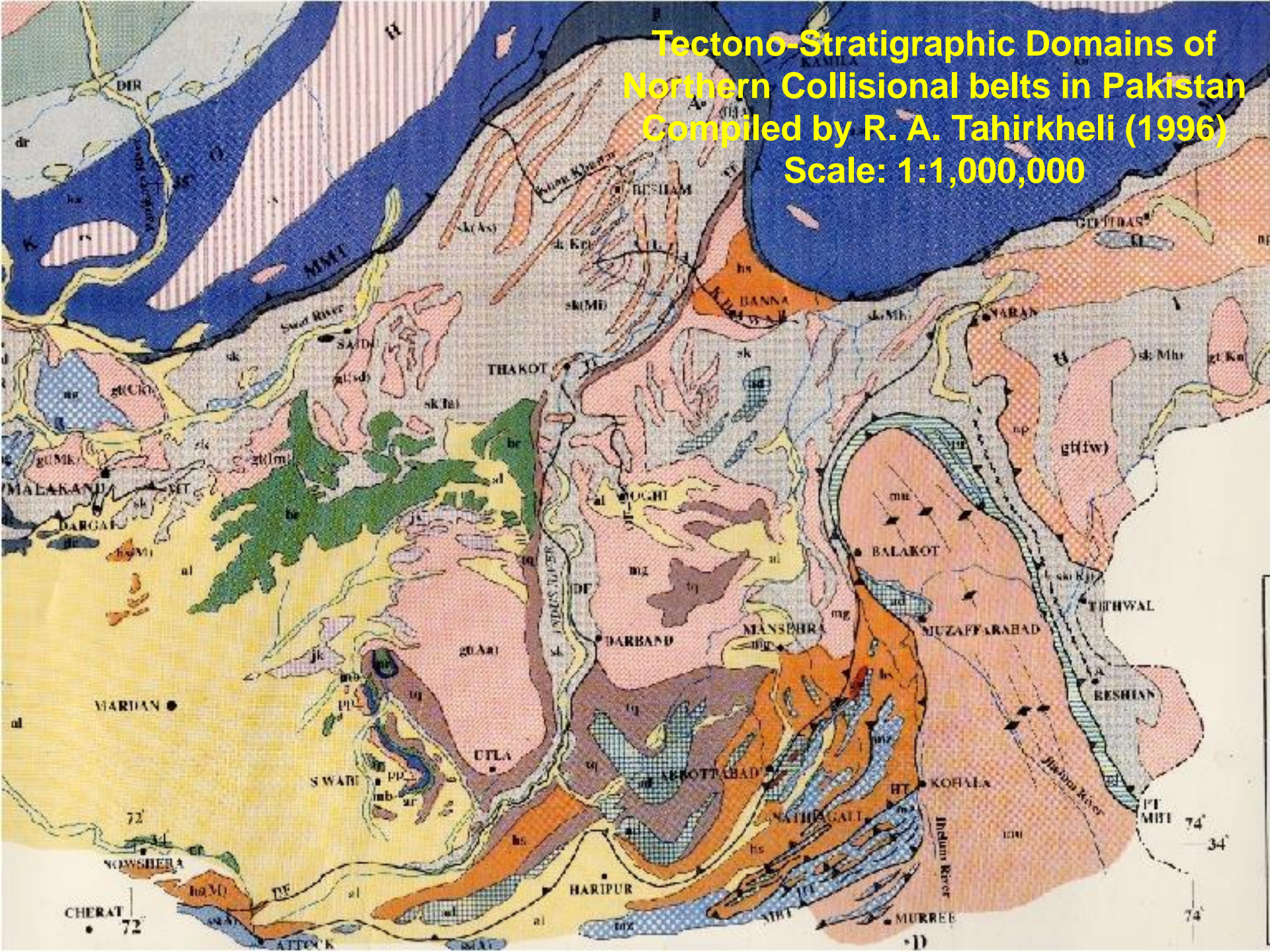
Topsheet No. 43-F/11
Survey of Pakistan
Scale 1:50,000



Topsheet No. 43-F/12
Survey of Pakistan
Scale 1:50,000

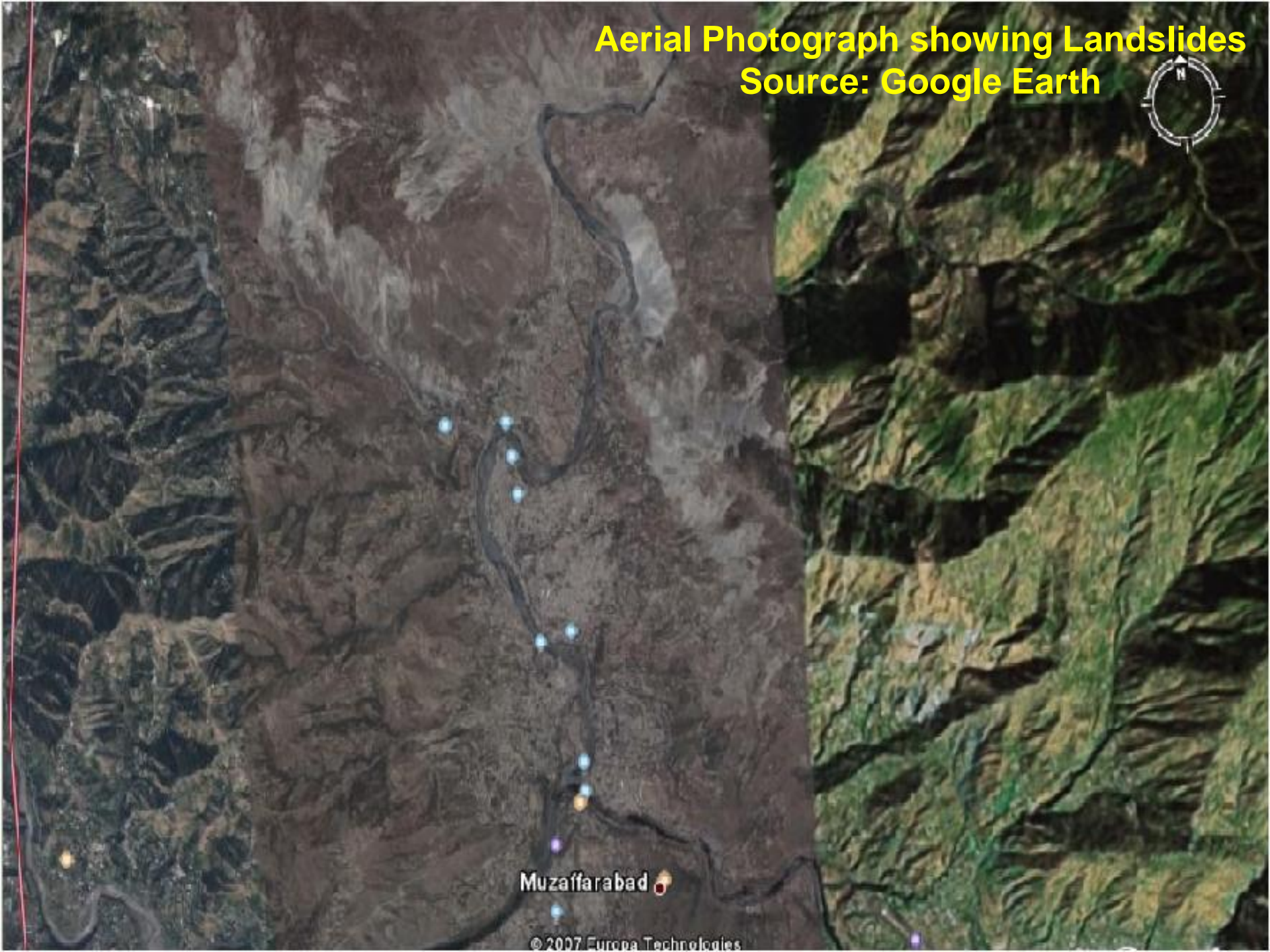


Tectono-Stratigraphic Domains of Northern Collisional belts in Pakistan
Compiled by R. A. Tahirkheli (1996)
Scale: 1:1,000,000



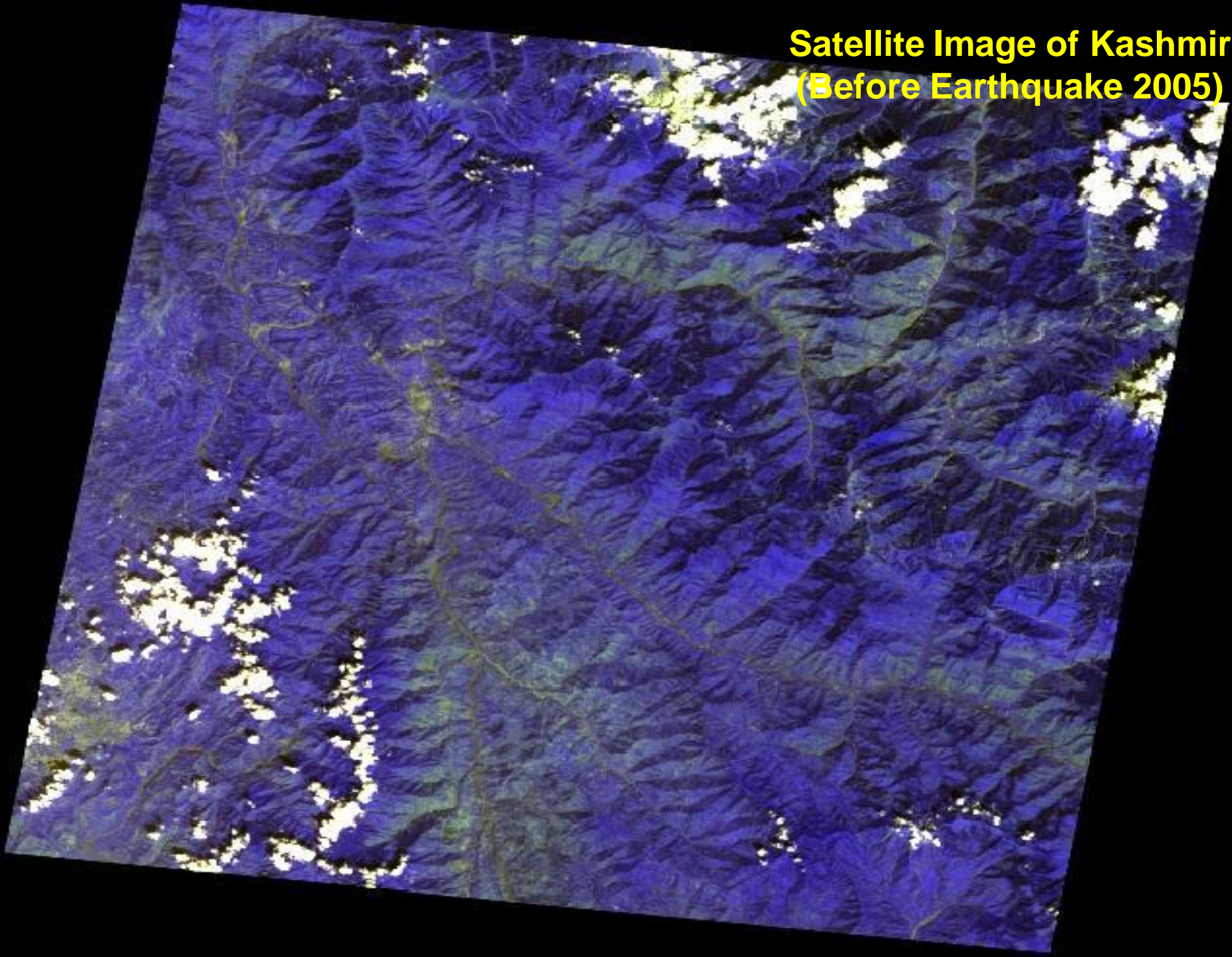
Aerial Photograph showing Landslides

Source: Google Earth

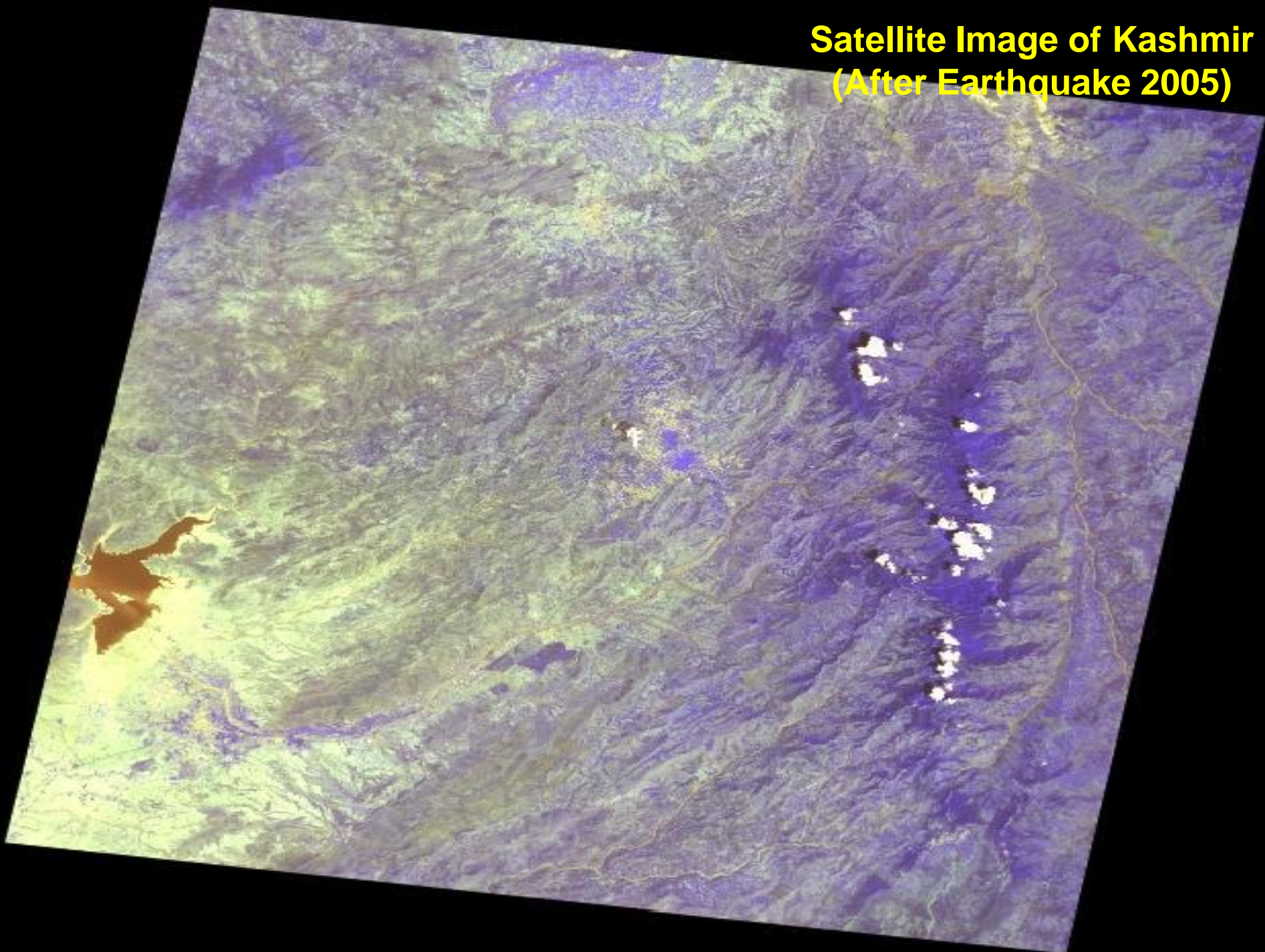


Muzaifdarabad

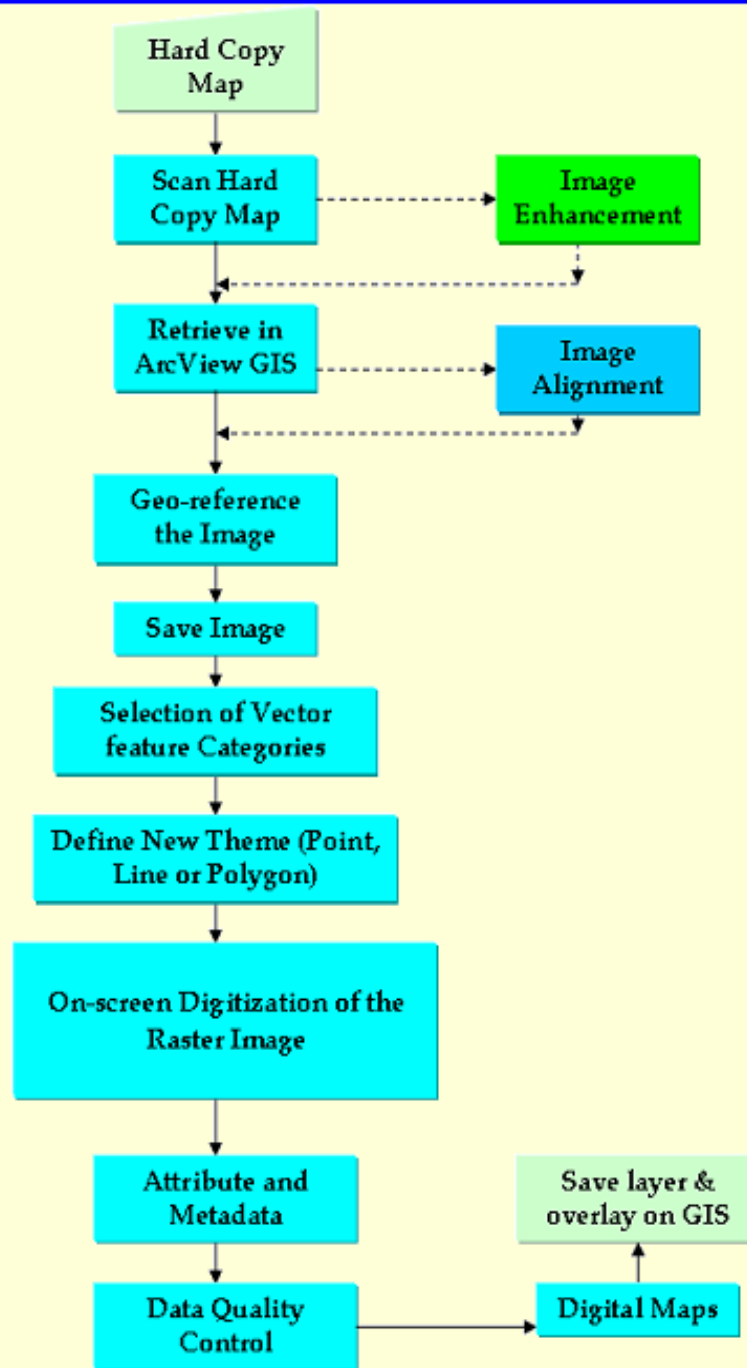
**Satellite Image of Kashmir
(Before Earthquake 2005)**



**Satellite Image of Kashmir
(After Earthquake 2005)**



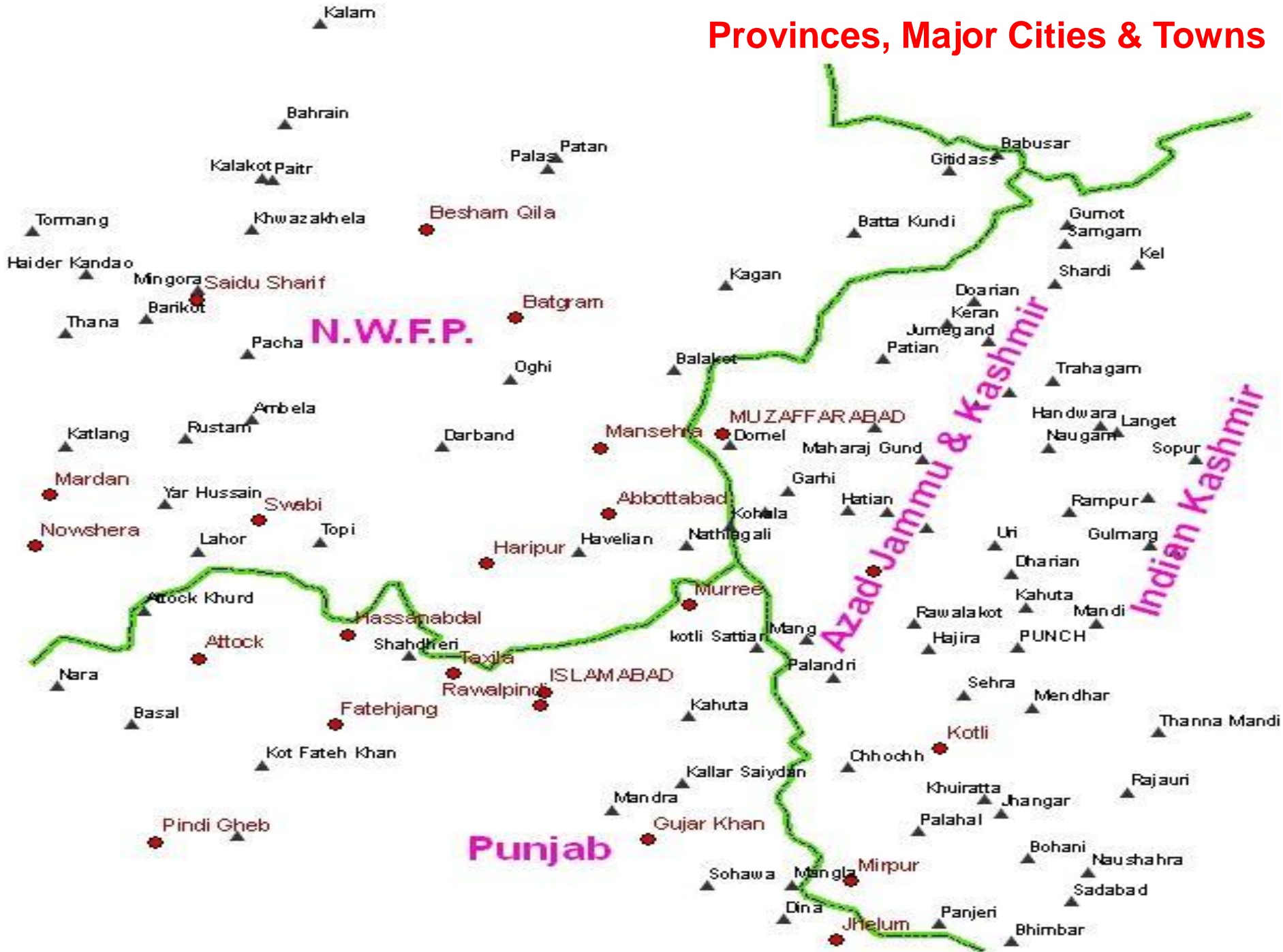
Workflows / Methodology Adopted



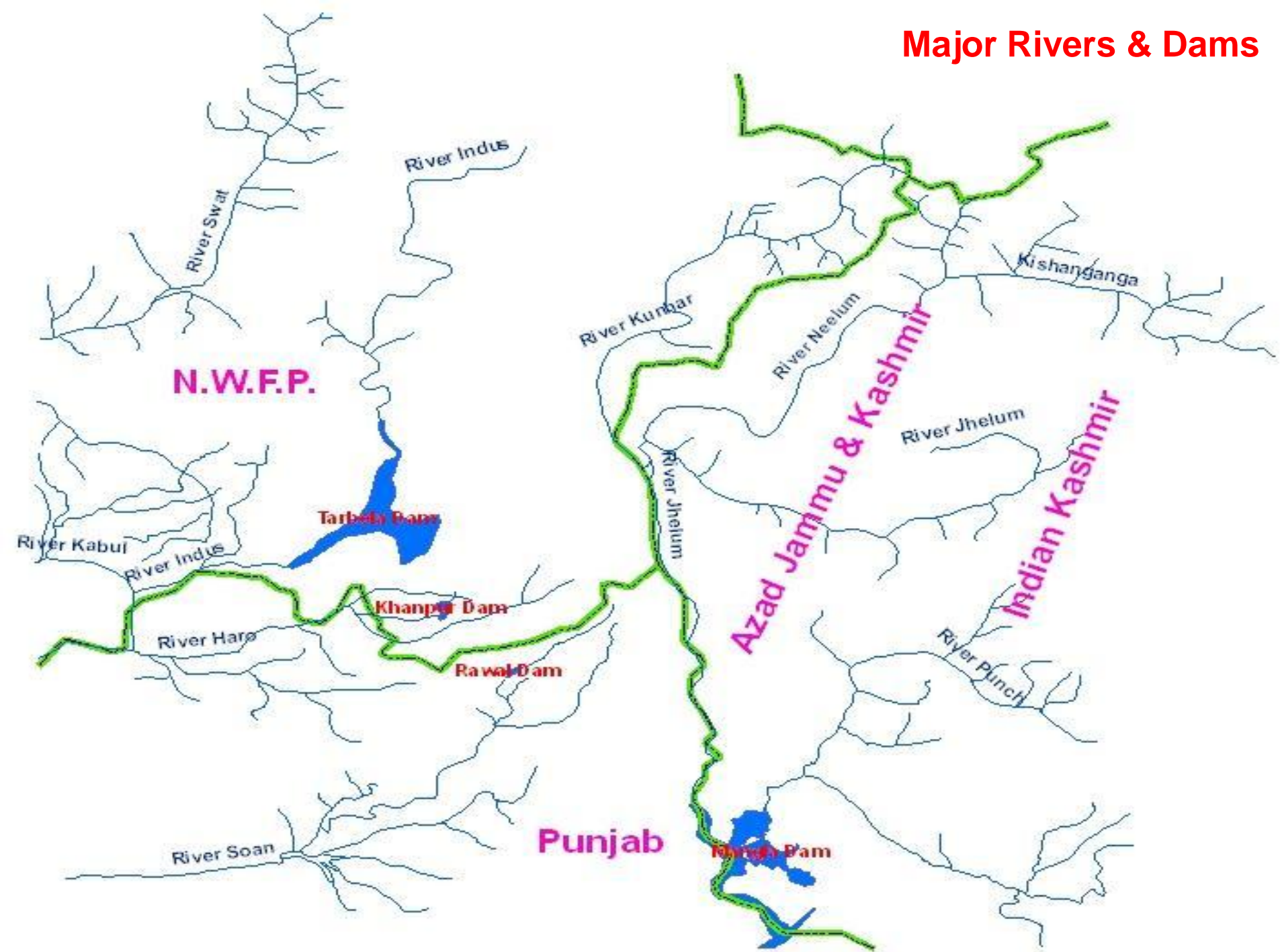
Level 1

Regional Cartography of Kashmir, NWFP & Punjab

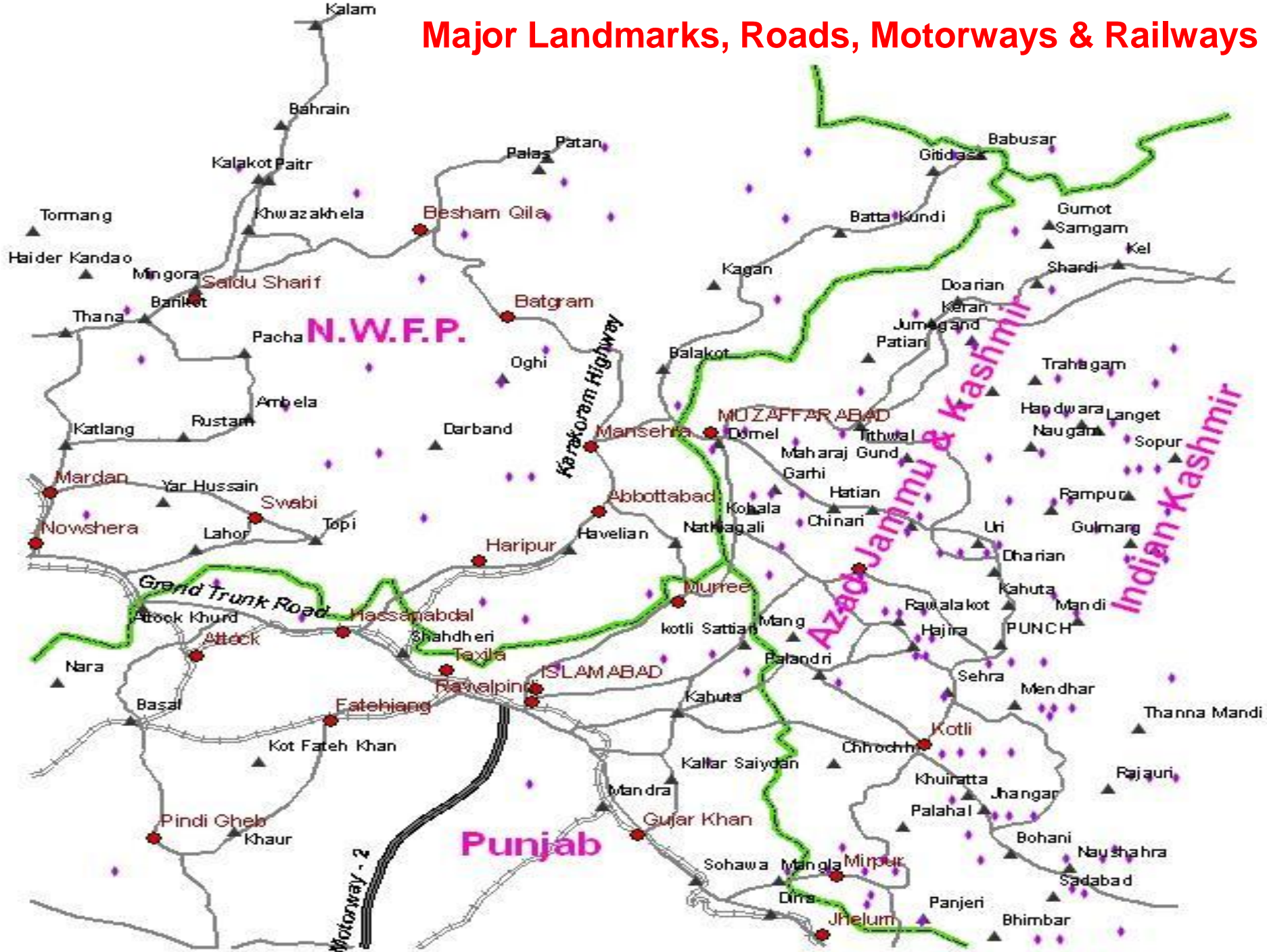
Provinces, Major Cities & Towns



Major Rivers & Dams



Major Landmarks, Roads, Motorways & Railways



E/Q 2005 Main Event & same day Aftershocks

Layers: <Top-most layer>

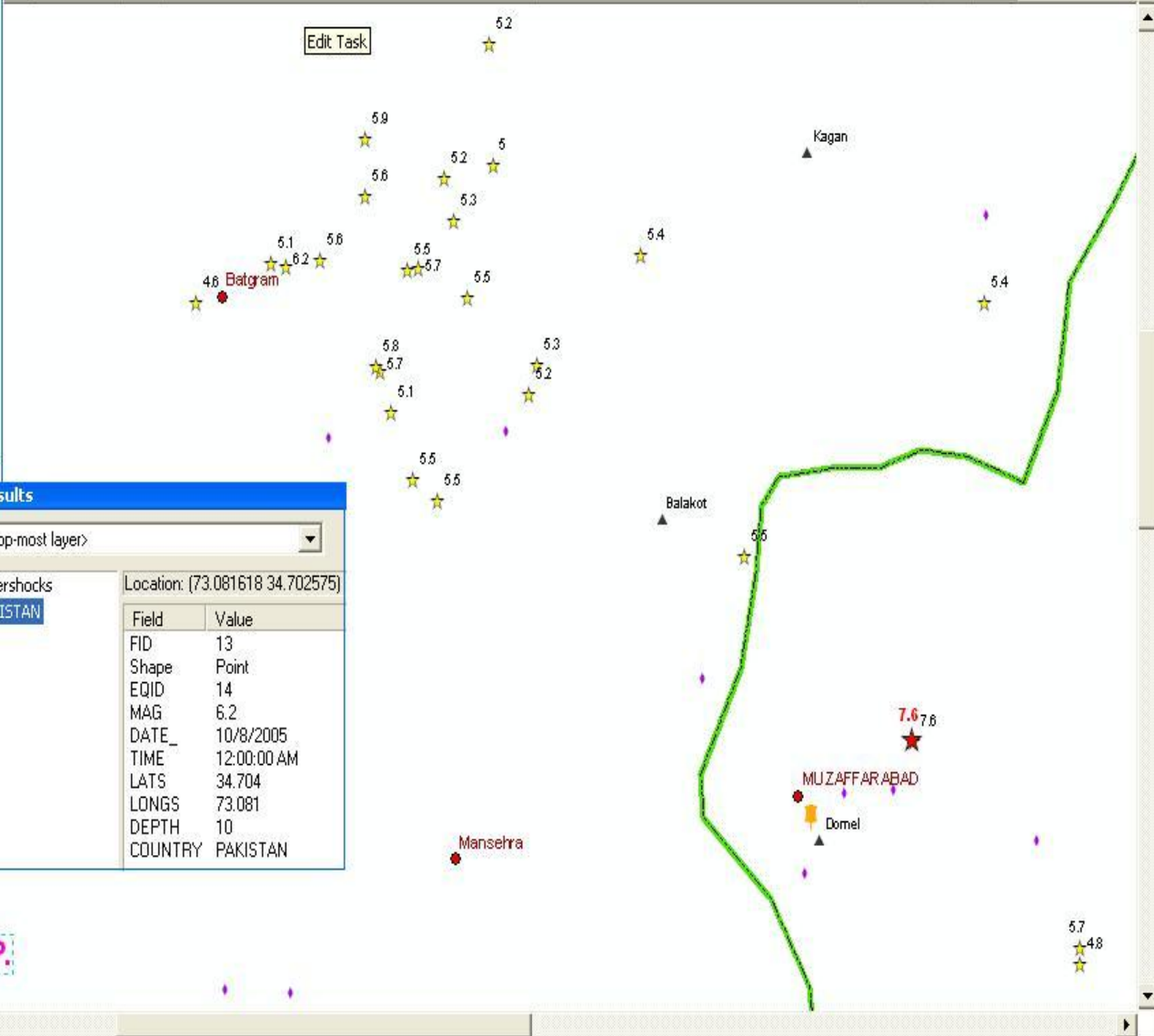
Epicenter2005

Location: (73.561660 34.401637)

Field	Value
FID	0
Shape	Point
Id	1
Location	Muzaffarabad
Longitude	73.560
Latitude	34.402
Day	Saturday
EQ_Date	8/10/2005
Time	08:52 AM
Magnitude	7.6
Intensity	11
Depth_KM	33
Hypo_KM	26
EQ_Type	Major
LOCMZDKM	19
LOCISBKM	100
AFSHK80	147
MAX_ARSHK	6.2
MIN_ARSHK	5.2
Count_Aft	Pakistan, India, Afghanistan
Remarks	Kashmir Earthquake, South Asia Earthquake, Great Pakistan Earthquake
Casualty	90,000
Injured	1,00,000
Homeless	2 Million

7.6

Editor Task: Create New Feature Target:



Legend:

- Pol_Boundaries
- Kashmir_Districts
 - District
 - Bagh
 - Bhimber
 - Kotli
 - Mirpur
 - Muzaffarabad
 - Neelum
 - Poonch
 - Sudhnoti
- Dams

Identify Results

Layers: <Top-most layer>

EQ_Aftershocks

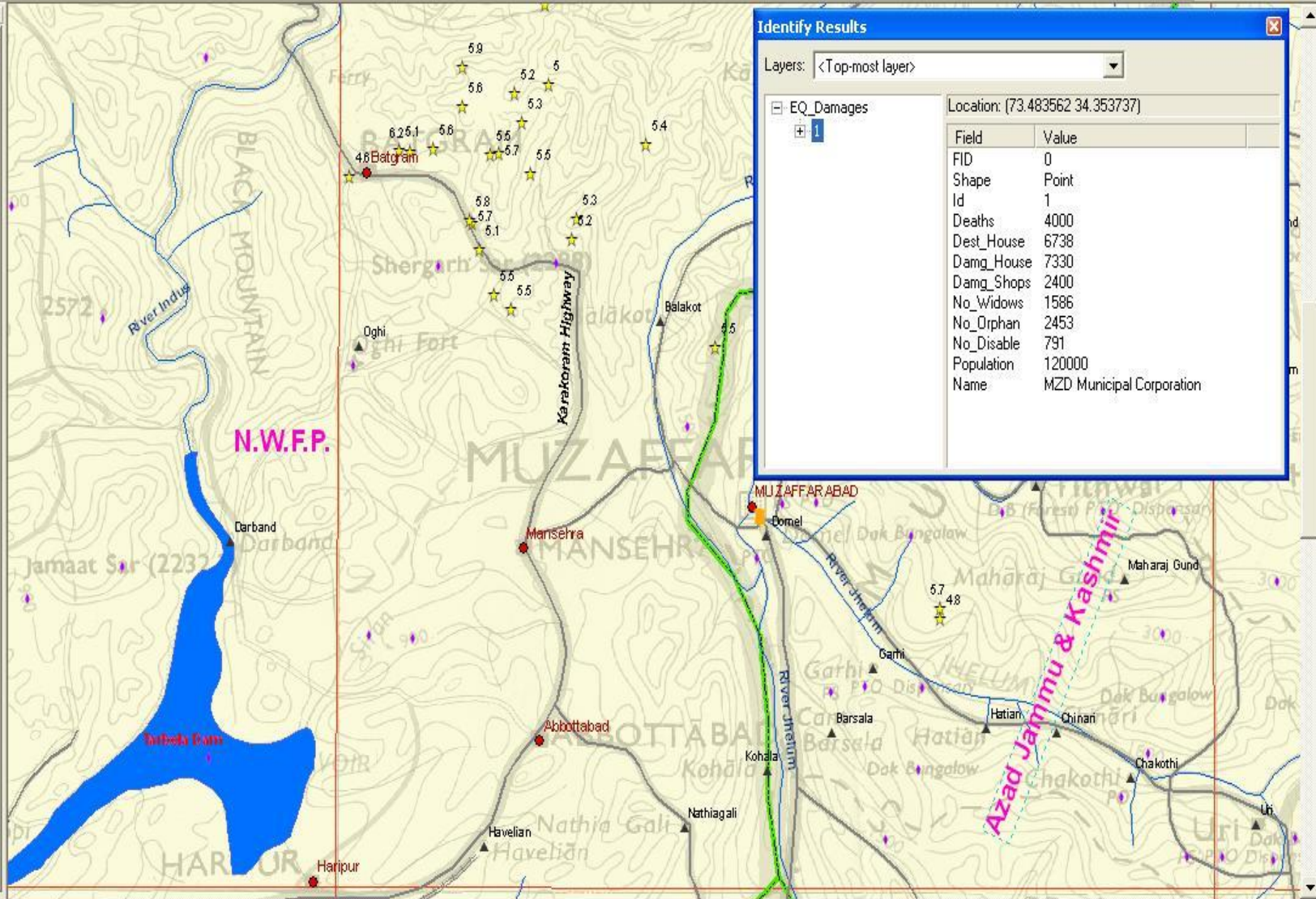
PAKISTAN

Location: (73.081618 34.702575)

Field	Value
FID	13
Shape	Point
EQID	14
MAG	6.2
DATE_	10/8/2005
TIME	12:00:00 AM
LATS	34.704
LONGS	73.081
DEPTH	10
COUNTRY	PAKISTAN

N.W.F.P.

- Major Landmarks
- Major Towns
- Major Cities
- Roads
- Motorway
- Railways
- Rivers
- Pol_Boundaries
- Kashmir_Districts
 - District
 - Bagh
 - Bhimber
 - Kotli
 - Mirpur
 - Muzaffarabad
 - Neelum
 - Poonch
 - Sudhnoti
- Dams
- Grid Lines
- AOI
- kashmir1_2_georef_c



Identify Results

Layers: <Top-most layer>

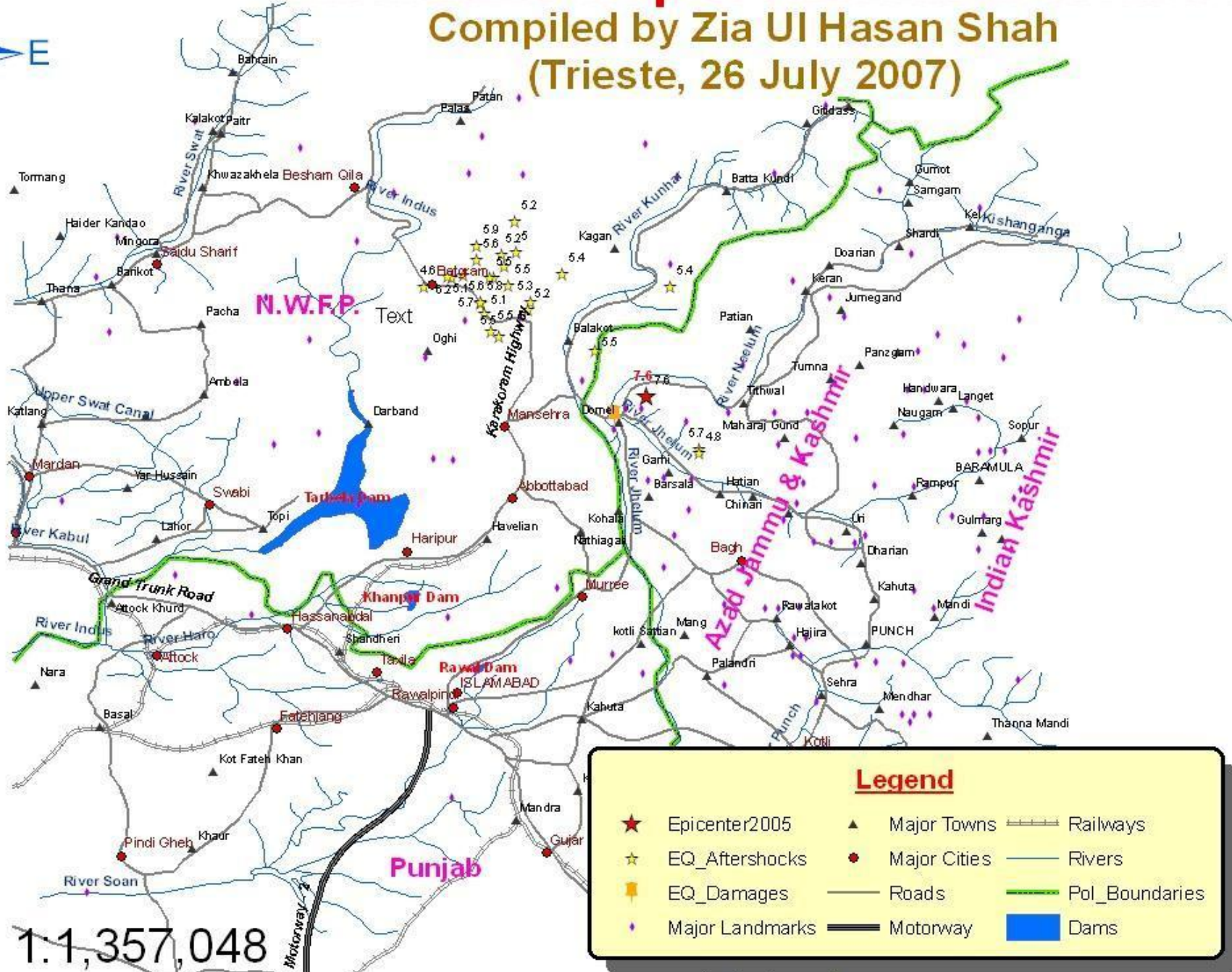
EQ_Damages

Location: (73.483562 34.353737)

Field	Value
FID	0
Shape	Point
Id	1
Deaths	4000
Dest_House	6738
Damg_House	7330
Damg_Shops	2400
No_Widows	1586
No_Orphan	2453
No_Disable	791
Population	120000
Name	MZD Municipal Corporation

Generalized Map of Kashmir & N.W.F.P.

Compiled by Zia Ul Hasan Shah
(Trieste, 26 July 2007)



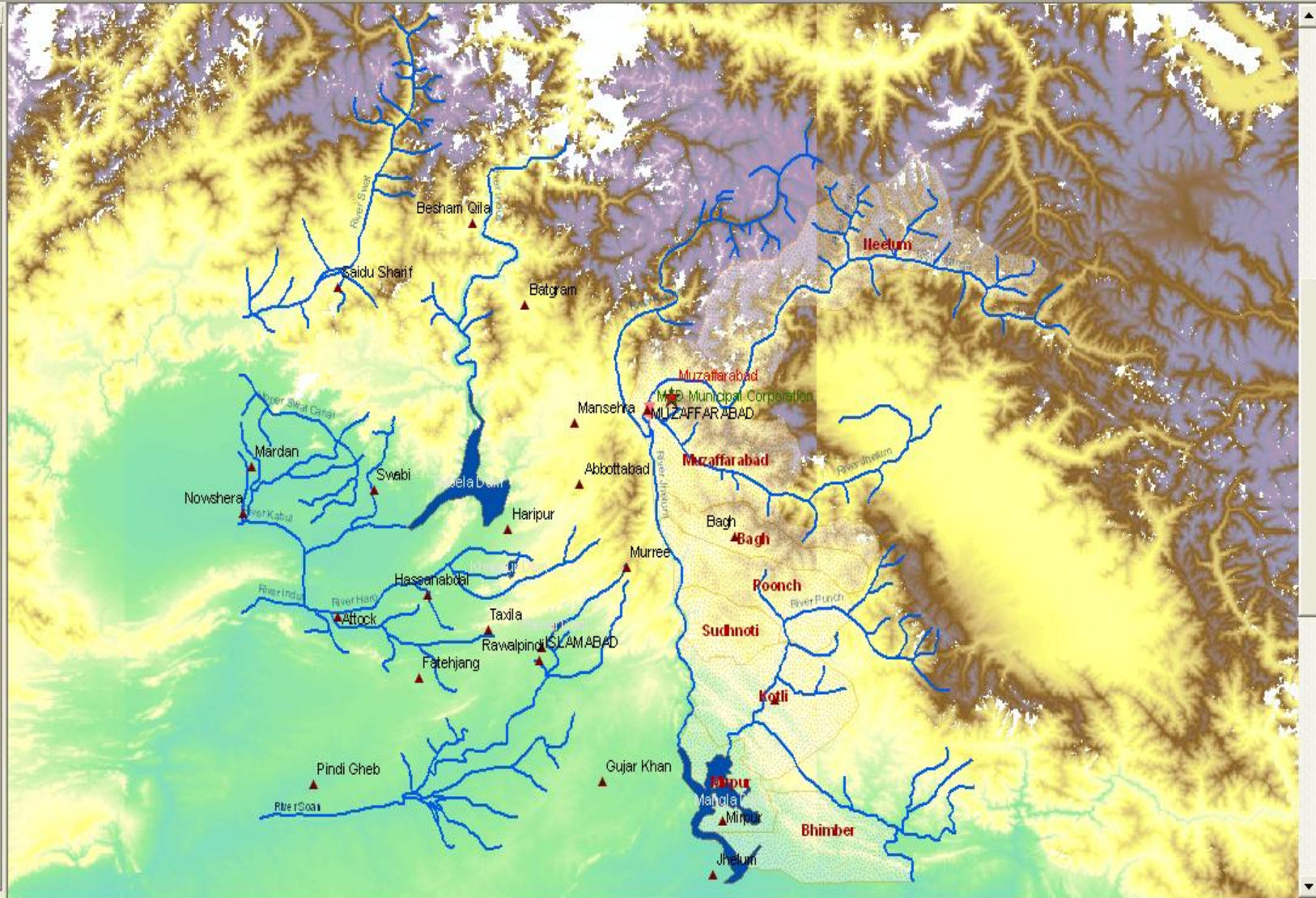
Scale: 1:1,357,048

1:1,841,775

Georeferencing Layer Editor Task: Create New Feature Target:

Layers

- Major Cities
- Epicenter2005
- EQ_Damages
- Rivers
- Dams
- Kashmir_Districts
- 30133059
Value
High : 5916
Low : 118
- 12111190
Value
High : 7025
Low : 126
- 11298966
Value
High : 7770
Low : 150



An aerial photograph of a mountain range. The mountains are light-colored, possibly limestone or sandstone, with visible vertical erosion patterns. A river valley runs through the center, with a river winding through it. The surrounding slopes are covered with sparse vegetation, including trees and shrubs. The sky is clear and light blue.

Level 2

Detailed Cartography of Kashmir

Districts of Kashmir

File Edit View Insert Selection Tools Window Help

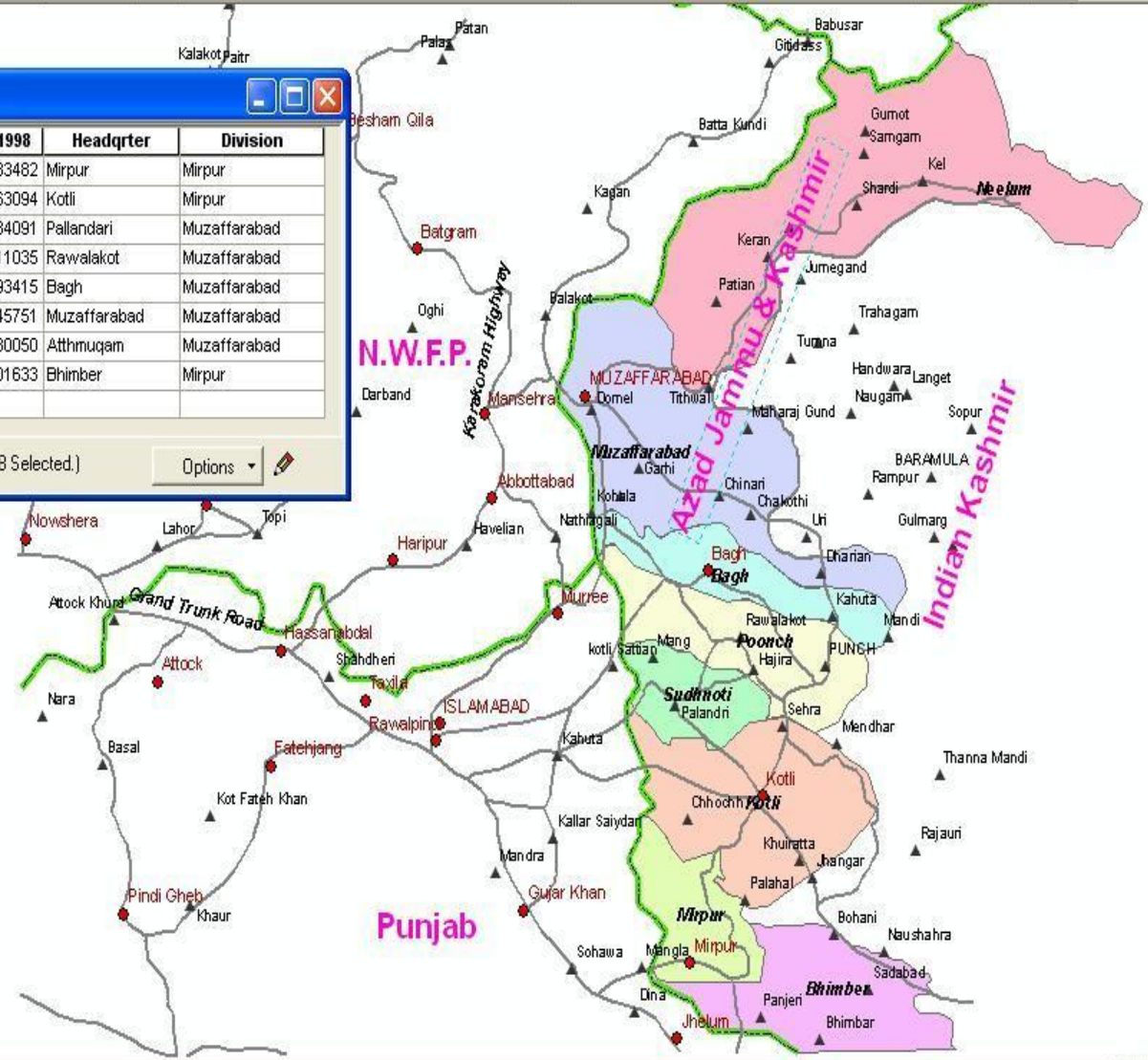
Georeferencing Layer: kashmir1_2_georef_gllimg Editor Task: Create New Feature Target: Kashmir_Districts

Attributes of Kashmir_Districts

FID	Shape*	Id	District	Area_sqKM	POP_1998	Headqrter	Division
0	Polygon	1	Mirpur	1010	333482	Mirpur	Mirpur
1	Polygon	2	Kotli	1862	563094	Kotli	Mirpur
2	Polygon	3	Sudhnoti	569	334091	Pallandari	Muzaffarabad
3	Polygon	4	Poonch	855	411035	Rawalakot	Muzaffarabad
4	Polygon	5	Bagh	1368	393415	Bagh	Muzaffarabad
5	Polygon	6	Muzaffarabad	2496	745751	Muzaffarabad	Muzaffarabad
6	Polygon	7	Neelum	3621	280050	Atthmuqam	Muzaffarabad
7	Polygon	8	Bhimber	1516	301633	Bhimber	Mirpur

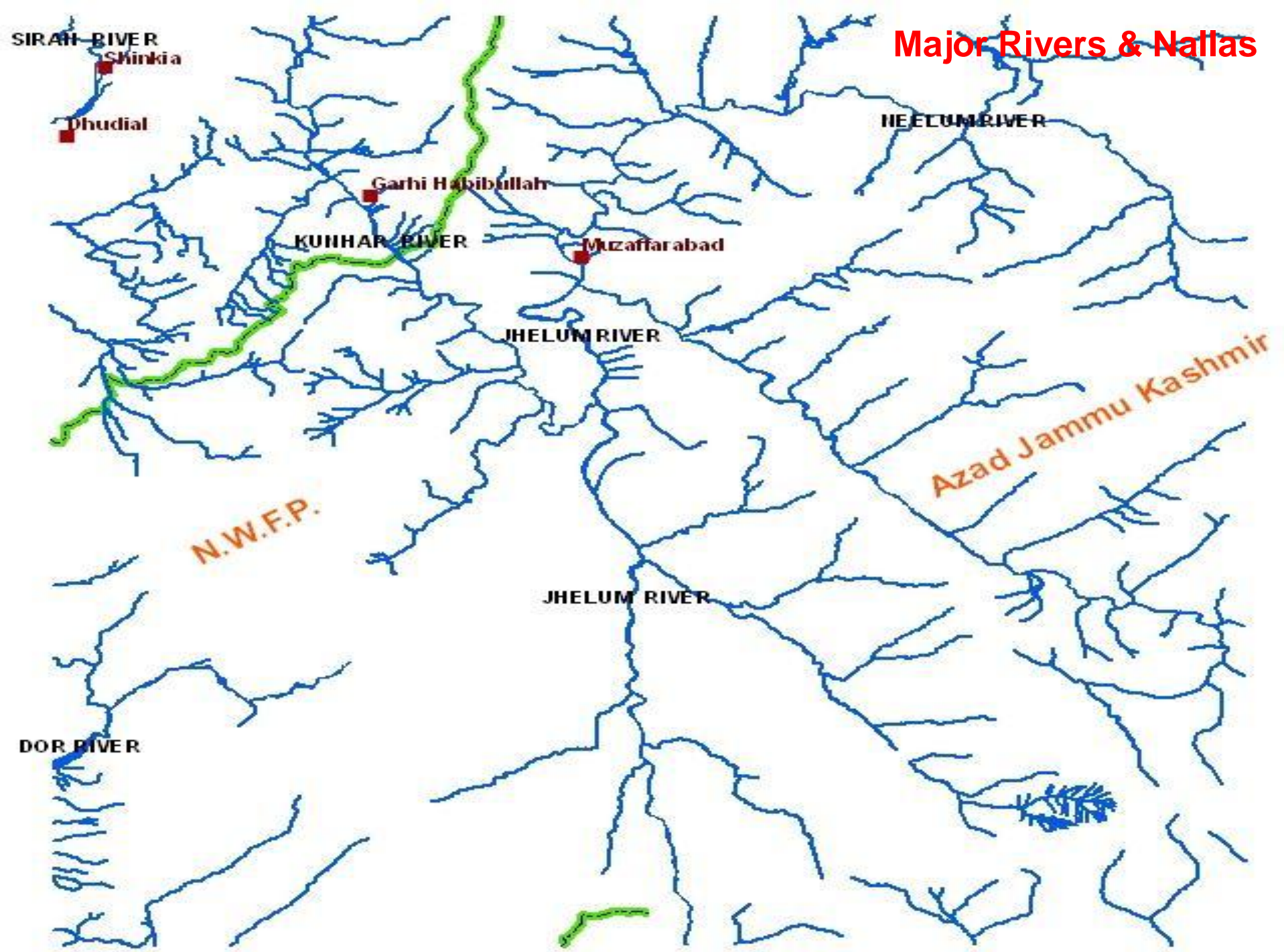
Record: 1 Show: All Selected Records (0 out of 8 Selected.)

- Railways
- Rivers
- Pol_Boundaries
- Kashmir_Districts
 - District
 - Bagh
 - Bhimber
 - Kotli
 - Mirpur
 - Muzaffarabad
 - Neelum
 - Poonch
 - Sudhnoti
- Dams

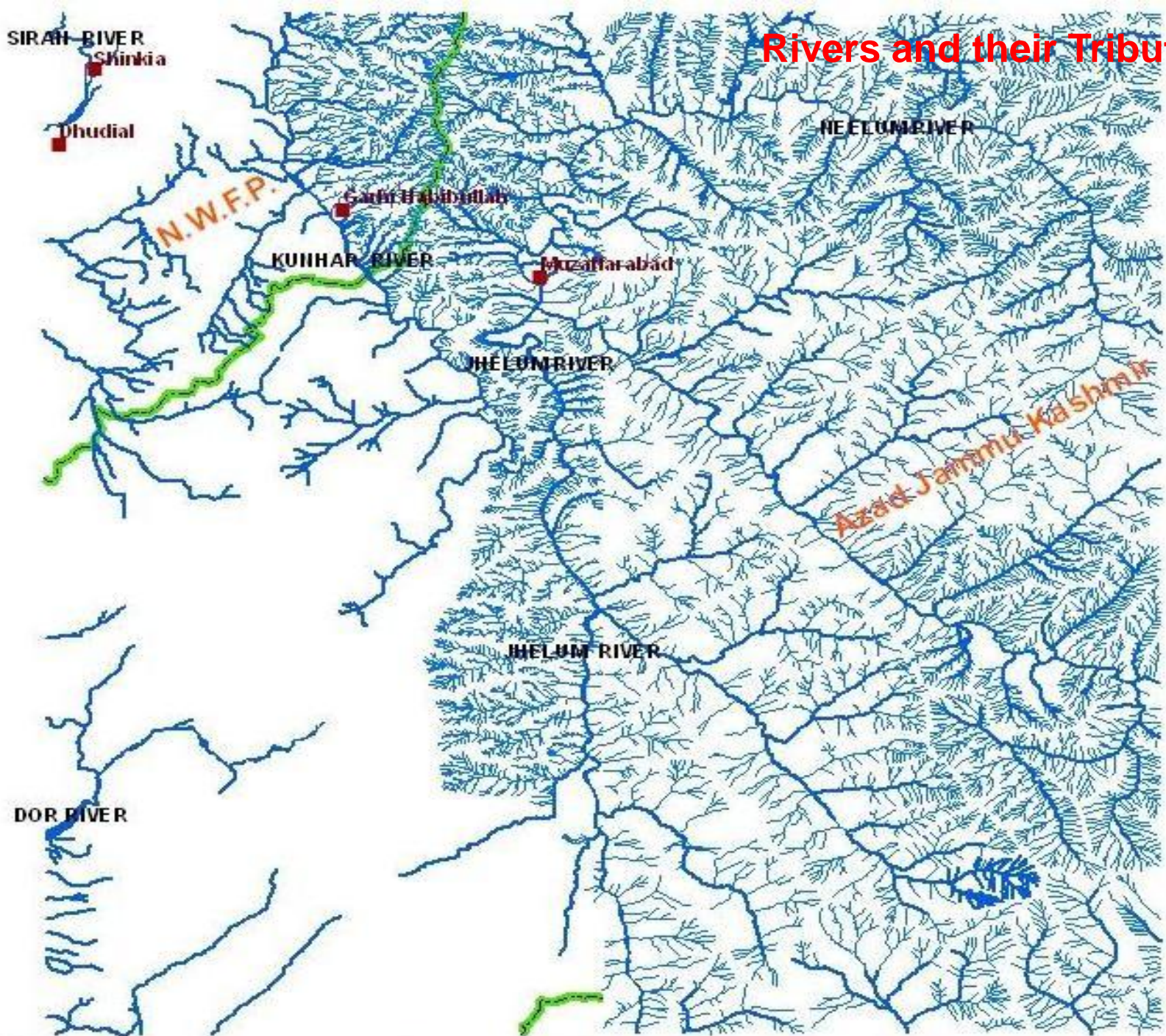


Drawing Tools: Arrow, Eraser, Text, Line, Polygon, etc. Scale: 16. Font: Arial.

Major Rivers & Nallas



Rivers and their Tributaries



Major places around Muzaffarabad

Layers

- Landslides_CAT
- Major Places
- Major Cities
- Major Villages
- LS_Direction
- LS_Risk
- Major Roads
- Tributaries
- Kathas
- LS_Hazard
- Landslides
- Rivers
- Boundary
- Kashmir_SatImg.tif
 - RGB
 - Red: Band_1
 - Green: Band_2
 - Blue: Band_3
- 43f7_georef_33.img
 - RGB
 - Red: RedBand

Display Source Selection

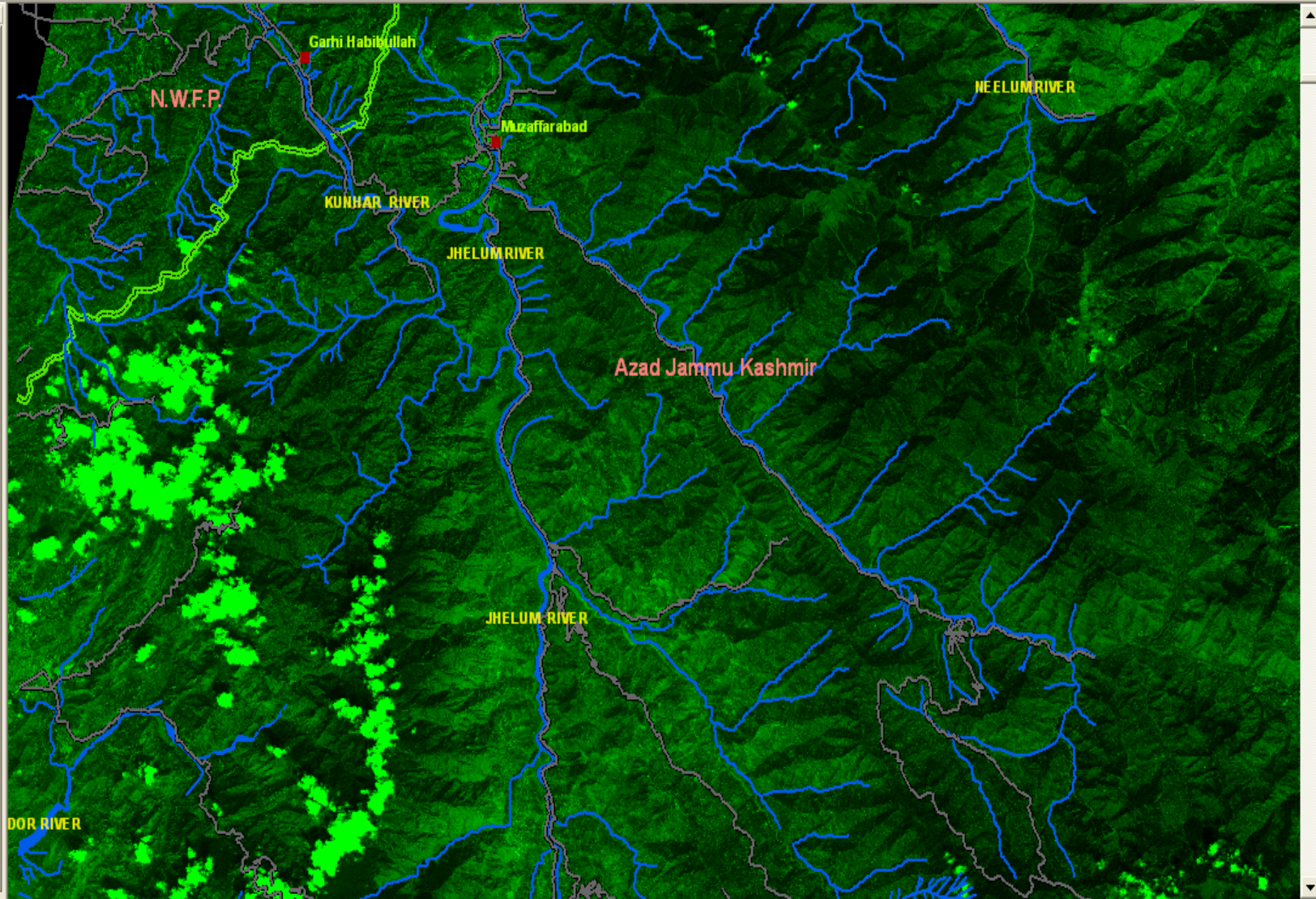


Raster and Vector overlay

Layers

- Landslides_CAT
- Major Places
 - Major Cities
 - Major Villages
- LS_Direction
- LS_Risk
- Major Roads
- Tributries
- Kathas
- LS_Hazard
- Landslides
- Rivers
- Boundary
- beforeeq_utm42.img
 - RGB
 - Red: NONE
 - Green: ASTER_Be
 - Blue: NONE
- Kashmir_Satimg.tif
 - RGB
 - Red: Band_1

Display Source Selection

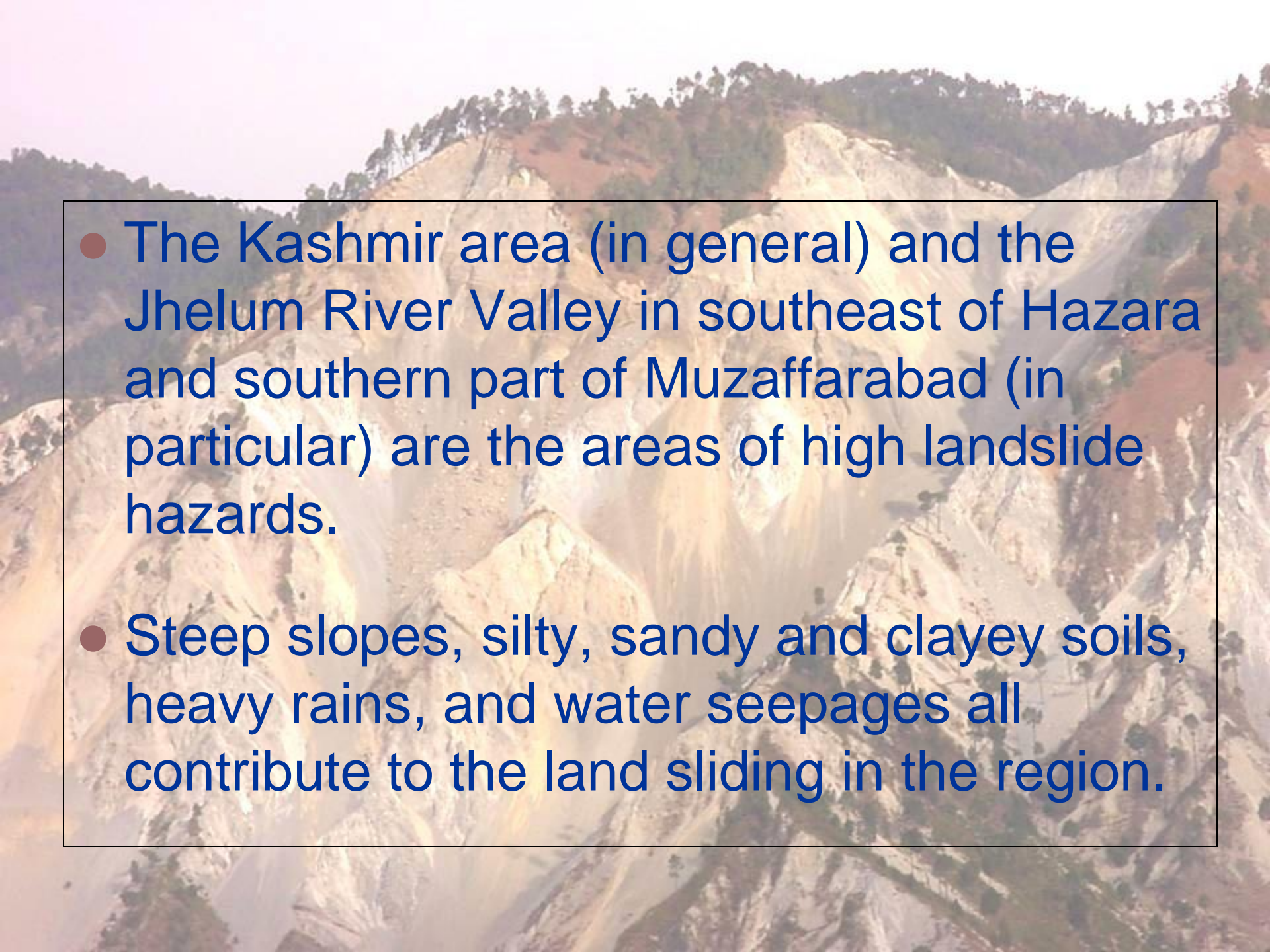


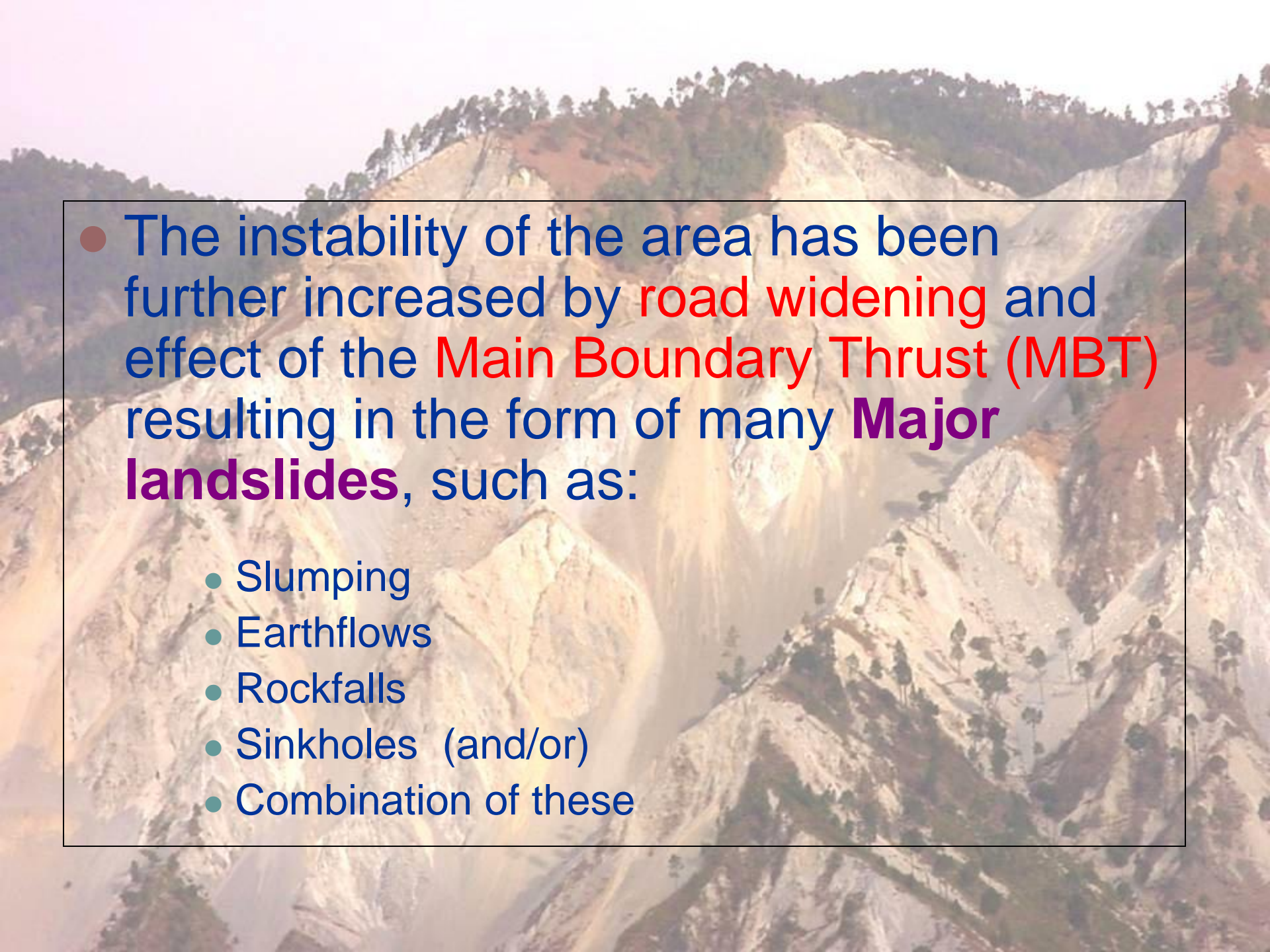
An aerial photograph of a mountain slope showing a large, light-colored landslide scar. The scar is a prominent feature, running down the center of the slope. The surrounding areas are covered in dense green forest. The sky is clear and blue.

Level 3

Landslides

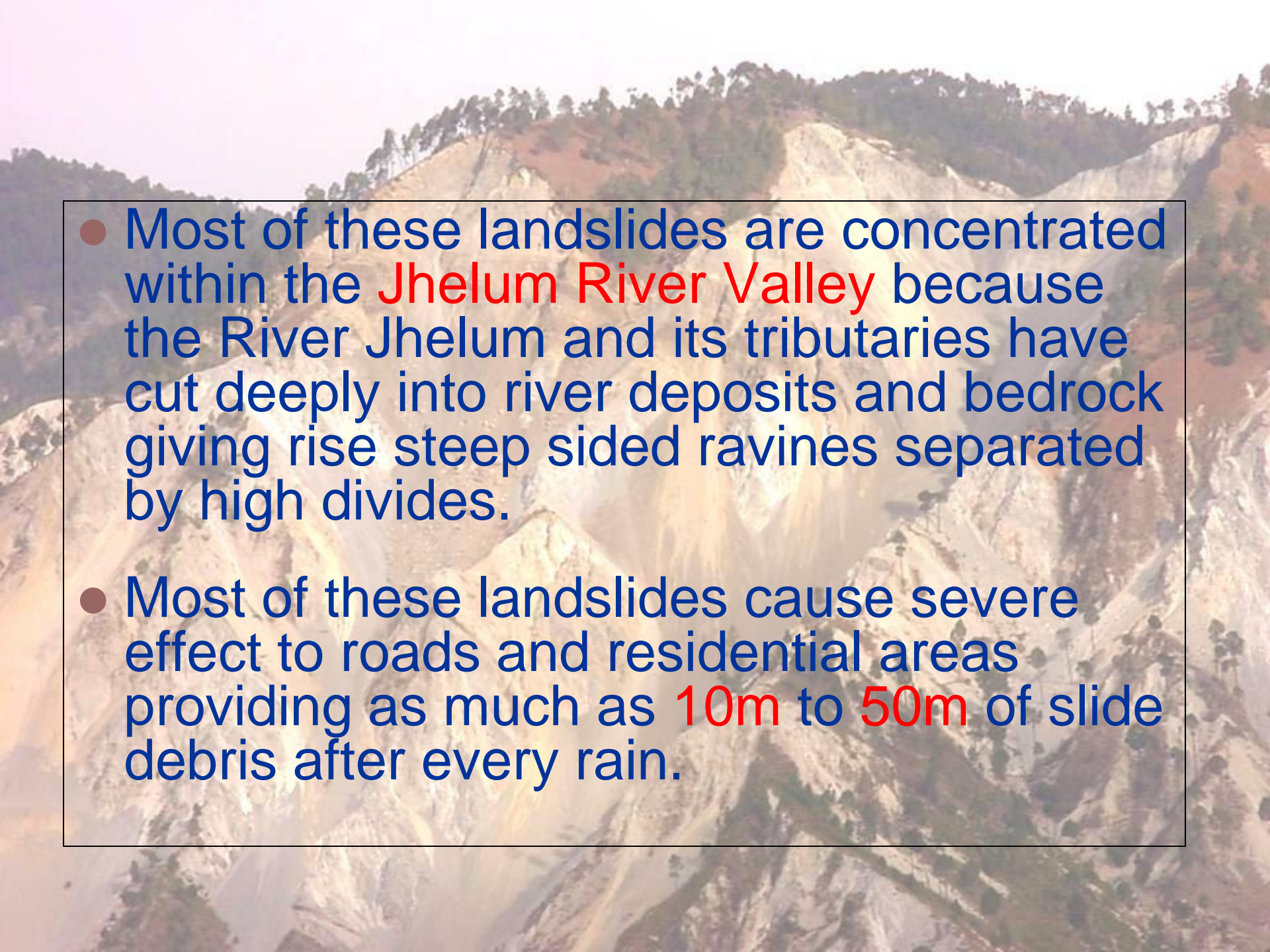
Mapping & Cataloguing

- 
- An aerial photograph of a mountainous region, likely in the Himalayas, showing steep slopes and a river valley. The terrain is rugged and appears to be composed of light-colored rock or soil. The river valley is visible in the lower part of the image, and the surrounding slopes are densely forested. The overall scene suggests a high-risk area for landslides.
- The Kashmir area (in general) and the Jhelum River Valley in southeast of Hazara and southern part of Muzaffarabad (in particular) are the areas of high landslide hazards.
 - Steep slopes, silty, sandy and clayey soils, heavy rains, and water seepages all contribute to the land sliding in the region.

An aerial photograph of a mountainous region. A road winds through a valley, and a river flows through it. The surrounding hillsides are steep and appear to be composed of light-colored rock or soil, with some sparse vegetation. The overall scene suggests a geologically active area with potential for landslides.

● The instability of the area has been further increased by **road widening** and effect of the **Main Boundary Thrust (MBT)** resulting in the form of many **Major landslides**, such as:

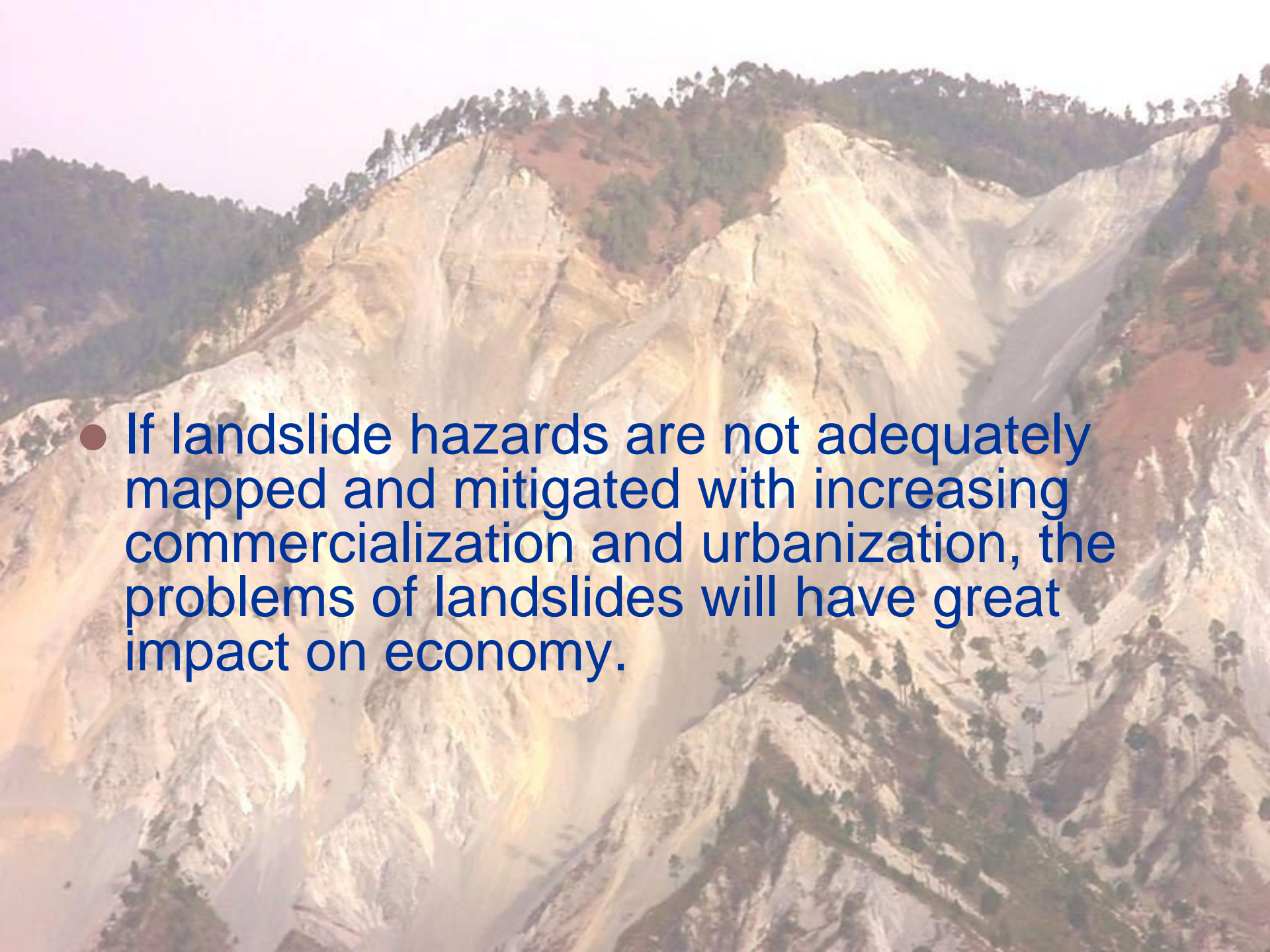
- Slumping
- Earthflows
- Rockfalls
- Sinkholes (and/or)
- Combination of these

- 
- An aerial photograph of a mountainous region, likely the Jhelum River Valley. The terrain is characterized by steep, eroded slopes with visible gullies and ravines. The river valley is prominent, showing a winding path through the landscape. The overall scene depicts a rugged and potentially landslide-prone environment.
- Most of these landslides are concentrated within the **Jhelum River Valley** because the River Jhelum and its tributaries have cut deeply into river deposits and bedrock giving rise steep sided ravines separated by high divides.
 - Most of these landslides cause severe effect to roads and residential areas providing as much as **10m to 50m** of slide debris after every rain.



Most of the landslide hazards were found in **Murree formation** in the MBT zone. This zone mainly consists of reddish brown Murree clays, highly fractured Murree sandstones, silty and sandy clays and claystones.

On top of it, **earthquake** of 08 October 2005 and subsequent **heavy rainfall** triggered so many landslides in the area.

- 
- An aerial photograph of a steep, rocky mountain slope. The rock face is light-colored and shows signs of erosion and fracturing. A large, dark, irregularly shaped area on the slope indicates a landslide or a zone of instability. The top of the mountain is covered with dense green forest. The sky is clear and blue.
- If landslide hazards are not adequately mapped and mitigated with increasing commercialization and urbanization, the problems of landslides will have great impact on economy.





































PAKISTAN - Muzaffarabad district - Northern City Area

Aerial view of Muzaffarabad showing Landslides



Legend

Forest	Grassland	Debris cone
River and bridge	Settlement	Road network

Interpretation

On October 8, 2005 a series of severe earthquakes (max. magnitude 7.6) struck eastern Pakistan and western India. The epicenter was located near Muzaffarabad in the Kashmir region, about 100 kilometers northeast of Islamabad, the capital of Pakistan.

This IKONOS satellite image, acquired on October 9, 2005, displays the Muzaffarabad district affected by the earthquake. Due to missing pre-disaster very high resolution imagery, damage assessment from visual image analysis currently can not be performed to its full extent.

Scale

0 100 200 300 400 500 m

Scale: 1:7.500 for Din A1 printing

Reference coordinate system: Geographic coord. info
 Projection: UTM Zone 43 N
 Spheroid: WGS 84
 Datum: WGS 84

Data Sources

IKONOS © SPACEIMAGING 2005

SPACE IMAGING
 Visual Information. Visible Results.

With kind support of Space Imaging Middle East and European Space Imaging

Processing/Analysis

Image processing and map creation by DLR:

- Image enhancement for IKONOS
- Contour lines from SRTM X-C-band DEM
- Identification of damaged areas
- Road network derived from IKONOS data

Map created October 11, 2005 by ZKI@DLR.DE

RESPOND
 DMES Services Supporting
 Disaster Relief, Disaster
 Reduction & Reconstruction

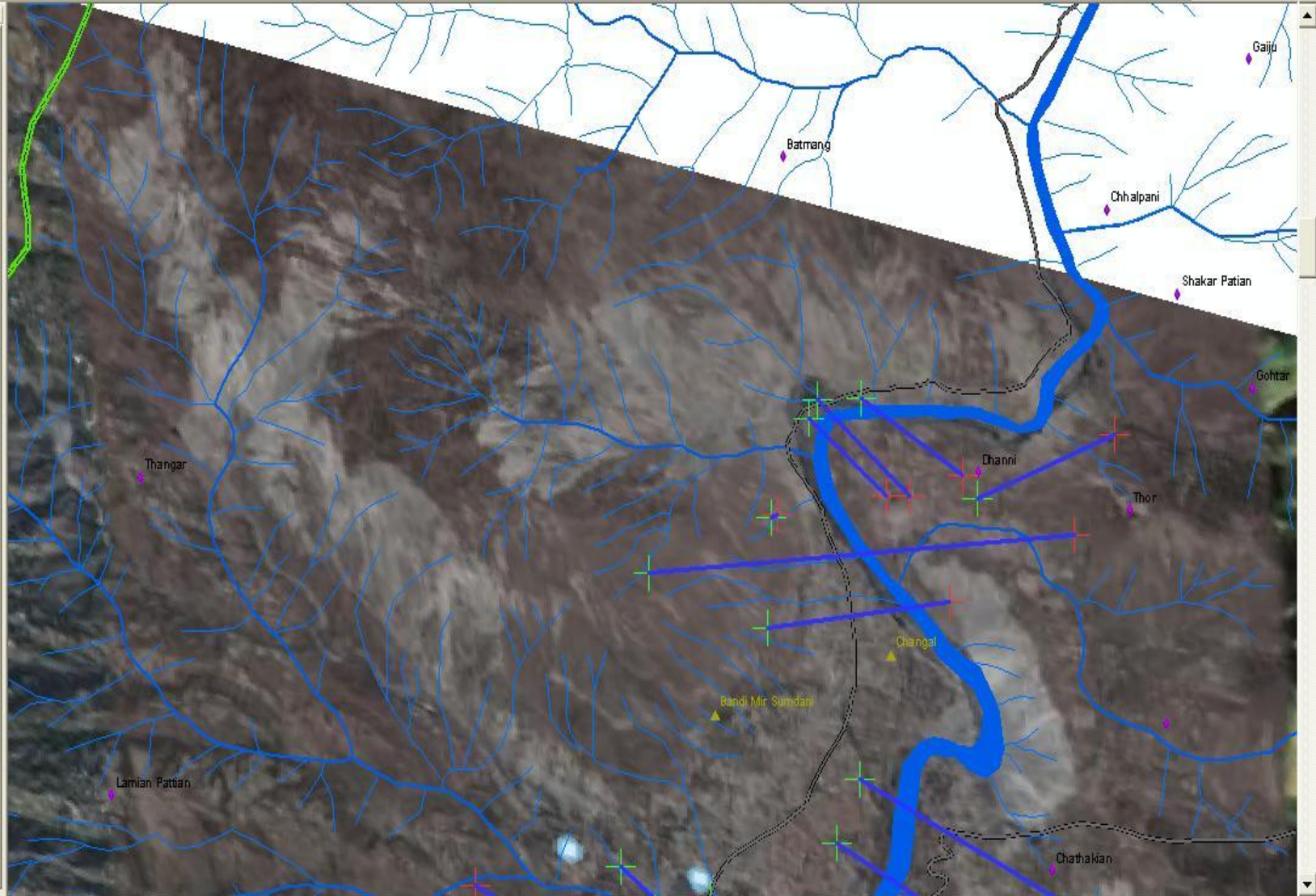
For more information visit: <http://www.respond-int.org>
 feedback@respond-int.org

- 
- An aerial photograph of a landslide area, showing a large, light-colored, eroded slope. The slope is characterized by numerous vertical and diagonal cracks, indicating significant geological instability. The surrounding area is covered with sparse vegetation and trees. The text is overlaid on the image, providing details about a project aimed at mapping and classifying landslide areas in the Kashmir region using GIS and Remote Sensing techniques. The text is presented in a list format with blue and red colors for emphasis.
- Under this project, an attempt is made:
 - to map and classify the landslide area to examine the overall destruction of slides and to suggest remedial measures.
 - to manage and catalogue all the landslides in the Kashmir area using GIS and Remote Sensing techniques.
 - This has been possible with the technical help of **Regional Office for the Geological Services Friuli-Venezia-Giulia.**

Aerial Photograph showing Landslides in Kashmir area

Georeferencing Layer: Kashmir_SatImg.tif Editor Task: Create New Feature Target:

- Layers
 - Landslides_CAT
 - Major Places
 - Major Cities
 - Major Villages
 - LS_Direction
 - LS_Risk
 - Major Roads
 - Tributaries
 - Kathas
 - LS_Hazard
 - Landslides
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 - 43f7_georef_33.img
 - RGB
 - Red: RedBand



Display Source Selection

Drawing Arial 10 B I U

Scheda 1° Livello

ID Frana **030** **00201** **00**

Sigla

Danni	Documentazione	Adempimenti normativi nazionali	Bibliografia
Generalità	Classificazione	Attività	Metodo valutaz. movimento e attività

Localizzazione

* Regione

* Provincia

* Comune

* Autorità di Bacino

Toponimo IGM

Compilazione

* Data

* Compilatore

* Istituzione

Note D1: reti aderenti lungo la parete rocciosa a bordo strada. Queste reti risultano danneggiate in diversi punti e presentano molti detriti a tergo (vedi foto F1). All'interno dell'area interessata è presente un tratto di linea ferroviaria (vedi foto F2) utilizzata raramente e per il solo trasporto di merci. L'area perimetrata si identifica nello studio

CTR

Scala 1: Numero

Toponimo

Form Level #1Landslide ID **104 00001 00**Ref.

Damages

Documentation

Fulfillment of National Regulations

Bibliography

General

Classification

Activity

Movement and Activity Evaluation Method

*Localization** Province * Districts * Municipality * River Basin Authority Place Name SOP *Compilation** Date * Compiled by * Institution

Remarks

Regional MapScale 1: Number Site Name 

Sblocca

Form Level #2

Form Level #3



Code

Search

Ref.



5330

Form Level #1

Landslide ID **104** **00001** **00**

Ref.

Damages	Documentation	Fulfillment of National Regulations	Bibliography
General	Classification	Activity	Movement and Activity Evaluation Method

Type of Movement **Debris Flow**

Remarks A large landslide in the locality of Bandi Mir Sumdani which has been triggered after the earthquake of 08 October 2005.

Form Level #1

Landslide ID **104** **00001** **00**

Ref.

Damages	Documentation	Fulfillment of National Regulations	Bibliography
General	Classification	Activity	Movement and Activity Evaluation Method

* Status

* Date of most recent observations to determine the status of the activity

Form Level #1

Landslide ID **104** **00001** **00**

Ref.

Damages

Documentation

Fulfillment of National Regulations

Bibliography

General

Classification

Activity

Movement and Activity Evaluation Method

* Methodology

Photo Interpretation

-
-
-
-

Name

scale 1:

date

Image

Swath

Type of Eval.

Sblocca

Form Level #2

Form Level #3

Code

Search

Ref.



Form Level #1

Landslide ID **104** **00001** **00**

Ref.

General

Classification

Activity

Movement and Activity Evaluation Method

Damages

Documentation

Fulfillment of National Regulations

Bibliography

Persons Injured Deaths

Building

* Damage Assessment

Standalone Building/Houses

Economical Activities

Roads

Sblocca

Form Level #2
Form Level #3

Code Search Ref.



Form Level #1

Landslide ID **104** **00001** **00**


Ref.

- General
- Classification
- Activity
- Movement and Activity Evaluation Method
- Damages
- Documentation**
- Fulfillment of National Regulations
- Bibliography

CARG

Archive

Documents



Form Level #1

Landslide ID **104** **00001** **00**

Ref.

General

Classification

Activity

Movement and Activity Evaluation Method

Damages

Documentation

Fulfillment of National Regulations

Bibliography

Fulfillment of National Laws

Interior Ministry (Civil Defense Dpt.)

Number



Description

Sblocca

Form Level #2
Form Level #3

Code Search Ref.





Form Level #1

Landslide ID

Ref.

General

Classification

Activity

Movement and Activity Evaluation Method

Damages

Documentation

Fulfillment of National Regulations

Bibliography

Bibliography

Authors

Title

Reviews/Book/Report

Editor/Agency

Volume

Pages

Year



5330



Sblocca

Form Level #2
Form Level #3



Code

Search

Ref.



Form Level #1

Landslide ID **104 00002 00**

Ref.

Damages	Documentation	Fulfillment of National Regulations	Bibliography
General	Classification	Activity	Movement and Activity Evaluation Method

Localization

* Province

* Districts

* Municipality

* River Basin Authority

Place Name SOP

Compilation

* Date

* Compiled by

* Institution

Remarks

Regional Map

Scale 1: Number

Site Name

Form Level #1

Landslide ID **104 00002 00**

Ref.

Damages	Documentation	Fulfillment of National Regulations	Bibliography
General	Classification	Activity	Movement and Activity Evaluation Method

Type of Movement

- Debris Flow
- N/A
- Rockfall/Toppling
- Soil Slip Rotation/Translation
- Expansion
- Creep
- Debris Flow
- Sinking
- Complex
- Deep Gravimetric Deformation
- Area subjected to widespread Rockfall/Overtum
- Area subjected to widespread sinking
- Area subjected to widespread Landslide

Remarks

ed after the

5330

Sblocca

Form Level #2

Form Level #3

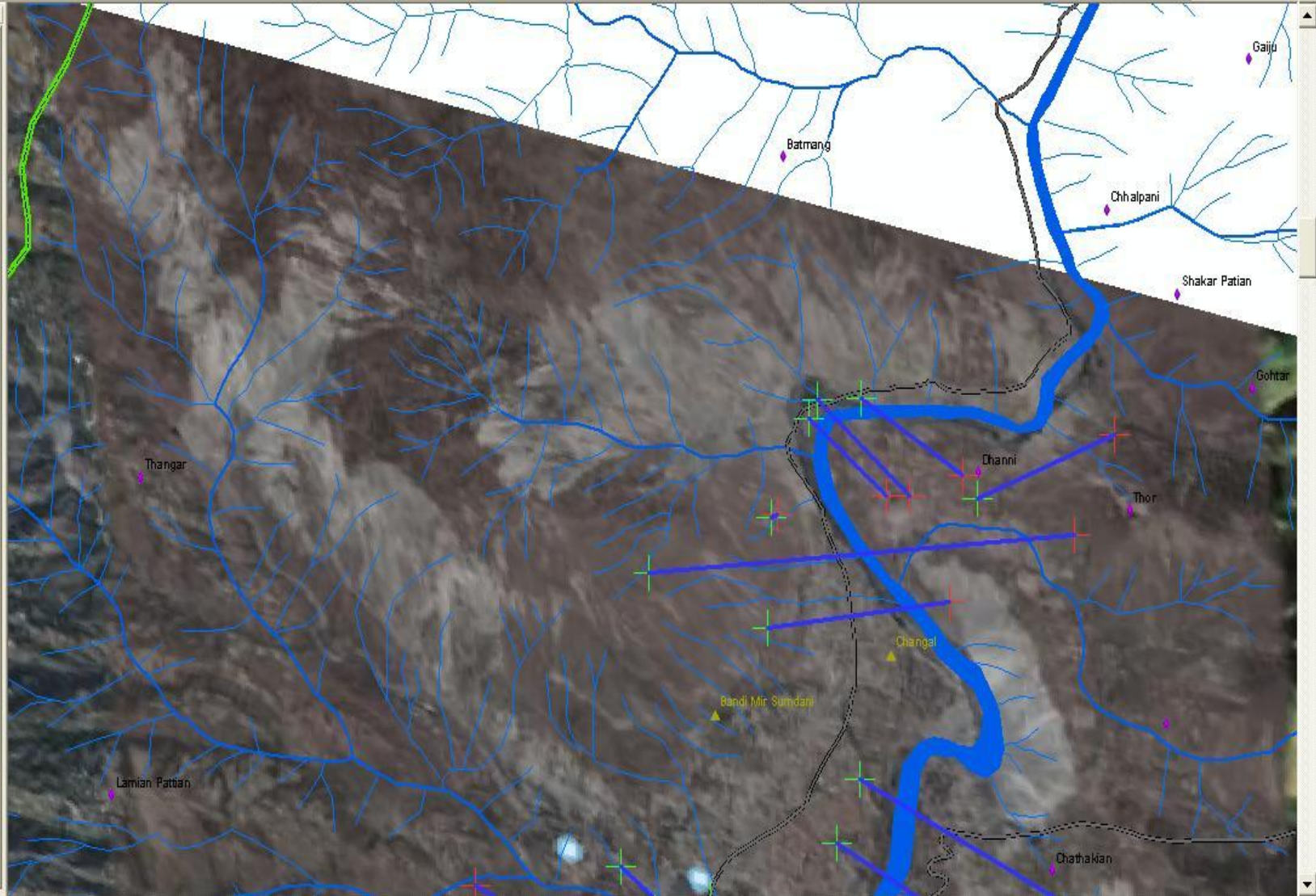
Code Search Ref.



Aerial Photograph showing Landslides in Kashmir area

Georeferencing Layer: Kashmir_SatImg.tif Editor Task: Create New Feature Target:

- Layers
 - Landslides_CAT
 - Major Places
 - Major Cities
 - Major Villages
 - LS_Direction
 - LS_Risk
 - Major Roads
 - Tributaries
 - Kathas
 - LS_Hazard
 - Landslides
 - Rivers
 - Boundary
 - Kashmir_SatImg.tif
 - RGB
 - Red: Band_1
 - Green: Band_2
 - Blue: Band_3
 - 43f7_georef_33.img
 - RGB
 - Red: RedBand



Display Source Selection

Drawing Arial 10 B I U A

Demarcation of Landslides on the Aerial Photograph

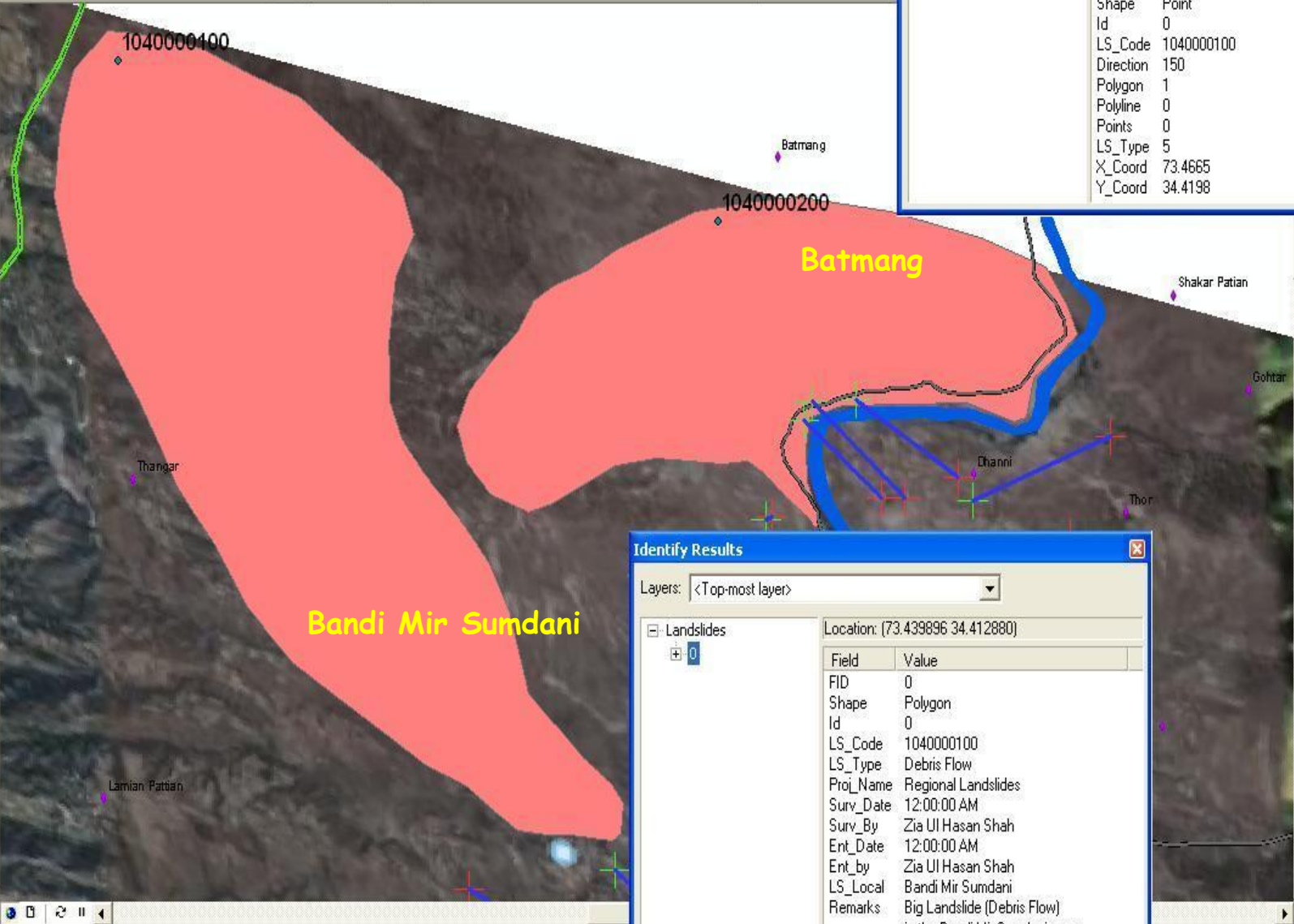
File Edit View Insert Selection Tools Window Help

Georeferencing Layer: Kashmir_SatImg.tif Editor Task: Create New Feature Target:

1:29,914

Layers

- Landslides_CAT
- Major Places
- Major Cities
- Major Villages
- LS_Direction
- LS_Risk
- Major Roads
- Tributaries
- Kathas
- LS_Hazard
- Landslides
- Rivers
- Boundary
- Kashmir_SatImg.tif
 - RGB
 - Red: Band_1
 - Green: Band_2
 - Blue: Band_3
- 43f7_georef_33.img
 - RGB
 - Red: RedBand



Identify Results

Layers: <Top-most layer>

Landslides: CA

Location: (73.43147824, 34.7821)

Field	Value
FID	1
Shape	Point
Id	0
LS_Code	1040000100
Direction	150
Polygon	1
Polyline	0
Points	0
LS_Type	5
X_Coord	73.4665
Y_Coord	34.4198

Identify Results

Layers: <Top-most layer>

Landslides

0

Location: (73.439896, 34.412880)

Field	Value
FID	0
Shape	Polygon
Id	0
LS_Code	1040000100
LS_Type	Debris Flow
Pro_Name	Regional Landslides
Surv_Date	12:00:00 AM
Surv_By	Zia Ul Hasan Shah
Ent_Date	12:00:00 AM
Ent_by	Zia Ul Hasan Shah
LS_Local	Bandi Mir Sumdani
Remarks	Big Landslide (Debris Flow) in the Bandi Mir Sumdani area developed after the 2005 earthquake.

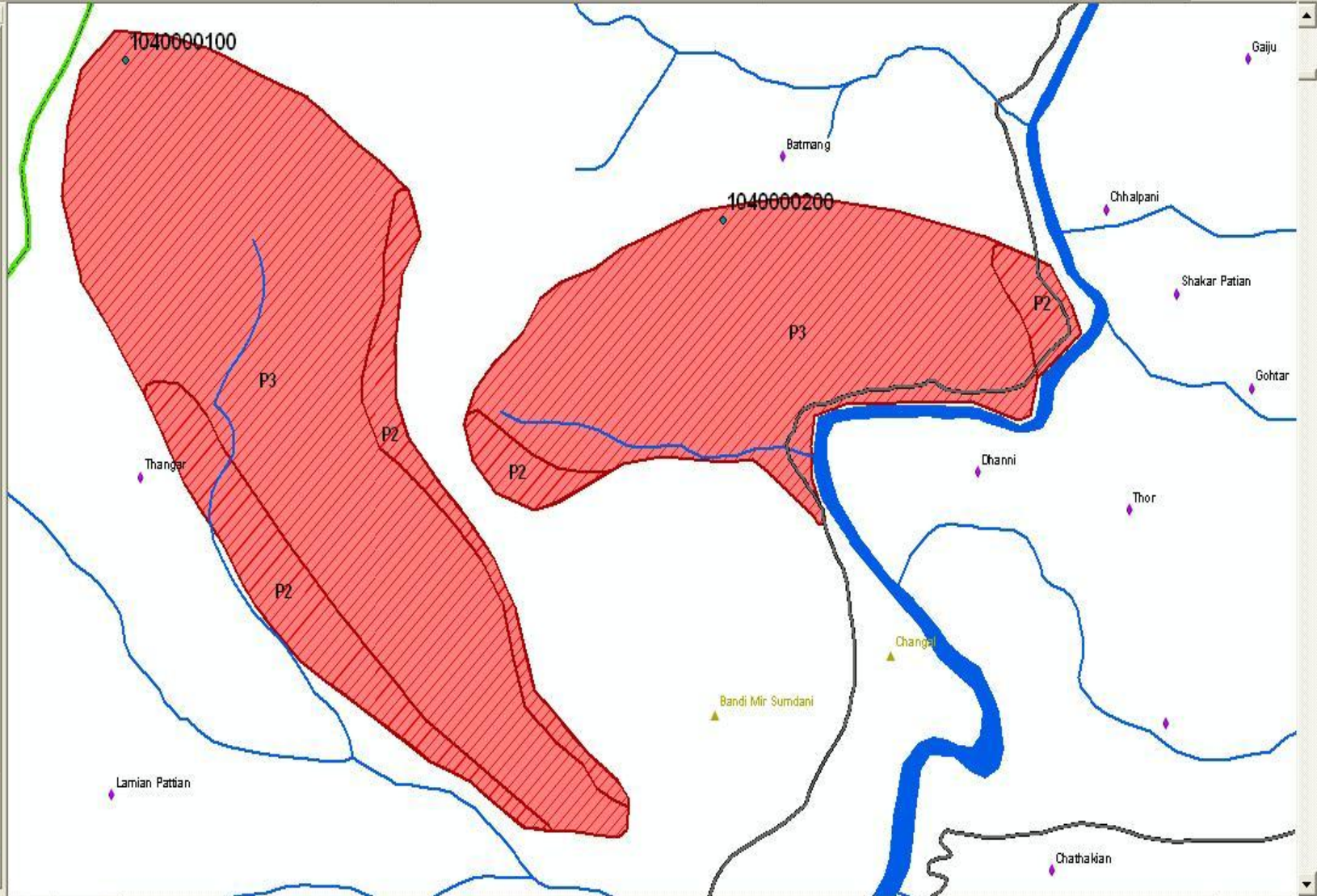
Drawing Arial 10 B I U A

Landslides Hazard

P1, P2, P3

Georeferencing Layer: Kashmir_SatImg.tif Task: Create New Feature Target:

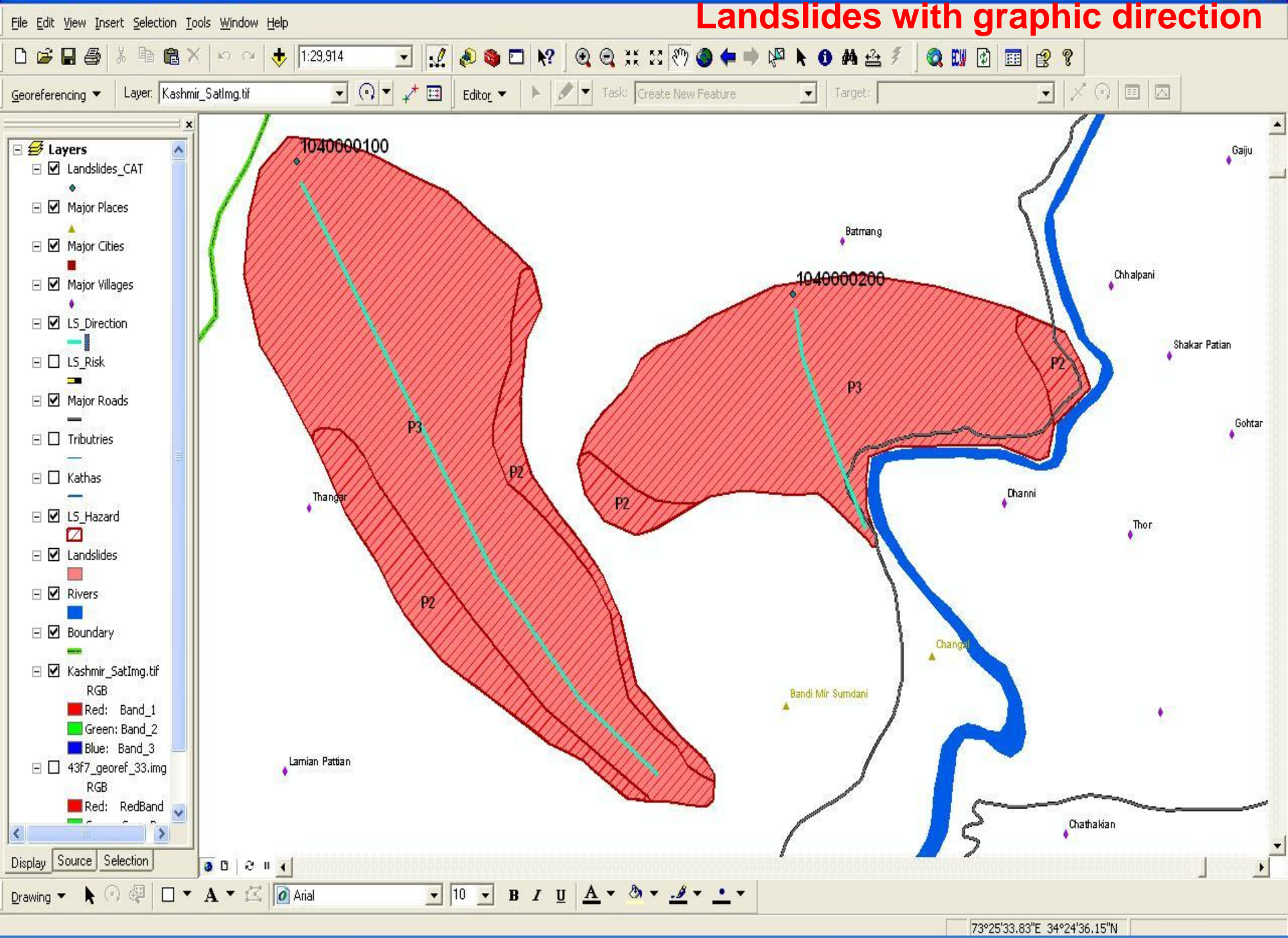
- Layers
- Landslides_CAT
- Major Places
- Major Cities
- Major Villages
- LS_Direction
- LS_Risk
- Major Roads
- Tributaries
- Kathas
- LS_Hazard
- Landslides
- Rivers
- Boundary
- Kashmir_SatImg.tif
 - RGB
 - Red: Band_1
 - Green: Band_2
 - Blue: Band_3
- 43f7_georef_33.img
 - RGB
 - Red: RedBand



Display Source Selection

Drawing Arial 10 B I U A

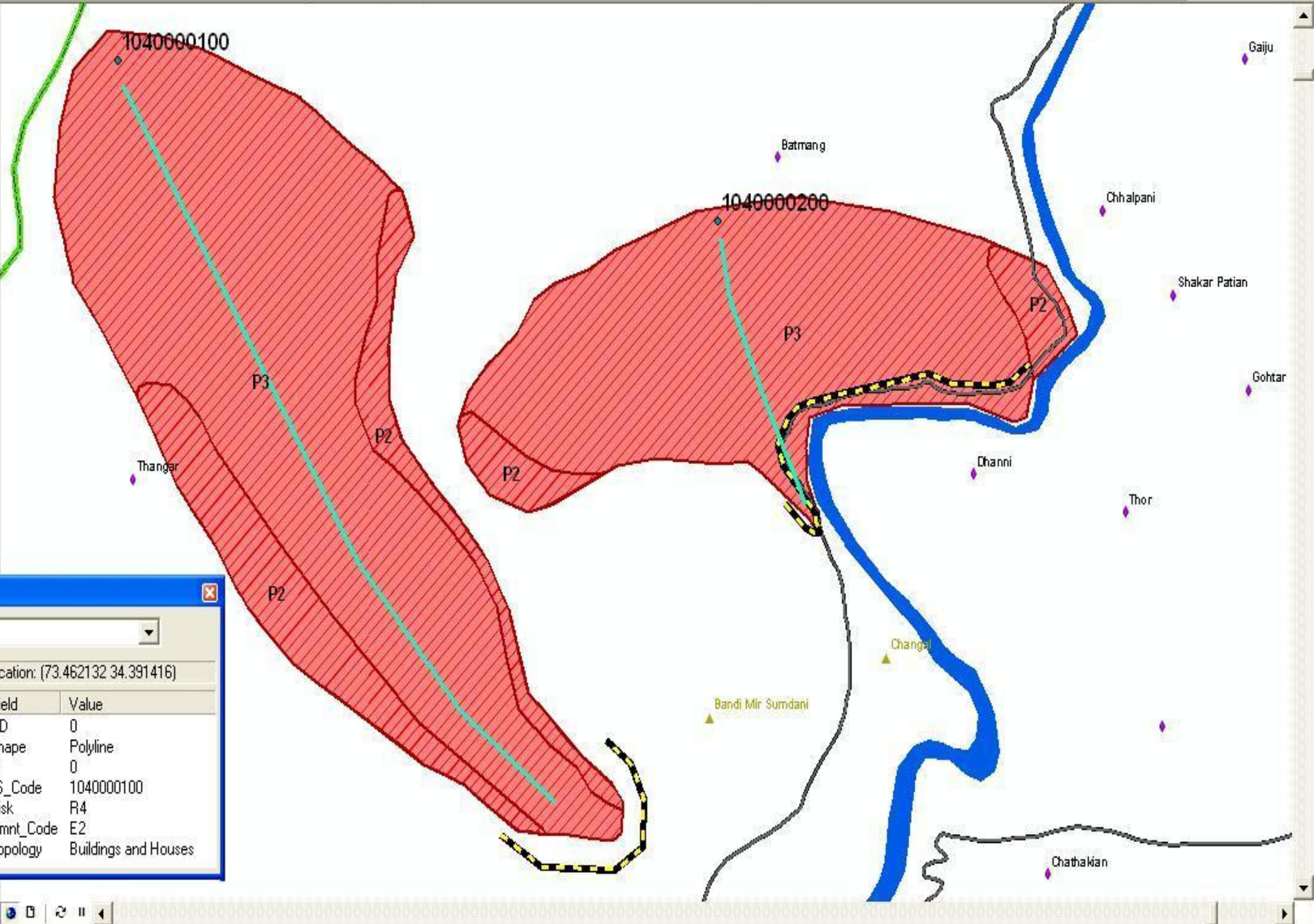
Landslides with graphic direction



Analysis of Landslides Risk

Georeferencing Layer: Kashmir_Satimg.tif Task: Create New Feature Target:

- Layers**
- Landslides_CAT
 - Major Places
 - Major Cities
 - Major Villages
 - LS_Direction
 - LS_Risk
 - Major Roads
 - Tributries
 - Kathas
 - LS_Hazard
 - Landslides



Identify Results

Layers: <Top-most layer>

- LS_Risk

Location: (73.462132 34.391416)

Field	Value
FID	0
Shape	Polyline
Id	0
LS_Code	1040000100
Risk	R4
Elmnt_Code	E2
Topology	Buildings and Houses

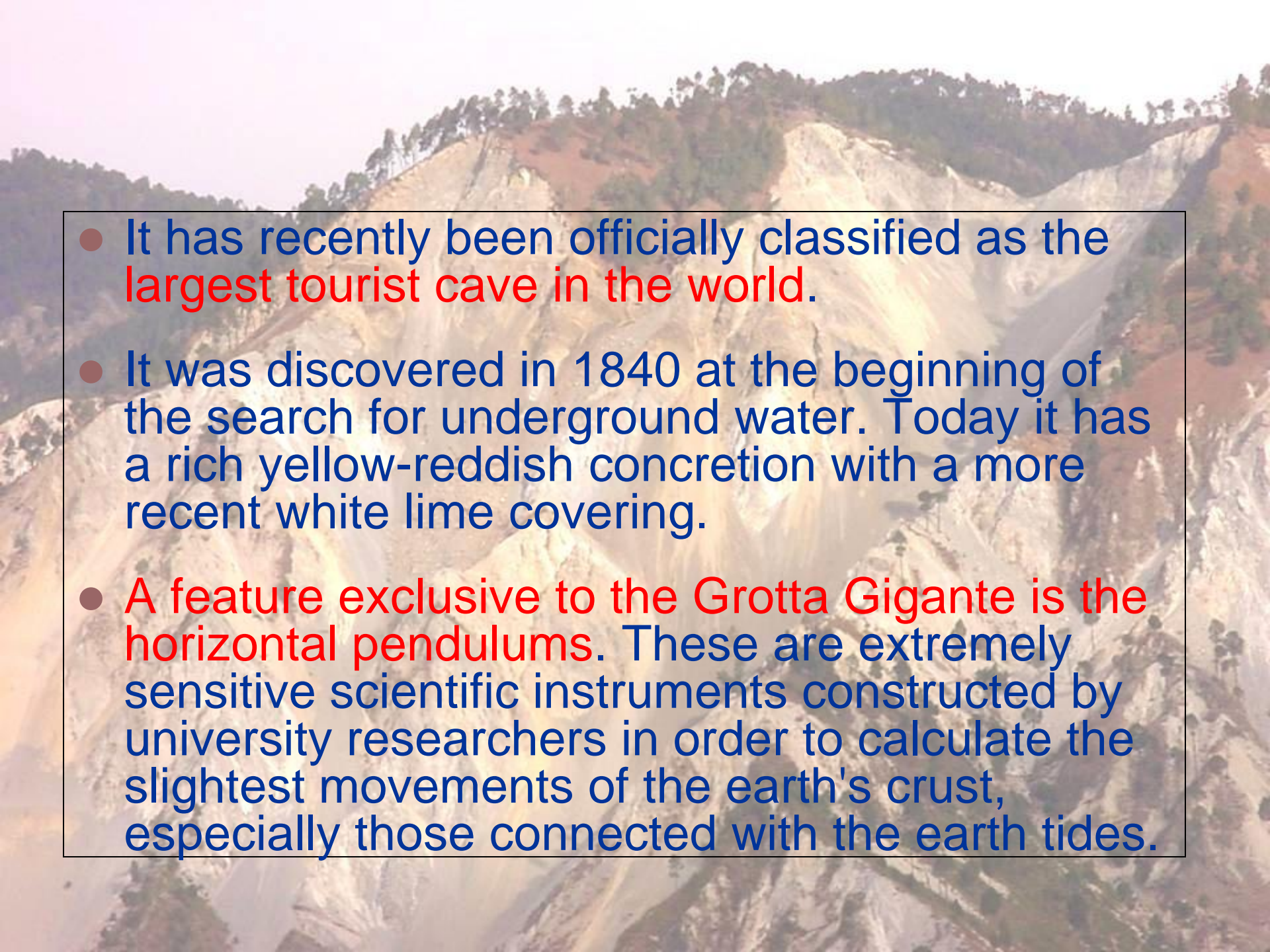
An aerial photograph of a mountain range. The mountains are characterized by steep, light-colored (tan or yellowish) rocky slopes. There are several distinct ridges and valleys. The vegetation is sparse, consisting of small, dark green trees scattered across the slopes and along the ridges. The sky is a pale, hazy blue. The overall scene is rugged and mountainous.

Fieldworks

conducted in Italy

**Grotta Gigante
(Prof. Giorgio Poretti)**



- 
- It has recently been officially classified as the **largest tourist cave in the world**.
 - It was discovered in 1840 at the beginning of the search for underground water. Today it has a rich yellow-reddish concretion with a more recent white lime covering.
 - **A feature exclusive to the Grotta Gigante is the horizontal pendulums.** These are extremely sensitive scientific instruments constructed by university researchers in order to calculate the slightest movements of the earth's crust, especially those connected with the earth tides.

Geological Fieldwork in Osoppo (Prof. Giovanni Battista Carulli)



**A visit to Friuli – 1976 E/Q affected area
6 May, 1976 (Friuli Region)
(Prof. Giovanni Battista Carulli)**



**GPS Measurements in Cavallino
(Prof. Giorgio Poretti)**



Landslides & Retaining Structure, Malborghetto
1000 Landslides / Debris flow on 29 August 2003 due to 400mm of rain in 06 hrs
(dott. Kranitz Fabrizio and dott. Massimilano Poretti)



Under construction Structure, Ponteeba
1000 Landslides / Debris flow on 29 August 2003 due to 400mm of rain in 06 hrs
(dott. Kranitz Fabrizio and dott. Massimiliano Poretti)



**Under construction Retaining Structures, Ponteeba
(dott. Kranitz Fabrizio and dott. Massimilano Poretti)**



Landslide at CASSO

09 October, 1963: 2000 Deaths

90 Km/min: 250 Million m³ Debris

(Dott. Tiziano Tirelli)



**Landslide at ERTO
(Dott. Tiziano Tirelli)**



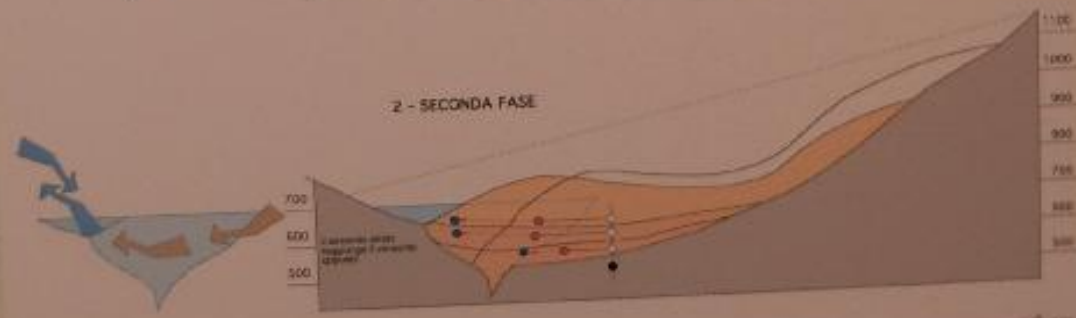
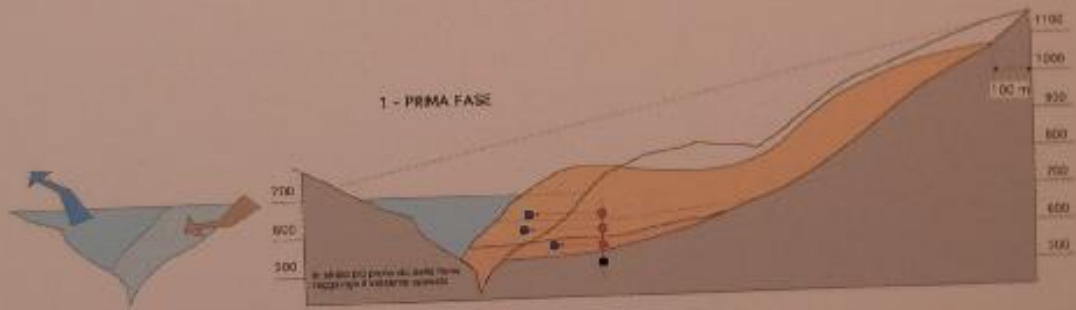
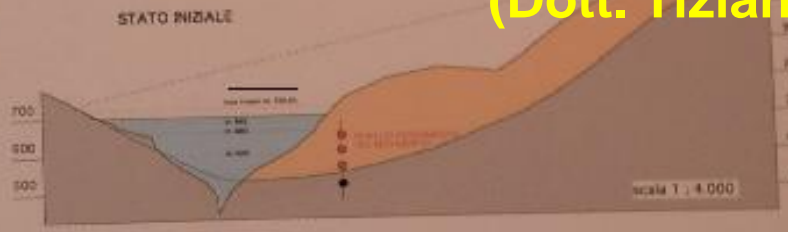
Mechanism of Landslide at CASSO

Catastrophe of 09 October, 1963: 2000 Deaths

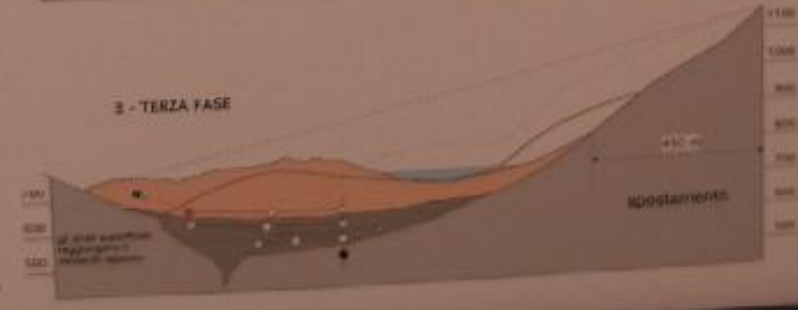
90 Km/min: 250 Million m³ Debris

(Dott. Tiziano Tirelli)

Il grafico ricostruisce il movimento franoso indicando schematicamente quattro punti di riferimento per evidenziarne la dinamica. Il corpo di frana, caratterizzato da strati paralleli al piano di scorrimento, si frantona quando raggiunge il versante opposto:
 - gli strati inferiori, dopo uno spostamento minore, si bloccano e subiscono il sovraccarico del corpo superiore;
 - gli strati sovrastanti compiono uno spostamento maggiore;
 - gli ultimi strati compiono il massimo spostamento e, scorrendo sul letto formale, raggiungono il versante destro del Vajont.



Fin dall'inizio ha luogo l'interazione tra frana e fenomeni idraulici. Il massimo effetto di esondazione si ha nella fase intermedia, corrispondente alla massima velocità ed allo svuotamento totale del bacino.
 Nella terza fase il corpo di frana impatta contro l'onda di riflusso della massa idrica prima sciolta verso l'alto.



**Multilevel Landslide Protection in ERTO
(Dott. Tiziano Tirelli)**



**Vajont Reservoir
270m high Concrete Dam
(Dott. Tiziano Tirelli)**



Technical Specs of Vajont Reservoir (Dott. Tiziano Tirelli)

DIGA DEL VAJONT SCHEMA ASSETTO ATTUALE



L'ENERGIA CHE TI ASCOLTA.

Soverzene - marzo 2007



- 
- Seismic Hazards and Risk Analysis
 - Digital Elevation Model & Slopes Measurement
 - Building Codes and Material Testing
 - Legislation for the infrastructure construction
 - Image Analysis
 - Civil Defense Work

An aerial photograph of a mountain range. The mountains are light-colored, possibly limestone or marble, with distinct vertical and diagonal ridges and gullies. A river valley is visible in the lower right, with a river winding through it. The surrounding slopes are covered with sparse green vegetation and some trees. The sky is a pale, hazy blue.

Word of Thanks

Word of Thanks!

- I can not find enough words to portray my true feelings regarding your hospitality, professionalism, and passion for work.
- To tell you the truth, me and my colleague were not sure about what to expect during our long stay in Italy.
- Today, I am glad to say that it was one of the best personal and professional experience that I had in my entire life....
- We had one of the best GIS/ GPS/ RS teachers available to guide us and provide answers to our questions.
- We had very efficient Project Manager and team to properly conclude all the stages in an immaculate way.

Word of Thanks!

- I hope that we will get more opportunities in future for such excellent interactions.
- On a personal note, you people never let us feel that we were away from home for such a long time.
- I hope that we will be able to fulfill your expectations and progress well on the project back in Pakistan.
- To reciprocate your hospitality, we will also like to host our friends in Italy (all of you) in Pakistan whenever you visit us.
- I am confident that such interactions will certainly pave the way for more projects between our institutions and countries.

Word of Thanks!

Prof. Giorgio Poretti (GPS Measurements, Monitoring and Management)

Department of Mathematics and Informatics

University of Trieste, Trieste, Italy

Prof. Andrea Favretto (Hands-on Training on ArcGIS and ERDAS)

Team: Giuliano, Federico, Alberto, Giovanni, Mariana and Francisco

GIS Laboratory

Department of Geographical and Historical Sciences

University of Trieste, Trieste, Italy

Prof.ssa Cefalo (Introduction to Cartography)

Department of Civil and Environmental Engineering

University of Trieste, Trieste, Italy

Word of Thanks!

Prof. Giovanni Battista Carulli (Geology of the Friuli Area)

Department of Geological Sciences
University of Trieste, Trieste, Italy

Dott. Tiziano Tirelli (Management of Landslides and its Cataloguing)

Team: Dott. Manca Paolo, Dott. Kranitz Fabrizio, Dott.ssa Oberti Sara,
Dott.ssa Piano

Regional Office for the Geological Services FRIULI-VENEZIA-GIULIA
(Servizio Geologico della Regione FRIULI-VENEZIA-GIULIA)

Dott. Massimiliano Poretti (Demo on the protection of Landslides)

Department of Civil and Environmental Engineering
University of Trieste, Trieste, Italy

Word of Thanks!

Dr. Enrico Priolo (Seismometric monitoring in NE Italy)

OGS - Seismological Research Centre
National Institute of Oceanography and Geophysics
Udine, Italy

Dott. Dario Sleiko (Guidelines for the Seismological Hazards)

OGS - Seismological Research Centre
National Institute of Oceanography and Geophysics
(Istituto Nazionale di Oceanografia e Geofisica Sperimentale)
Opicina, Italy

Prof.ssa Elisabetta Garboni (Italian Language Course)

Istituto Foscolo
First Floor, Via Giulia, Trieste, Italy

Special Thanks!

In the end, I will like to dedicate our
Special Thanks to

Prof. Alfredo Bellen

Director

Department of Mathematics and Informatics

University of Trieste, Trieste, Italy

For all arrangements at the Department of
Mathematics & Informatics and his motivation

Special Thanks!

In the end, I will like to dedicate our
Special Thanks to

Prof. Giorgio Poretti

Department of Mathematics and Informatics
University of Trieste, Trieste, Italy

Grazie di Tutto

Our Project Manager who arranged everything
for us in Italy (including meetings, fieldworks,
accommodation, traveling, and a lot more)

Special Thanks!

In the end, I will like to dedicate our
Special Thanks to

Mr. Giuliano Petrarulo

Department of Geographical and Historical Sciences
University of Trieste, Trieste, Italy

Helped a lot from first day till today both
technically and generally in a
very friendly environment

An aerial photograph of a mountainous region with a river valley. The mountains are light-colored, possibly limestone or sandstone, and are partially covered with green vegetation. A river flows through the valley below. The sky is clear and blue.

Thanks to ALL!

I, on the behalf of all Pakistanis,
specially on the behalf of
Bahria and AJ & K University,
thanks a lot to all of you,
Individuals, University of Trieste and
Region FRIULI-VENEZIA-GIULIA
(for funding this study)

A large, light-colored, rocky mountain slope dominates the background, showing signs of erosion and a landslide. The foreground features a village with several buildings, some with colorful facades, nestled among green trees. The sky is clear and blue.

Thank You