
بسم الله الرحمن الرحيم

GEOSPATIAL ANALYSIS OF GLACIAL HAZARDS PRONE AREAS OF SHIGAR AND SHAYOK BASINS OF PAKISTAN

By
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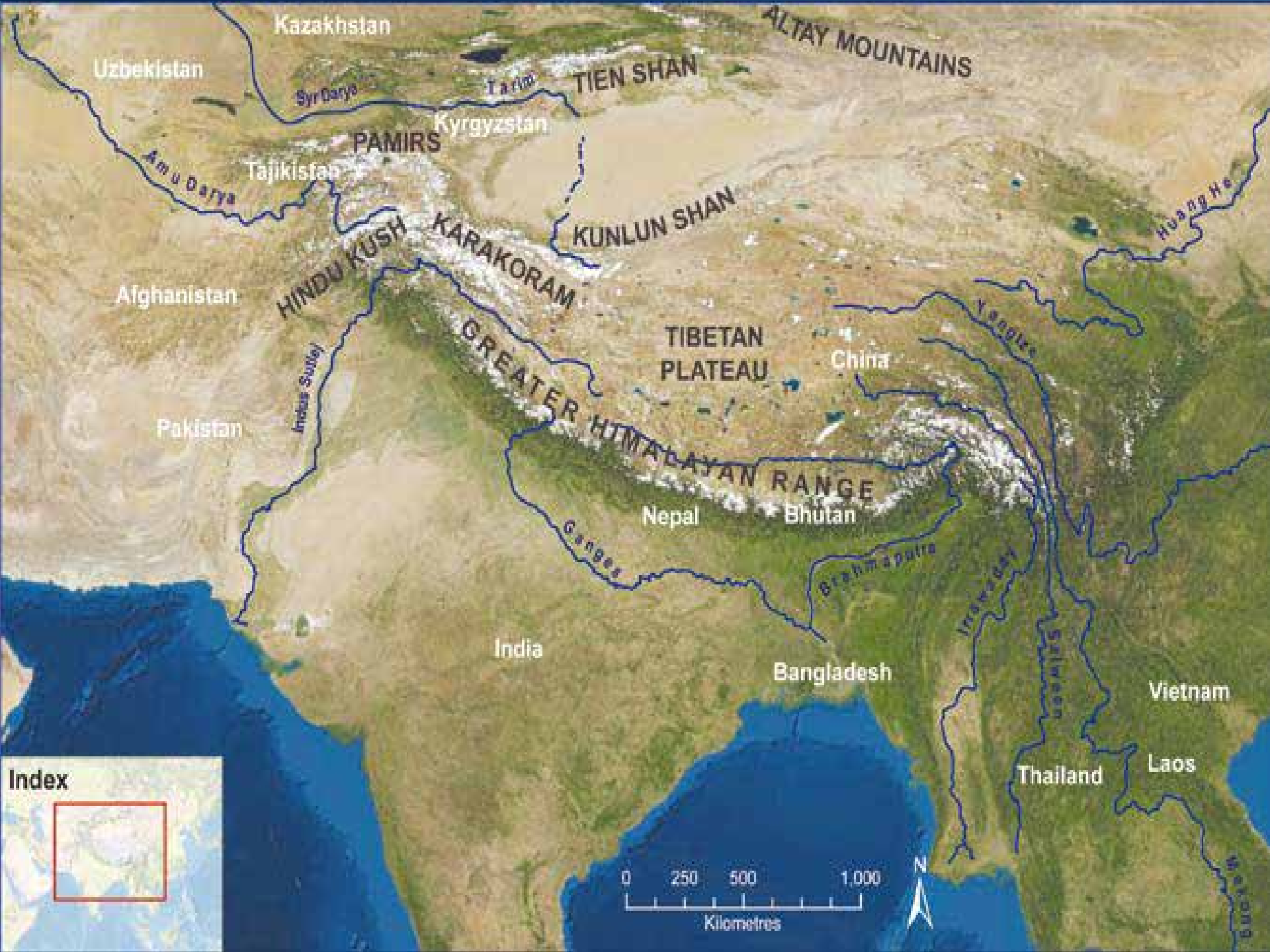
PRESENTATION OUTLINE

- Introduction
  - Problem Statement / Rationale
  - Objectives
- Material and Methods
  - Study Area
  - Datasets
  - Methodology
- Data Analysis / Assessment
- Results / Outcomes

INTRODUCTION


Kazakhstan
Uzbekistan
ALTAY MOUNTAINS
TIEN SHAN
Syr Darya
Tarim
Kyrgyzstan
PAMIRS
Tajikistan
Amu Darya
KUNLUN SHAN
HINDU KUSH
KARAKORAM
Afghanistan
Huang He
TIBETAN PLATEAU
China
Yangtze
Indus Sutlej
GREATER HIMALAYAN RANGE
Pakistan
Nepal
Bhutan
Ganges
Brahmaputra
Irrawaddy
India
Bangladesh
Salween
Vietnam
Thailand
Laos
Mekong
Index
0 250 500 1,000
Kilometres
N

INTRODUCTION

- The northern Pakistan Himalayan Karakorum Hindukush (HKH) Mountain range contains world largest glaciers outside the Polar Regions.
- Global warming has a major impact on glacial and periglacial dynamics, resulting in changes of hazards throughout the world's mountain regions.
- Glacier shrinkage can lead to the formation or growth of glacial lakes.
- In particular moraine-dammed glacial lakes often bear some considerable risk of lake outbursts, e.g. triggered by mass movements affecting the lake and producing impact waves and subsequent dam failure.
- Glacier Lake Outburst Floods (GLOF) is sudden discharge of a huge quantity of water from a glacial lake.

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INTRODUCTION

- These have the potential to release millions of cubic meters of water and debris, with peak flows as high as 15,000 cubic meters per second.
- It causes flood up to hundreds of kilometers of downstream and undermines the already meager sources of people living in hilly areas.
- In the northern glaciated regions of Pakistan the vulnerabilities of loss of human life, agriculture land and property caused by GLOF has tremendously increased due to global warming.
- The situation demand preparedness and risk reduction response at community level.

INTRODUCTION

- Glaciated high-mountain regions are particularly susceptible to climate change (IPCC, 2007) and associated changes in hazard situations (Stoffel and Huggel, 2012).

- Recent glacier melt has given rise to the formation of moraine-dammed glacier lakes (Clague and Evans, 2000), which typically form between the glacier snout and end moraines during periods of glacier retreat (Costa and Schuster, 1988).

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INTRODUCTION

- Moraine dams are inherently prone to failure because of their often weak structure, loose internal composition and lack of an engineered spillway. Glacial lake outbursts may drain as powerful floods (Mergili et al., 2011) and are considered the most important glacier-related hazard in terms of direct damage potential (Osti and Egashira, 2009).

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INTRODUCTION

- Glacier lake outburst floods (GLOFs) have killed thousands of people in many parts of the world (Clarke, 1982; Hewitt, 1982; Clague and Evans, 1994, 2000; Watanabe and Rothacher, 1996; Richardson and Reynolds, 2000a; Huggel et al., 2004; Carey, 2005) and with ongoing glacier retreat new, often unstable glacier lakes are likely to develop in the future (Frey et al., 2010)

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PROBLEM STATEMENT / RATIONALE

The melting ice is a manifest of global warming. Alpine Glaciers are subjected to the climate change, which is a consequence of terrestrial heat flux.

This research has resulted in determination of Glacial Hazard in Shigar and Shayok basins in order to earmark settlement prone to glacial hazard and determine suitable re-location.

OBJECTIVES

The specific objectives of the study are as following:

- Ident of hazard prone areas in Shigar and Shayok basins pertaining to glacial activity for declaration of high risk areas by formulation of Risk Index (%).
- Estimation of major glaciers depletion.
- Correlation of snow coverage depletion with average annual temperature rise in northern areas of Pakistan.
- GIS based identification of suitable locations keeping in view the qualitative risk mitigation.

MATERIAL AND METHODS

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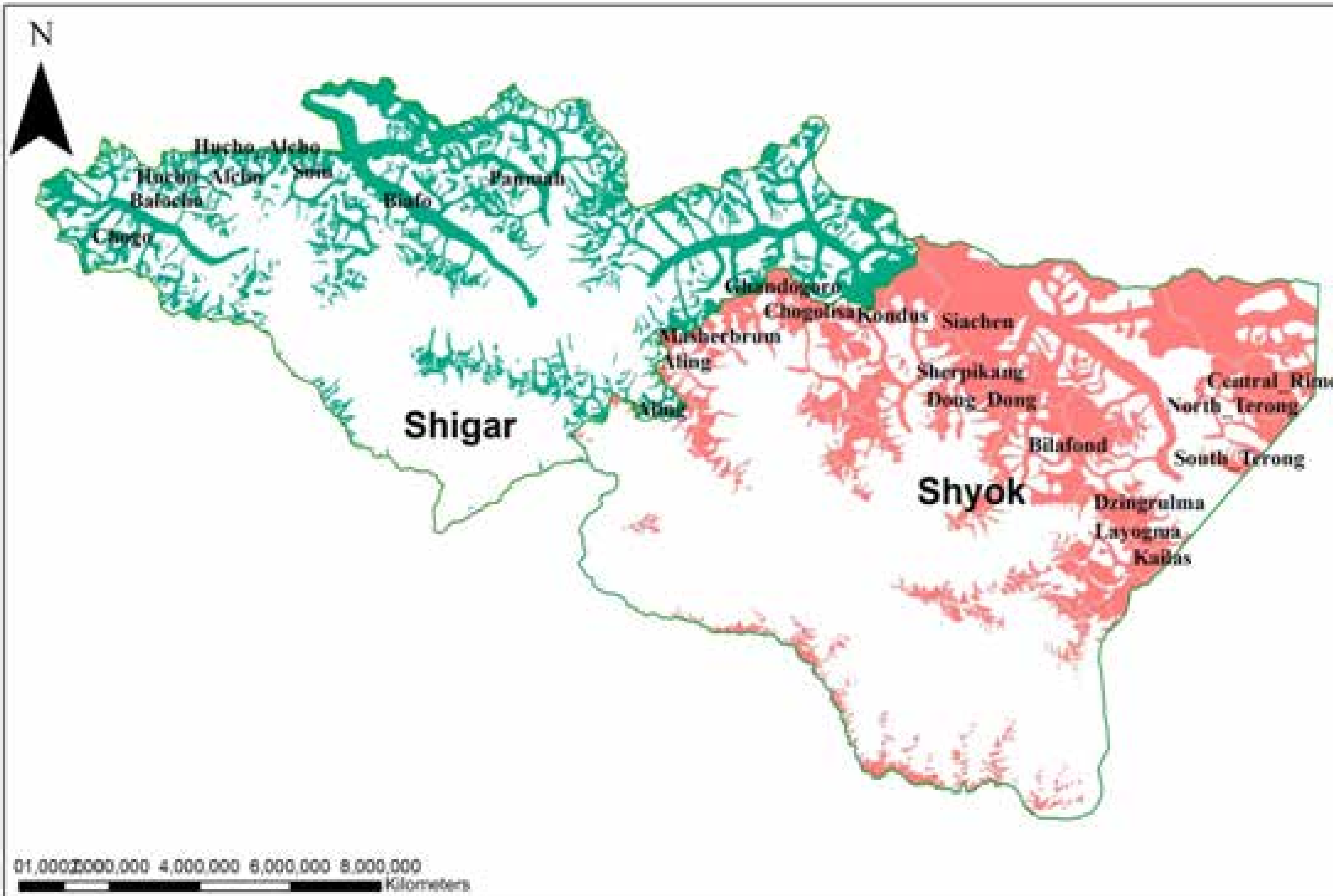
STUDY AREA



N
Hucho_Alcho
Hucho_Alchu
Bafocho
Chogo
Biafo
Panmah
Chogolisa
Kondus
Siachen
Masherbrum
Sherpikang
Dong_Dong
Central_Rimo
North_Terong
Bilafond
South_Terong
Shigar
Shyok
Dzingrulma
Layogma
Kailas
Kilometers

DATA SETS

Following datasets are incorporated to run complete the study:

- Ø Satellite Data (satellite Imagery with high spatial, spectral and temporal resolution)
- Ø Digital Elevation Model (30 m DEM & 15 m GDEM)
- Ø Field Data (people interviews affected by GLOFs and glacial avalanches)
- Ø Socio-Economic Data
- Ø Hydrological Data (water discharge data from the identified GLOFs)
- Ø Land Use Data (the land cover classification)
- Ø Historical GLOFs and avalanches Data

DATA SETS

IMAGERY

Sat	Qty	Sensor	Bands	Time Lag (Yrs)	Spatial Resolution (m)
LandSat	6	Multi	7	5	30
SPOT	30	Multi	4	5	2.5
ASTER	30	Multi	14	6	15

DEM

Source	Acquisition Yr	Spatial Resolution
ASTER	2005	28m
SRTM	2000	90m

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GLACIAL HAZARD RISK INDEX

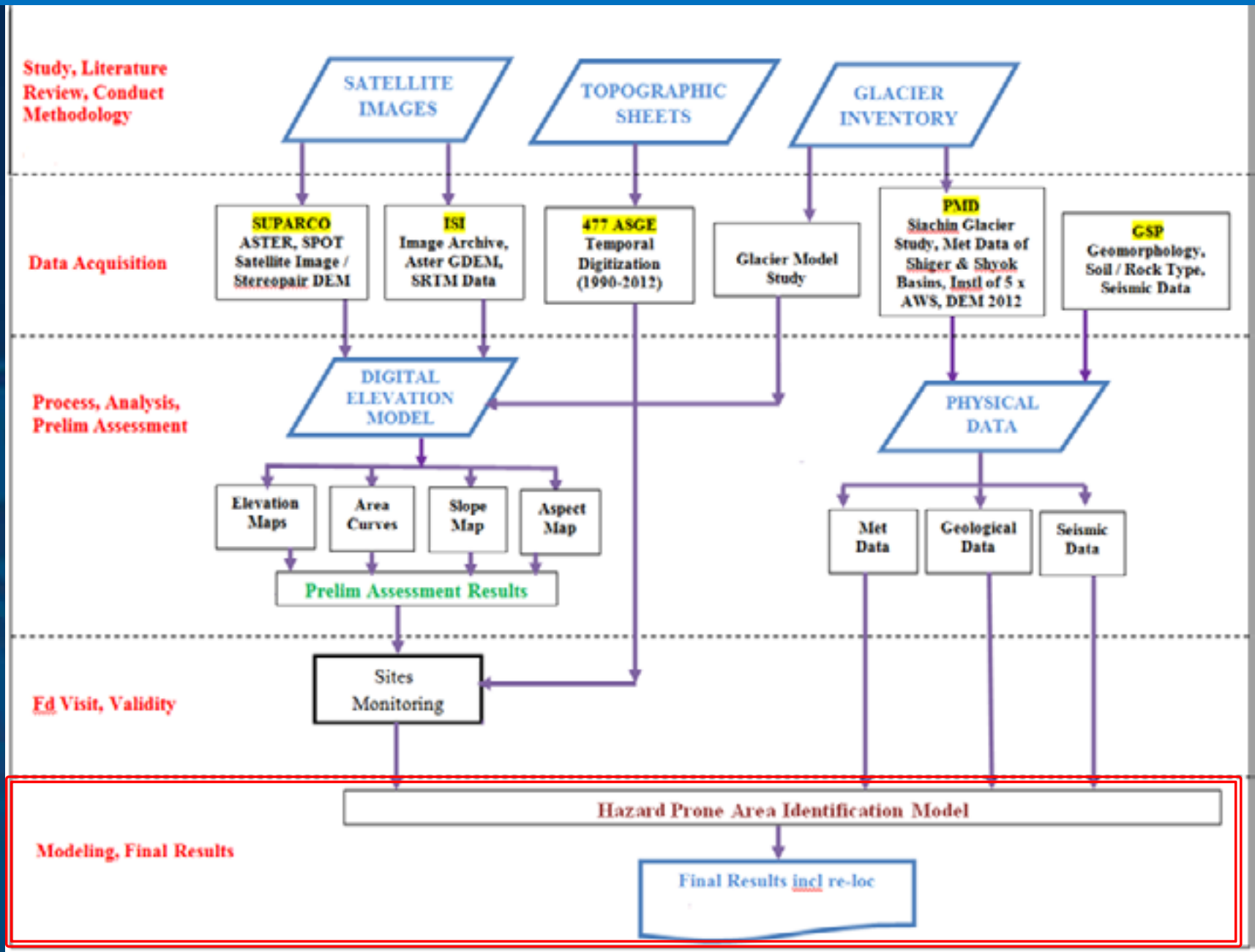
GLACIAL HAZARD RISK INDICATORS

Indicators	Description of Risk
Location	Location of a **settlement vis-a-vis Glacier** with abrupt changes in melting rate is dangerous
Elevation	Glaciers **< 14000 ft** height have direct relation with the probability of glacial hazard occurrence
Aspect	The glaciers facing **South** are more prone to glacial disaster as it endures more solar radiation causing depletion
Slope	Glaciers having slope between **30 – 45 %** are prone to glacial hazards such as avalanches and slides
Geomorphology	Type of **underneath surface** of site

RISK INDEX

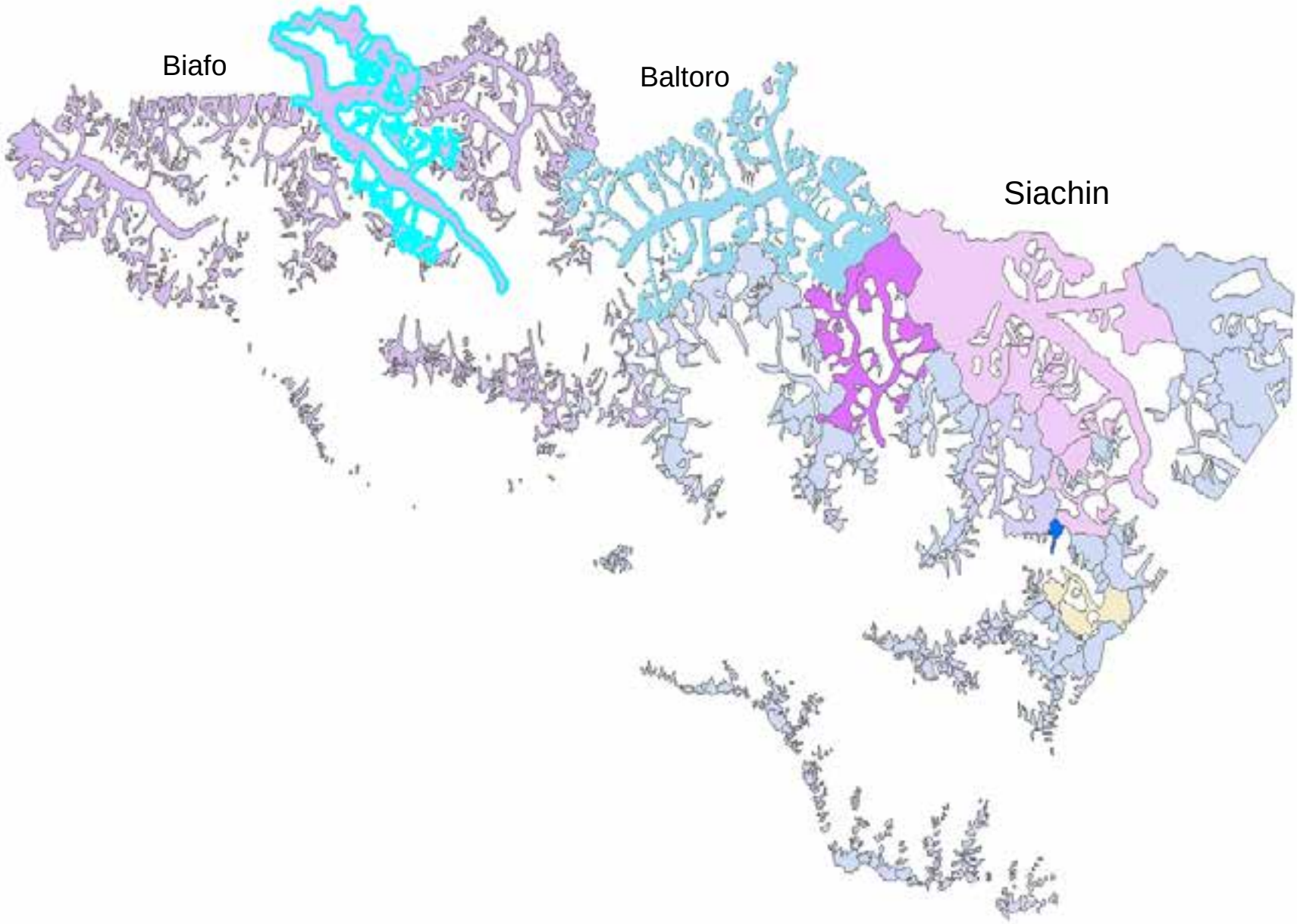
Qualitative Degree of Risk	Degree of Risk (%)	Remarks	Probability
Dangerous	**80-100**	Re Location	**High**
Very High	**60-80**	Re Adjustment	**High**
High	**40-60**	Cont at High Risk	**Medium**
Moderate	**20-40**	Cont at Moderate Risk	**Medium**
Low	**0-20**	May Cont	**Low**

METHODOLOGY



RESULTS / OUTCOMES

GLACIERS DISTRIBUTION IN SHIGAR & SHYOK



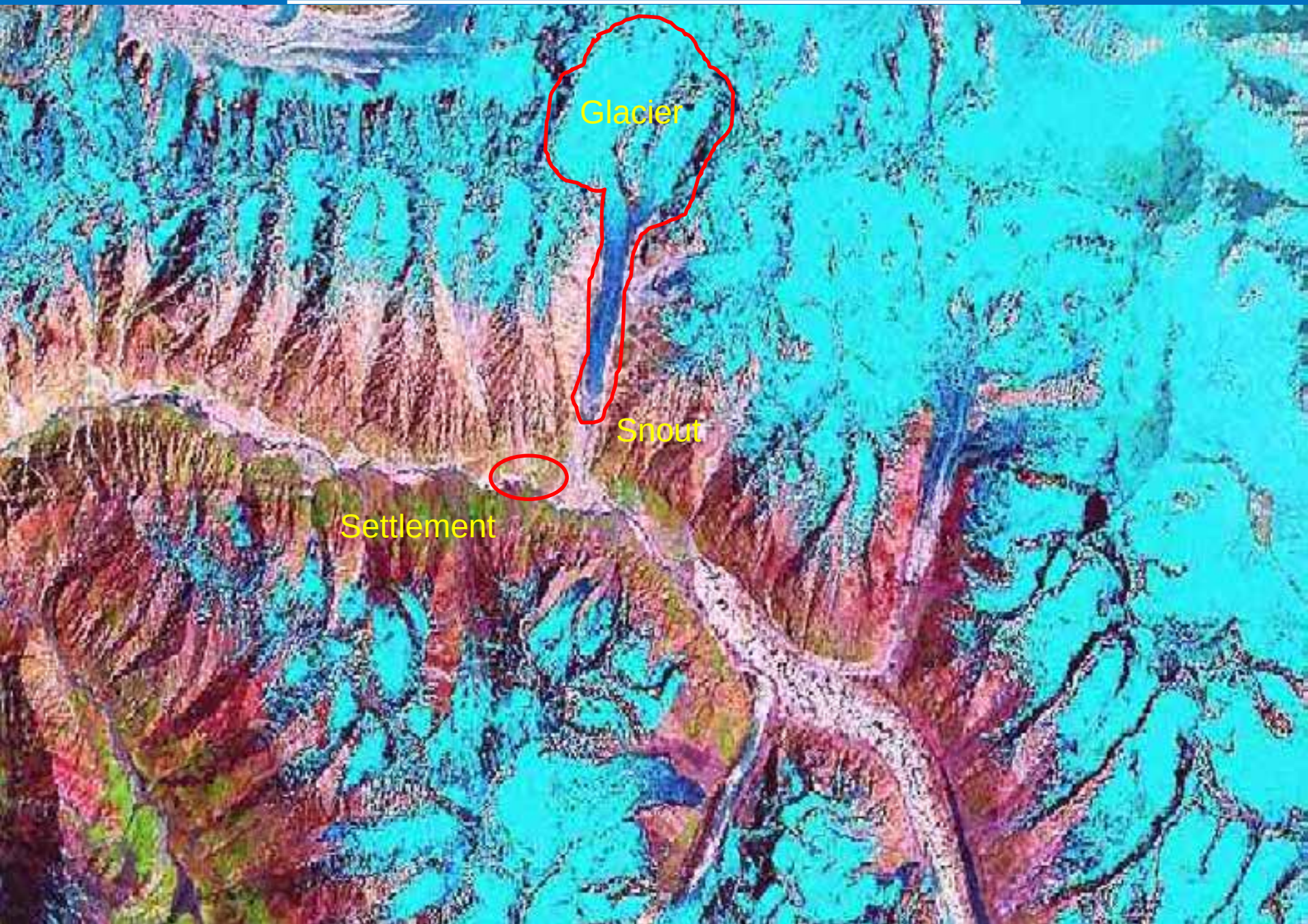
GLACIAL HAZARD RISK ASSESSMENT

GLACIER APROCHING SETTLEMENT

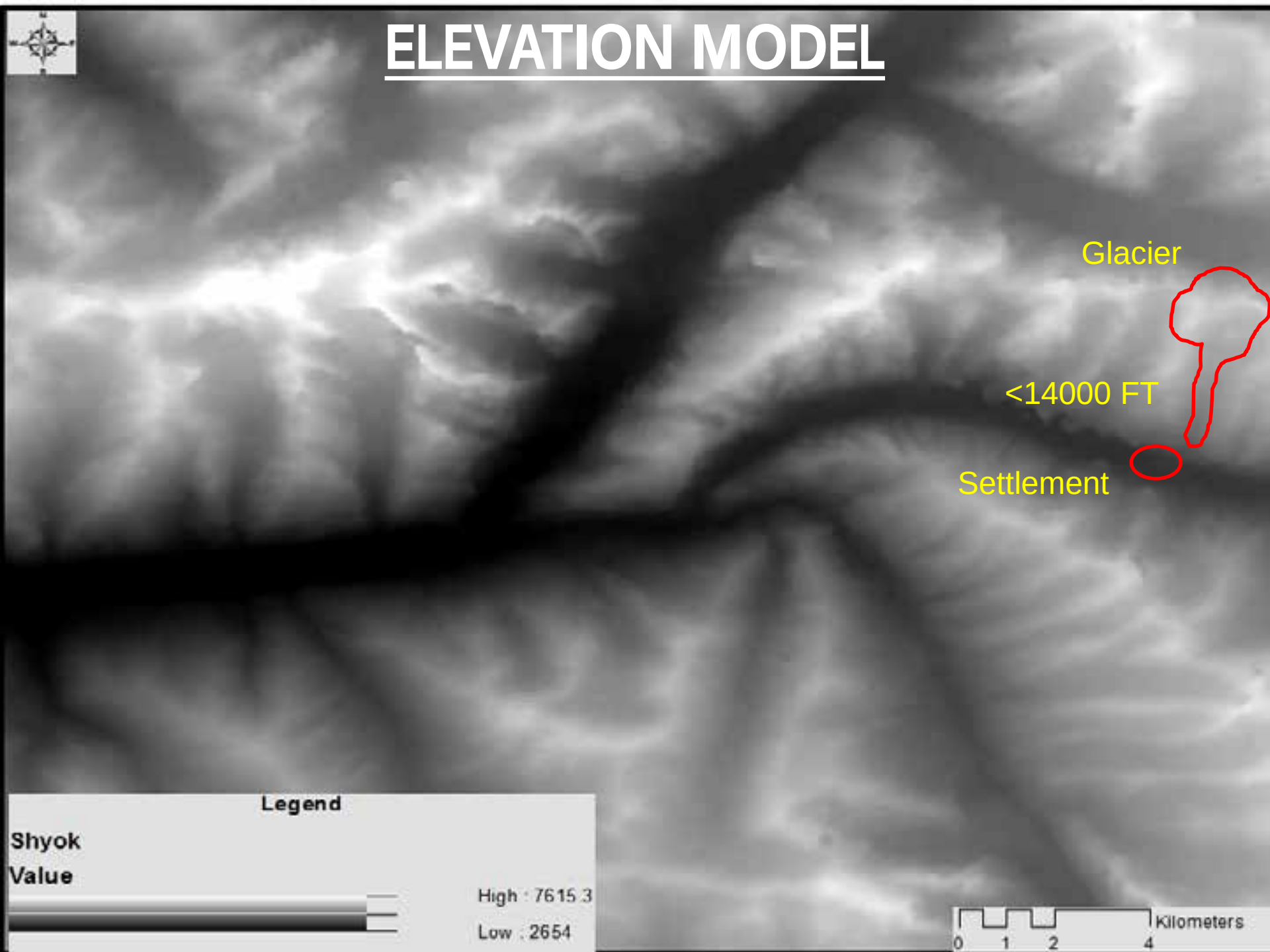
GLACIER APROCHING SETTLEMENT

PARAMETER	VALUE
LENGTH	1791 m
ASPECT	South
SLOPE	31 %
AREA	7.76 $(Km)^2$
THICKNESS	87.0702 m
ICE RESERVE	0.68 $(Km)^3$
LAT	35° 12' 05.64" N
LONG	76° 59' 43.53" E

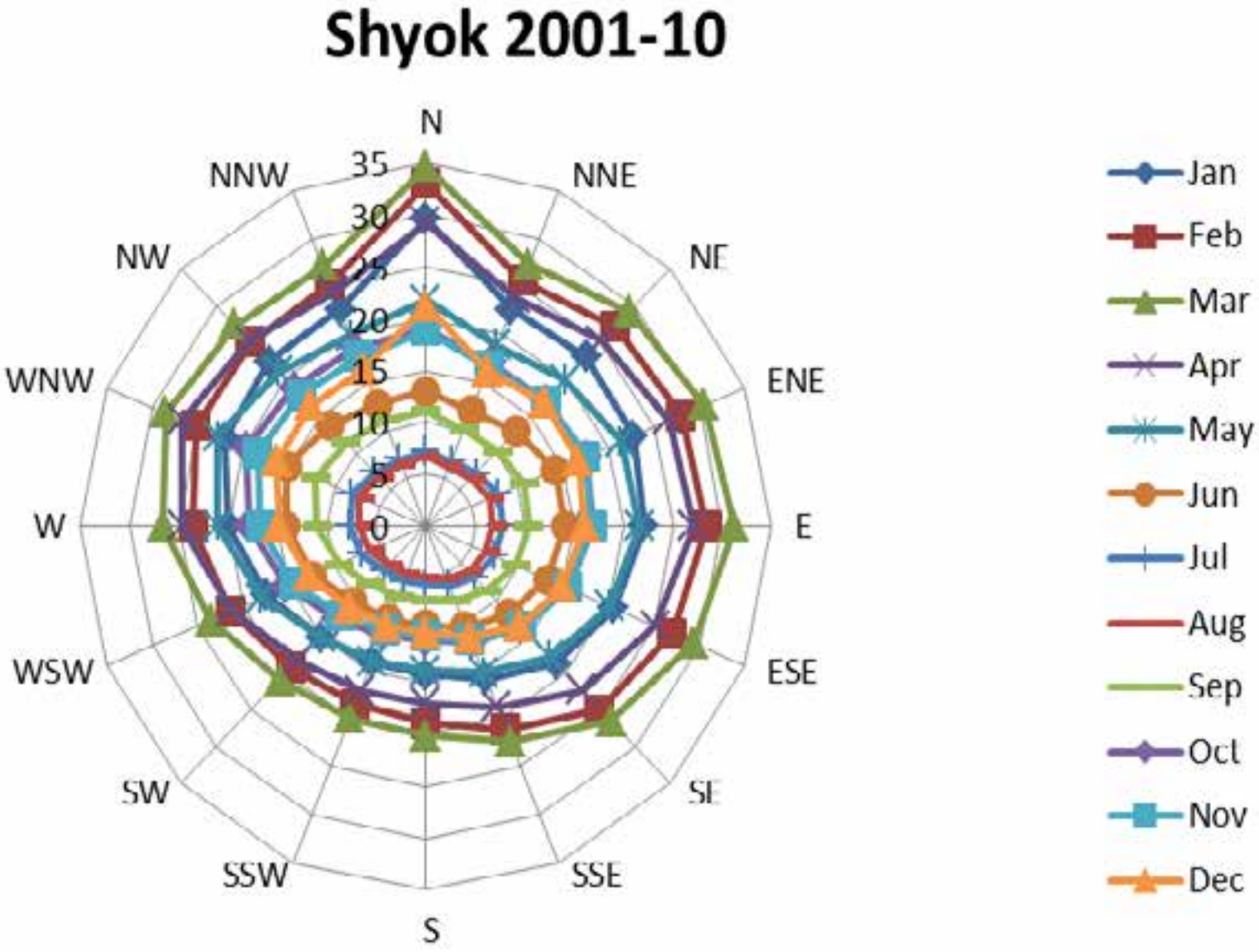
LOCATION OF GLACIER SNOUT



ELEVATION MODEL

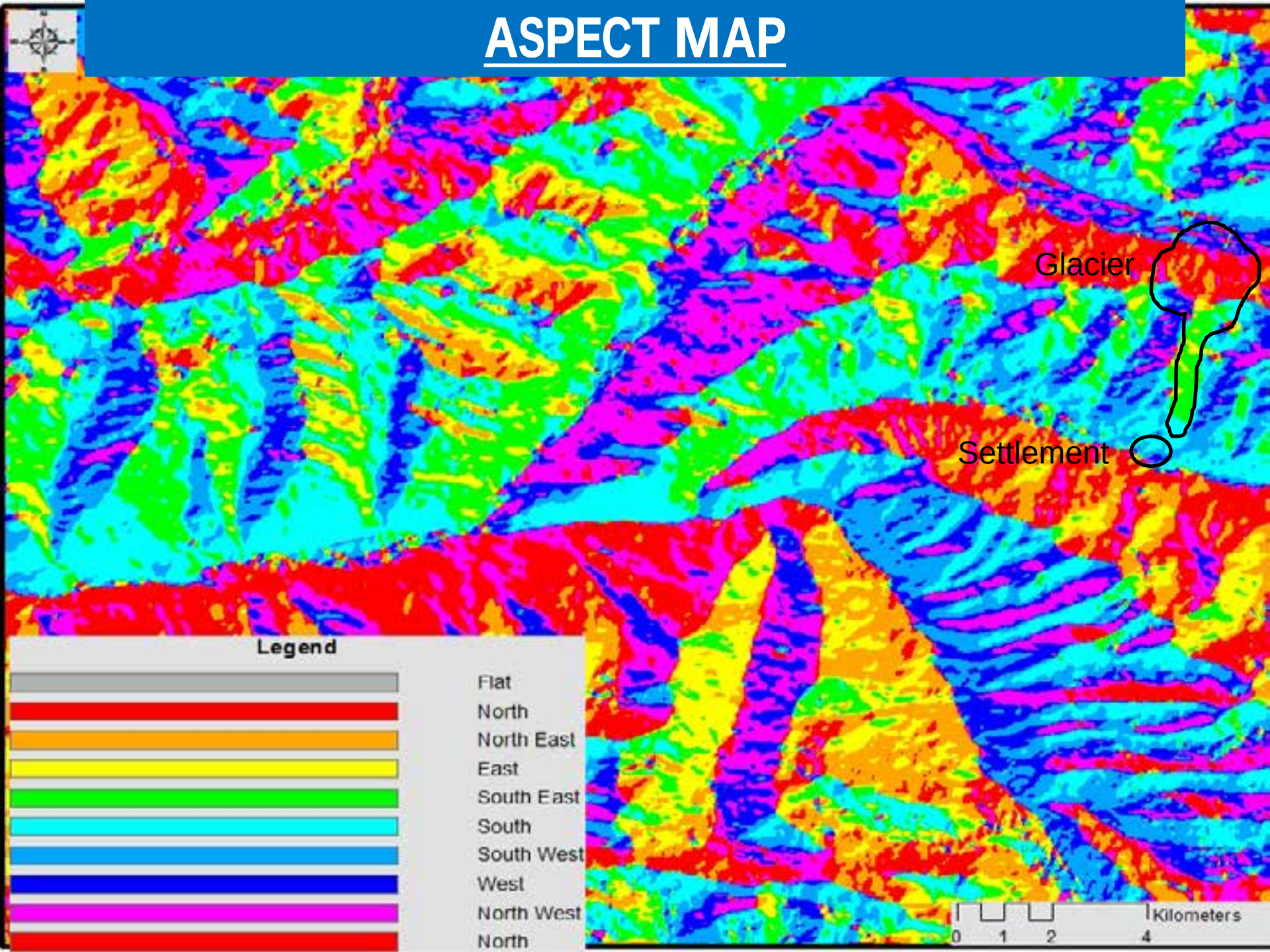


ASPECT – SHYOK RIVER BASIN

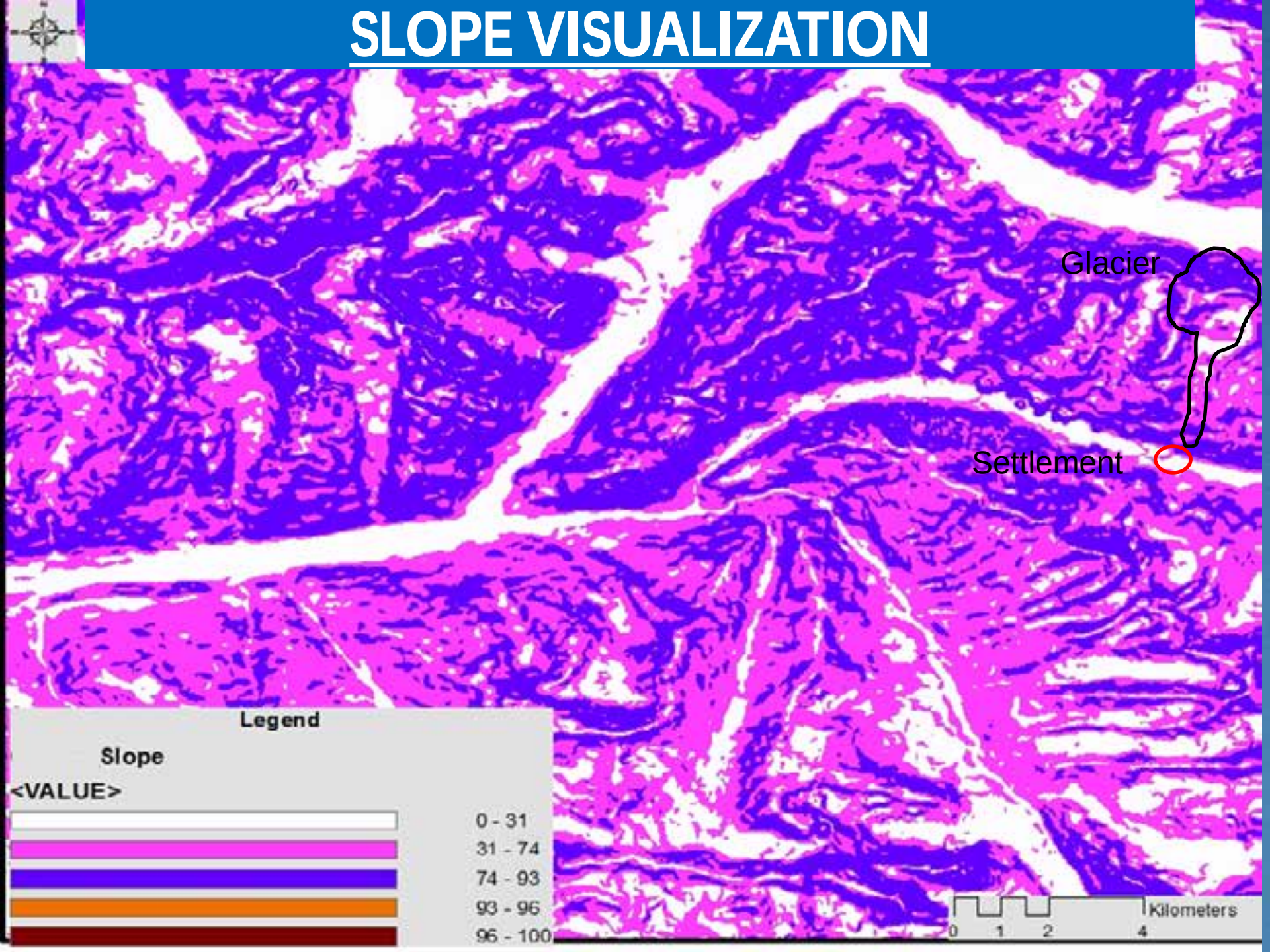


Aspect wise snow coverage of Shyok River Basin

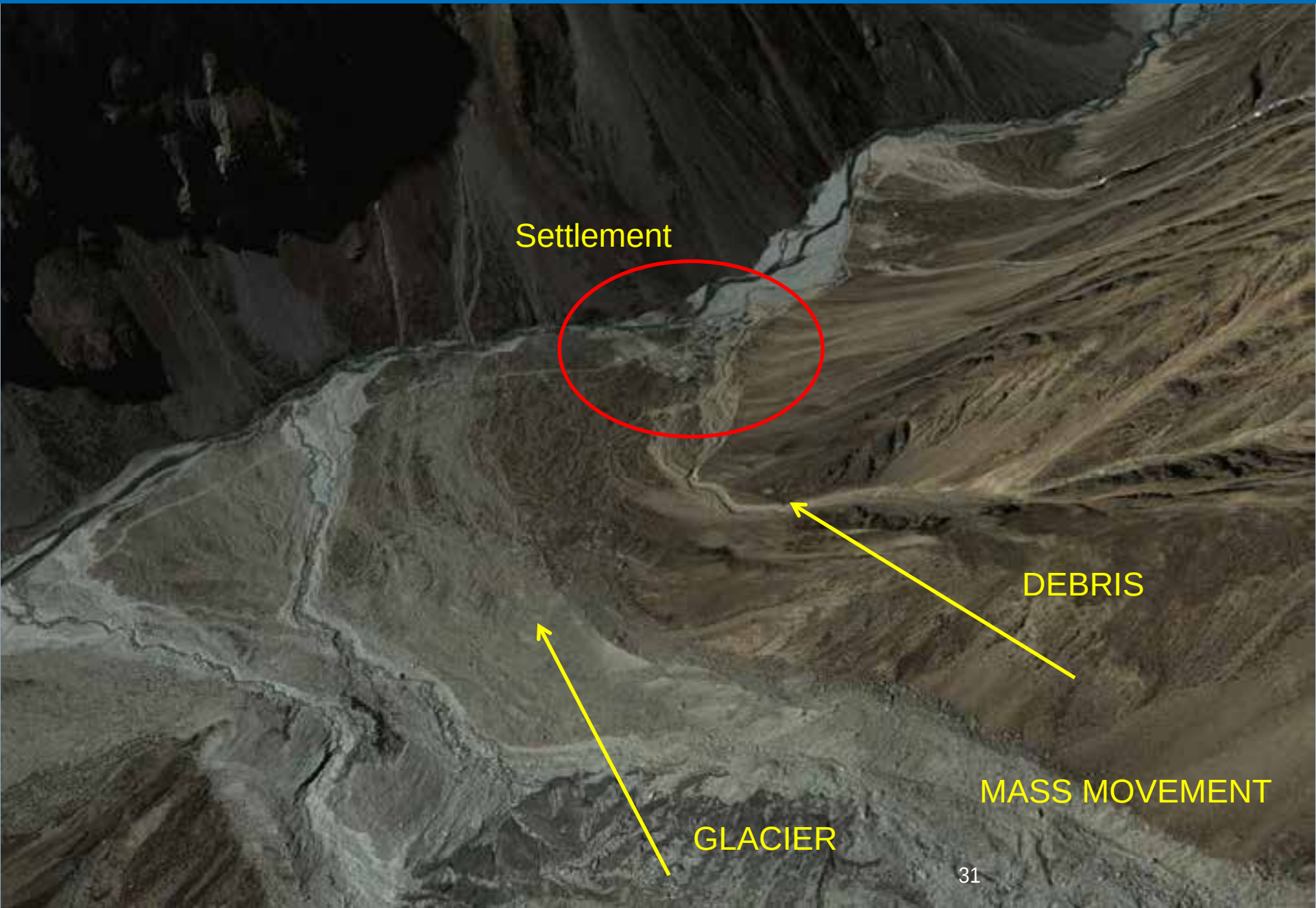
ASPECT MAP


Glacier
Settlement
Legend
Flat
North
North East
East
South East
South
South West
West
North West
North
Kilometers
0
1
2
4

SLOPE VISUALIZATION



GEOMORPHOLOGY



PROBABILITY OF GLACIAL HAZARD OCCURRENCE

SITE	ABC
Area	Sq Km
Degree of Risk	80-100 (%)
Qualitative Degree of Risk	Dangerous
Probability	High
Remarks	Re-Location

CONCLUSIONS

- The Shyok and Shigar basins having ice reserve of 2,738 km^3 are subjected to manifest of global warming which is causing their decay, posing the glacial hazard to the settlements in the vicinity.
- The volumetric decrease of Baltoro, Biafo and Siachen glaciers is calculated as 7 % with an increase of 1.78^{0}C average temperature rise during the decade.
- The aspect, slope, loc, elev and geomorphology are the major factors for volumetric decrease / depletion of the glaciers, which must be catered for while sitting a settlement.

CONCLUSIONS

- The impacts of glaciers volumetric decrease / depletion like avalanches and outburst floods need monitoring and early warning systems to protect infrastructure.
- The settlement site under threat of glacial mass movement and debris flow, loc on the margins of an alluvial fan will make the probability of occurrences very high.
- The seismic activities should be closely watched and in case of any such activity, the situation on glaciers should be monitored aerially.

CONCLUSIONS

- The dangerous moraine dams formed as a consequence of volumetric decrease of glaciers, near the headwaters and settlements be monitored regularly.
- In the HKH region, inter-country flood warning systems should be established by devising a mechanism for sharing the costs and benefits of flash flooding mitigation works.

Thank You

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