



SPACE BASED ASSESSMENT OF GLACIER FLUCTUATION IN THE HUNZA BASIN, WESTERN KARAKORAM, PAKISTAN

Presented by:

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**Pakistan Space & Upper Atmosphere Research Commission
(SUPARCO)**

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Presentation Outline

- **Background**
- **Objectives**
- **Study area**
- **Methodology**
- **Results**
- **Conclusion**

Background

➤ ***Glaciers***

- **Sensitive indicator of climate change**
- **Contain a considerable part of the world's fresh water**
- **Critical component of the Earth's system**
- **Fluctuation in glacier represents fast and abrupt climate change**

➤ ***Glaciers impacts on environment and human***

- **Natural disaster**
- **Water supply**
- **Economic livelihood**
- **Sea level change**

Background conti....

➤ ***Problems***

- **Lack of systematic observation of the glaciers extent**
- **Complex topography**
- **High elevation**
- **Remoteness of the terrain**
- **High altitude climate records**

Background conti....

- ***Currently, limited studies on glaciation in the Karakoram Mountains***
- **Inform no ice loss and slight mass gain**
(Cogley 2012, Gardelle et al., 2012)
- **Retreat and advance of glaciers are reported**
(Hewitt 2005, Rankl, Kienholz and Braun 2014, Bishop et al., 2008)
- **The situation is still unclear which factor control glacier behavior**

Background conti....

- **Remote sensing approach promise to offer new insight into the nature of glacier fluctuations**
- **RS and GIS in glacial studies plays an important role to find out the scientific reasons**
- **Systematic approaches may develops spatial database of contemporary glaciers, which would be used significantly for understanding the present situation of glaciers fluctuations and dynamics**

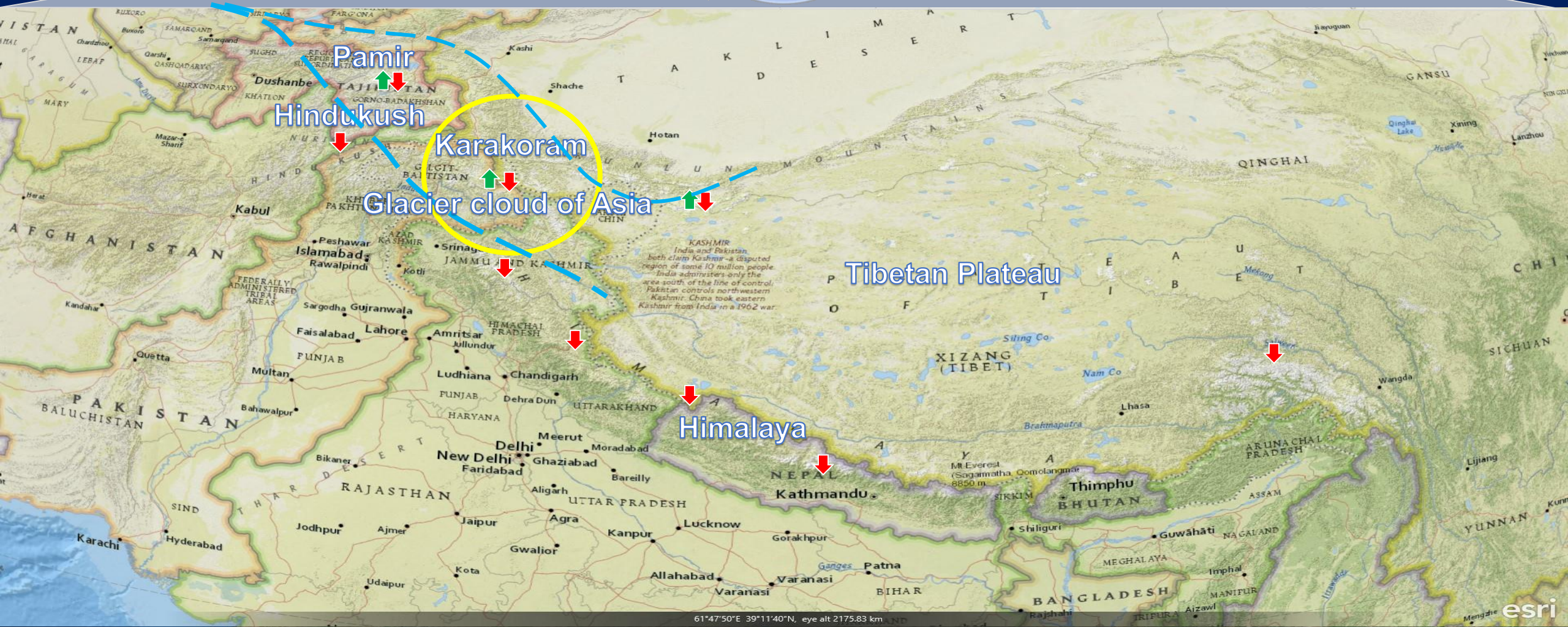
Objective

Determine the contemporary glaciers extent, fluctuation and understanding the present situation of glaciers dynamics

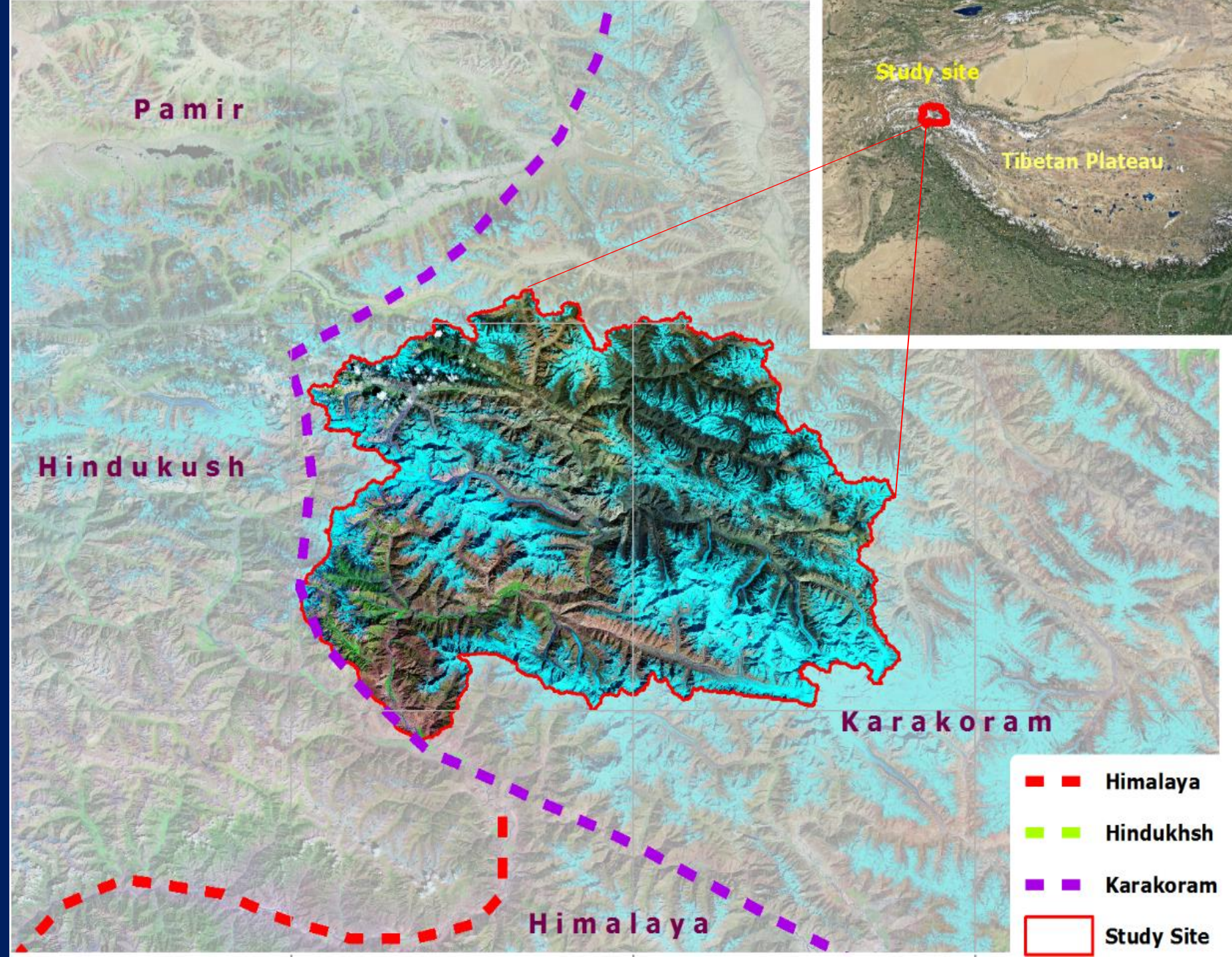
- **Implementation of remote sensing techniques to extract glacier extent (1973 to 2014)**
- **Apply GIS methods to calculate glacier parameters (area, length, slope, aspect)**
- **Analyze the changes in glacier parameters**

Study Area

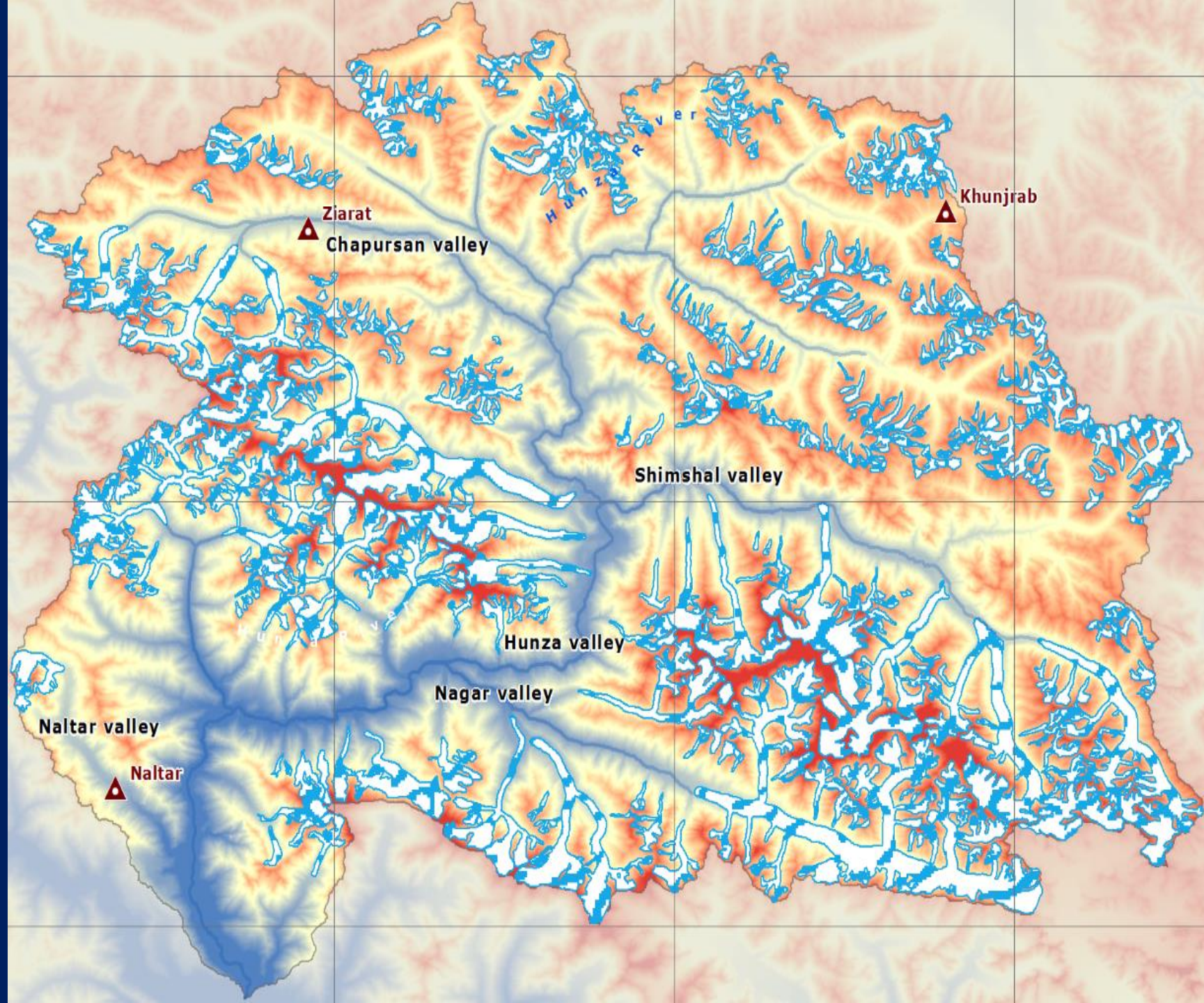
Regional Overview



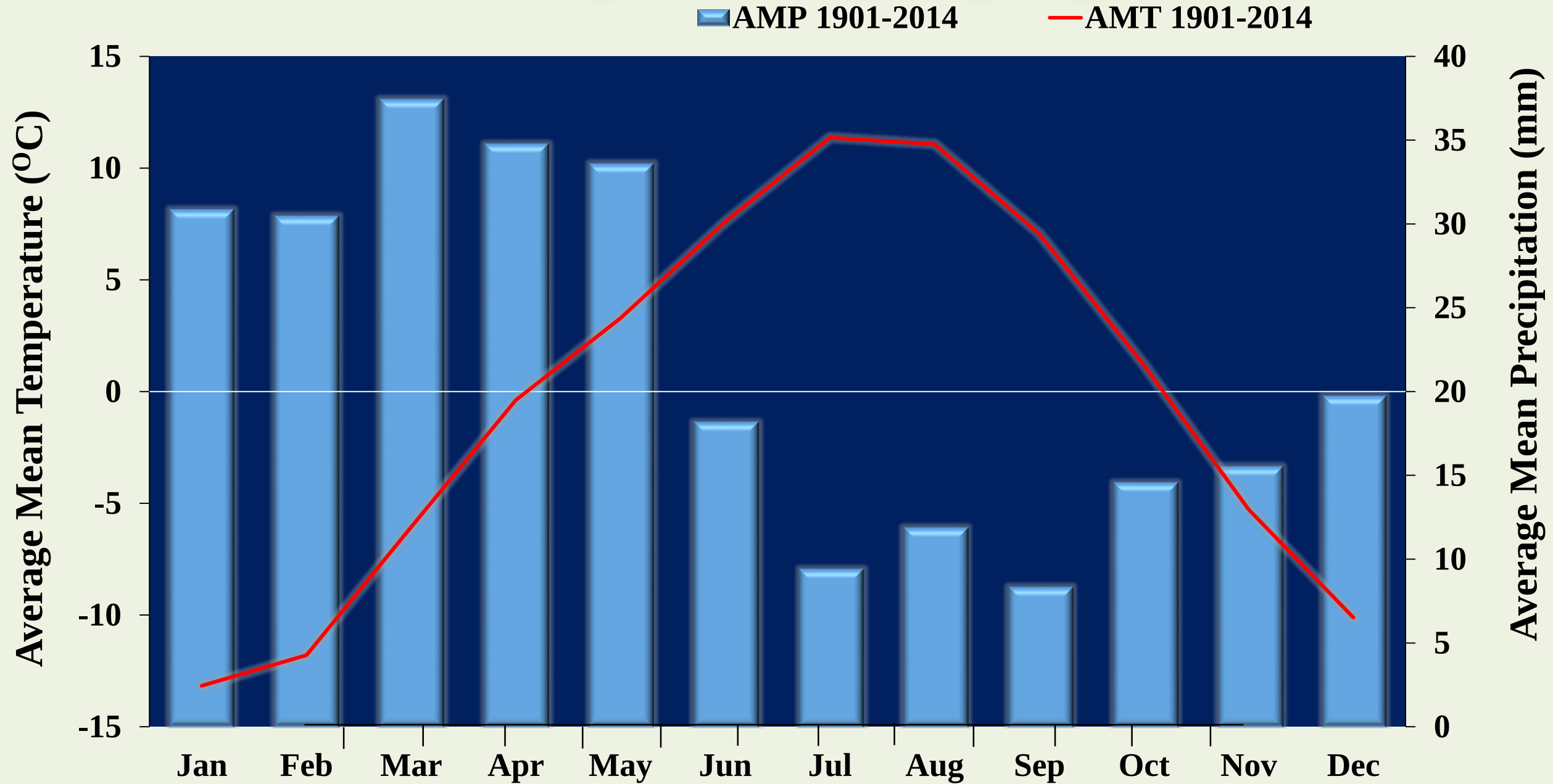
- The Hunza Basin is an important sub-basin of the Upper Indus Basin (UIB)
- Geographically, it is located in extremely northern part of Pakistan



- The basin covers 13,718 km² catchment area
- Elevation range from 1391 to 7850 m above sea level
- The basin contains several large glacial systems such as Hispar (349 km²) and Batura (226 km²)



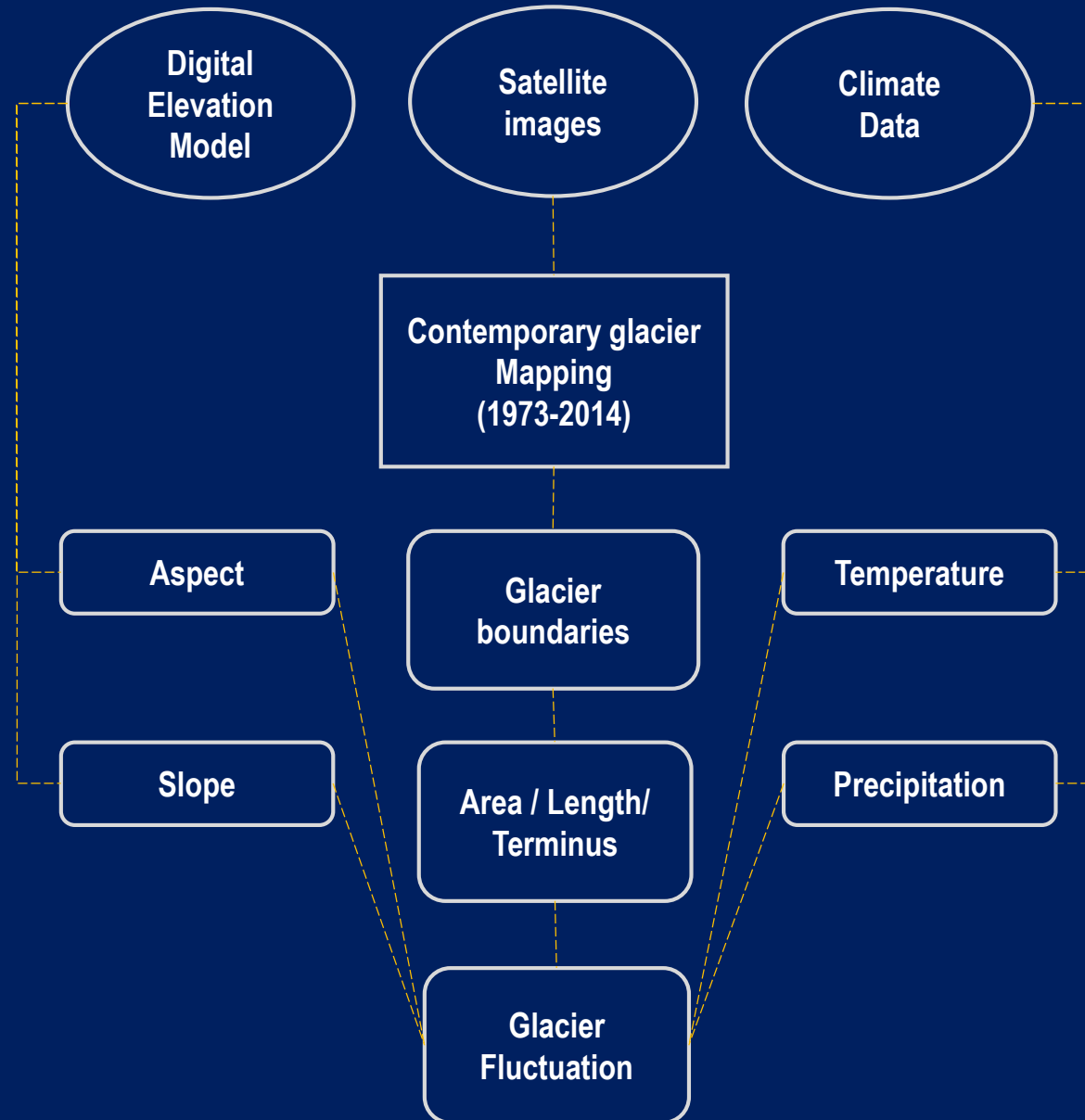
Study area - Climate (CRU)



Dataset

Data source	Path/ Row	Acquisition Date	Image resolution (meter)	RMSE
CORONA KH-9	DZB/1206	Aug-1973	8	7.25 (58 m)
	DZB/1207			
Landsat-8 Operational Land Imager (OLI)	149/34	Sep - 2014	30	0.12 (3.6 m)
	149/35			
	150/34			
	150/35			
Landsat-5 Thematic Mapper (TM)	149/34	Oct - 2008	30	0.12 (3.6 m)
	149/35	Aug - 1998	30	0.0
	150/34	Oct - 1992	28.5	0.15 (4.27 m)
	150/35			
Landsat-2 Multispectral Scanner (MSS)	160/34	Aug - 1977	57	0.5 (28.5 m)
	161/35			
SRTM	-	Feb 2000	30	0.25 (7.5 m)

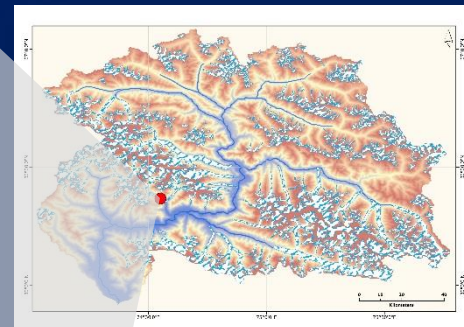
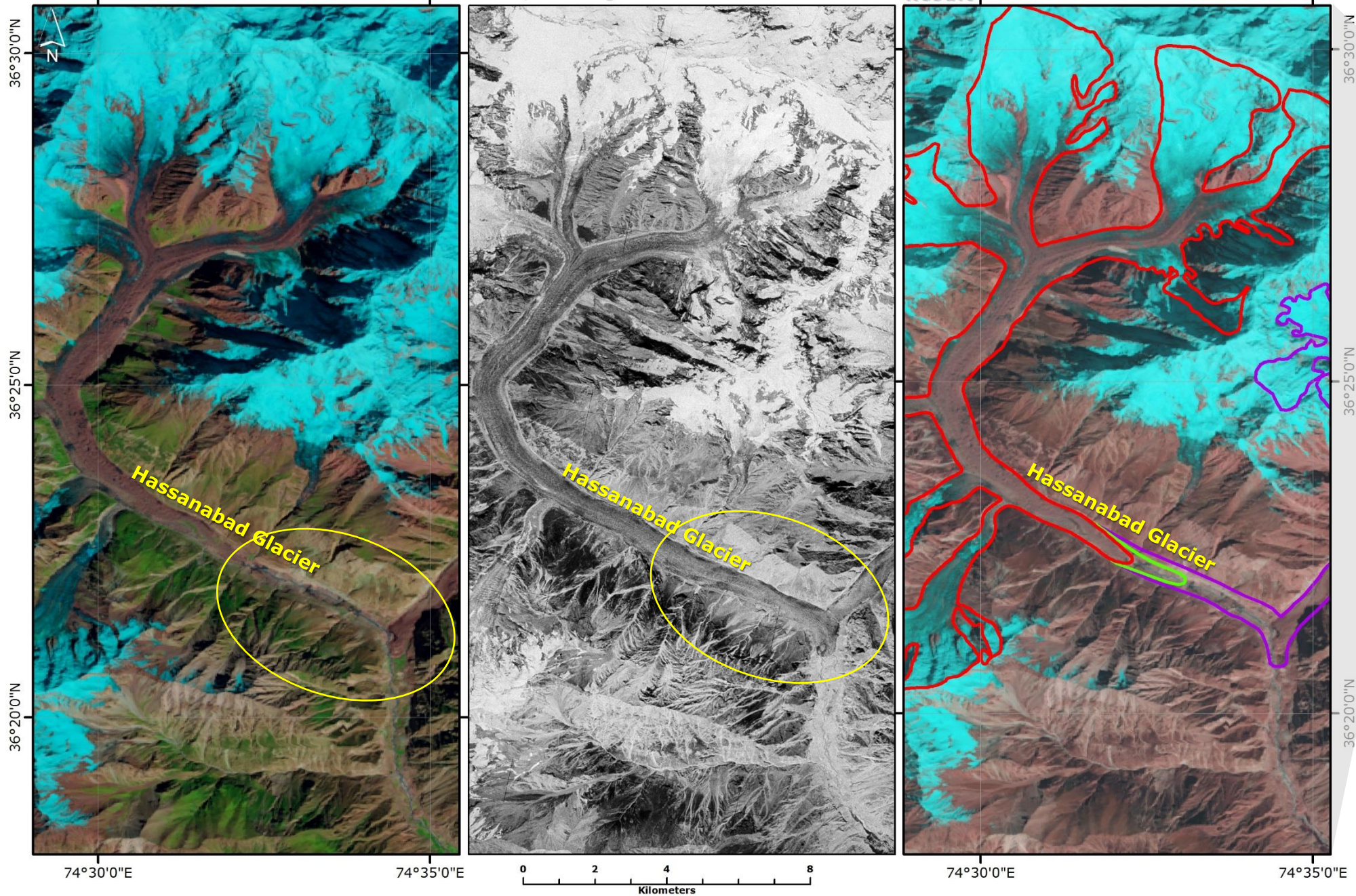
Methodological framework



Landsat-10-Sep-2014

KH-9, 04-Aug-1973

Result



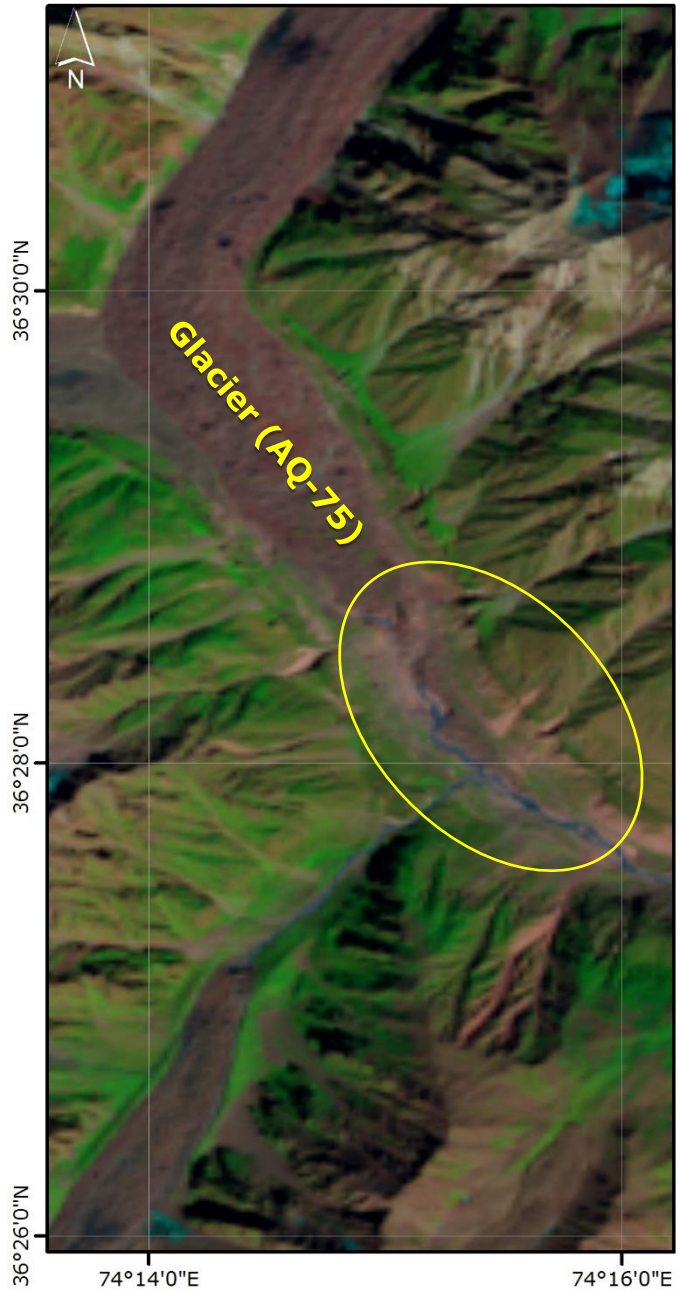
Analysis:

Hassanabad glacier (AQ-84) slightly advancing occurred in length is about 356 meter during the period 1973-1977 and retreating observed from 1977 to 2008 at an average rate of 51 m/y. although, its behave as a stable mode from 2008 to 2014.

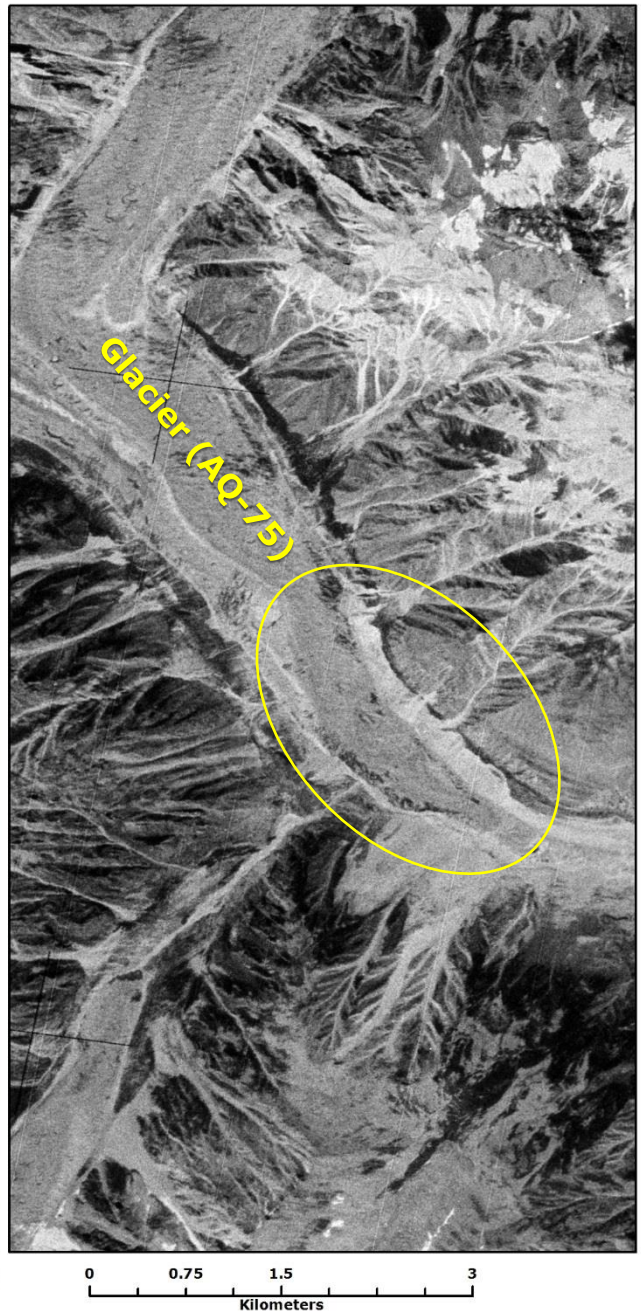
Glacier Boundary



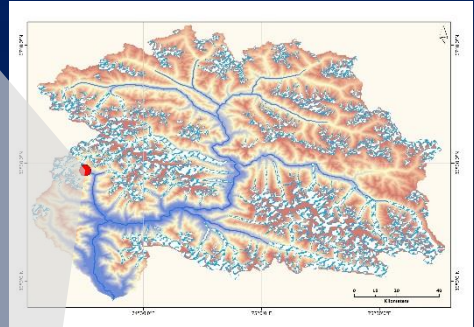
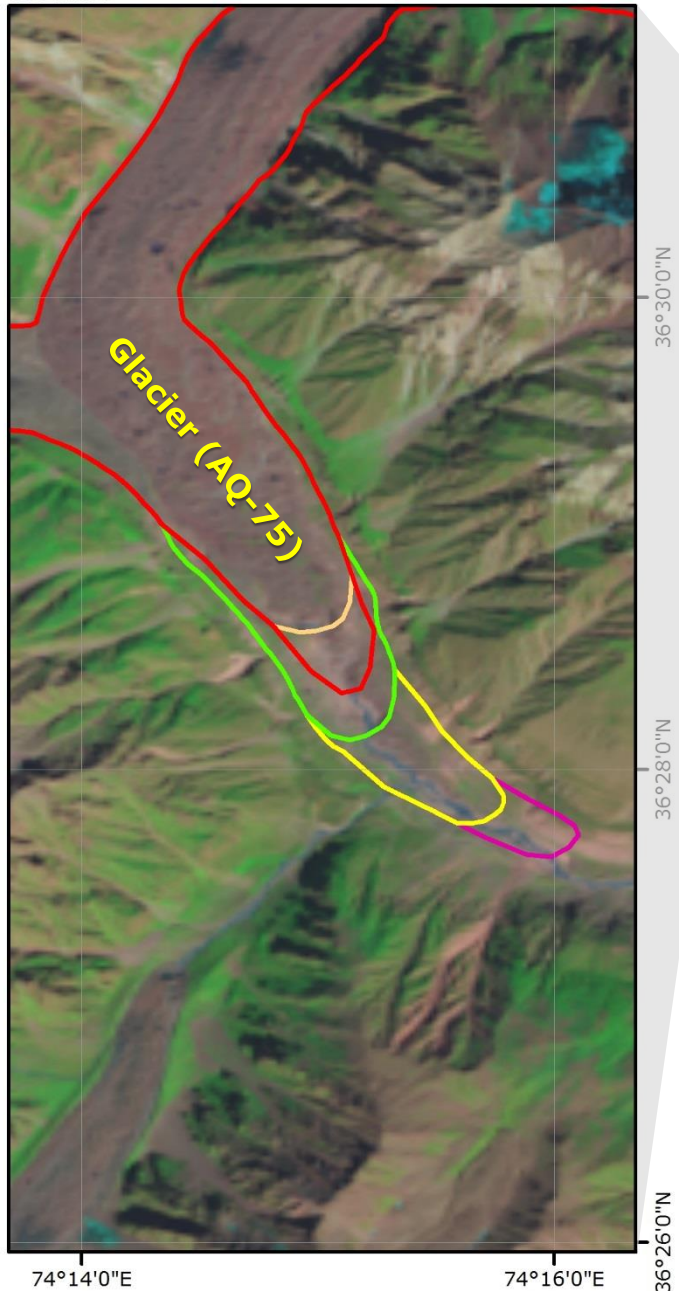
Landsat-10-Sep-2014



KH-9, 04-Aug-1973



Result



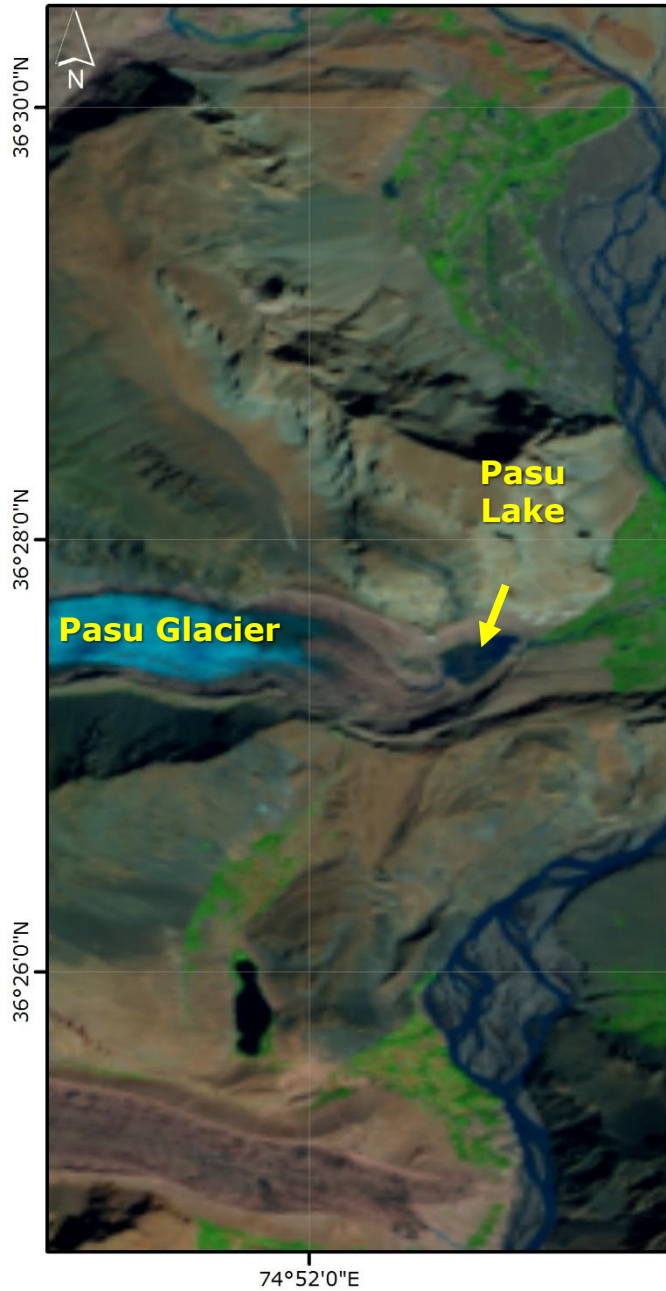
Analysis:

Retreating observed in length from 1977 to 2008 at an average rate of 25.8 m/y. from 2008 to 2014 on advancing mode at an average rate of 88 meter per year.

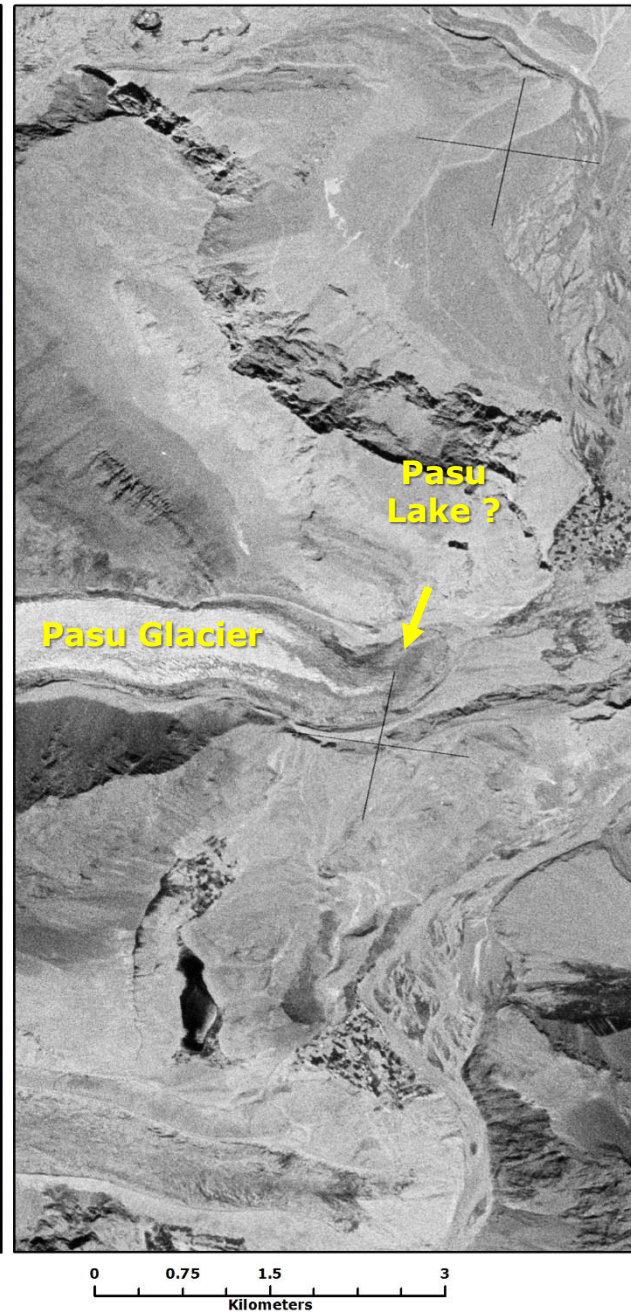
Glacier Boundary



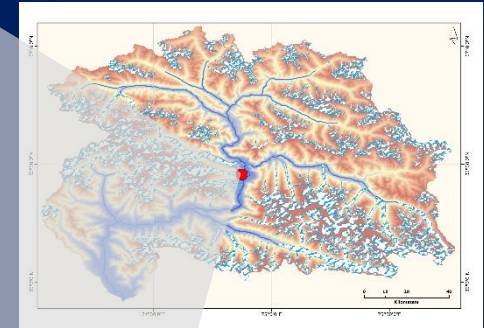
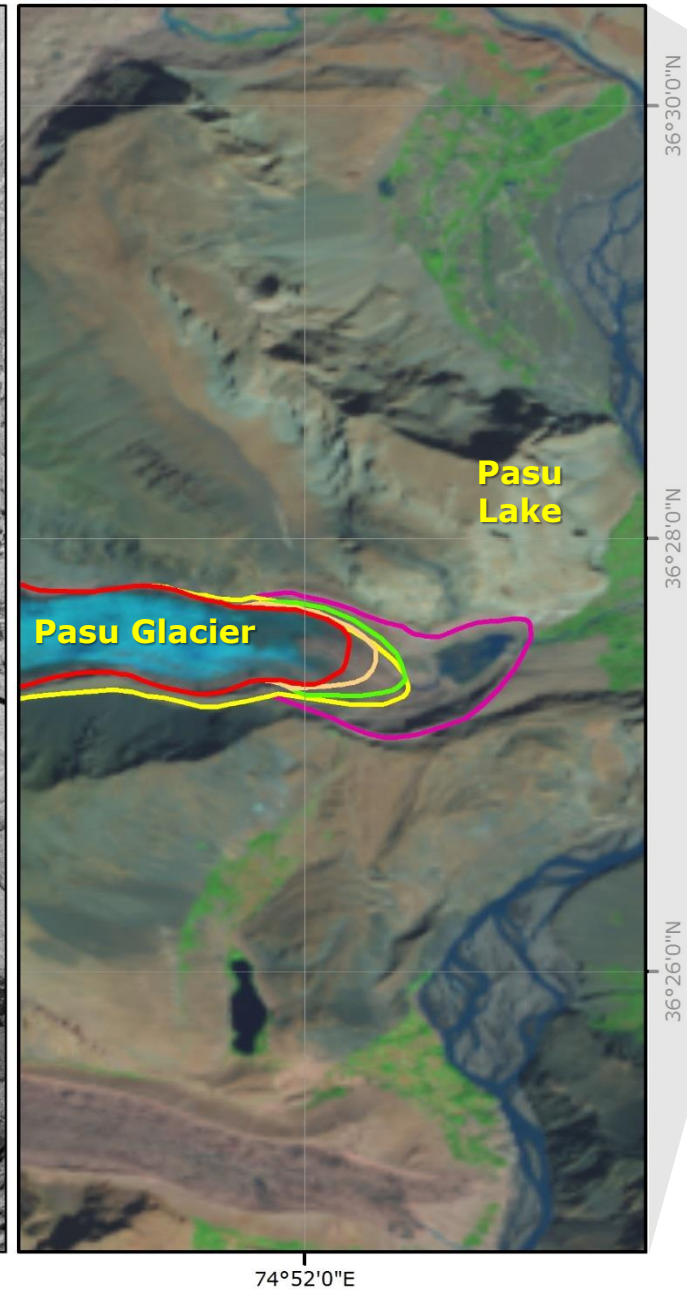
Landsat-10-Sep-2014



KH-9, 04-Aug-1973



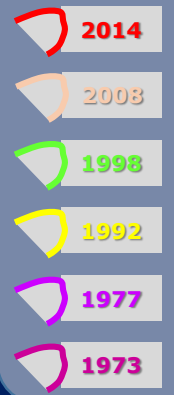
Result



Analysis:

Retreating observed in the length on Pasu glacier (AQ-58) from 1977 to 2014 at an average rate of 11.4 m/y. It is also noted that the Pasu lake may developed during the period of 1973-1992 when glacier average retreat rate of 47 m/y.

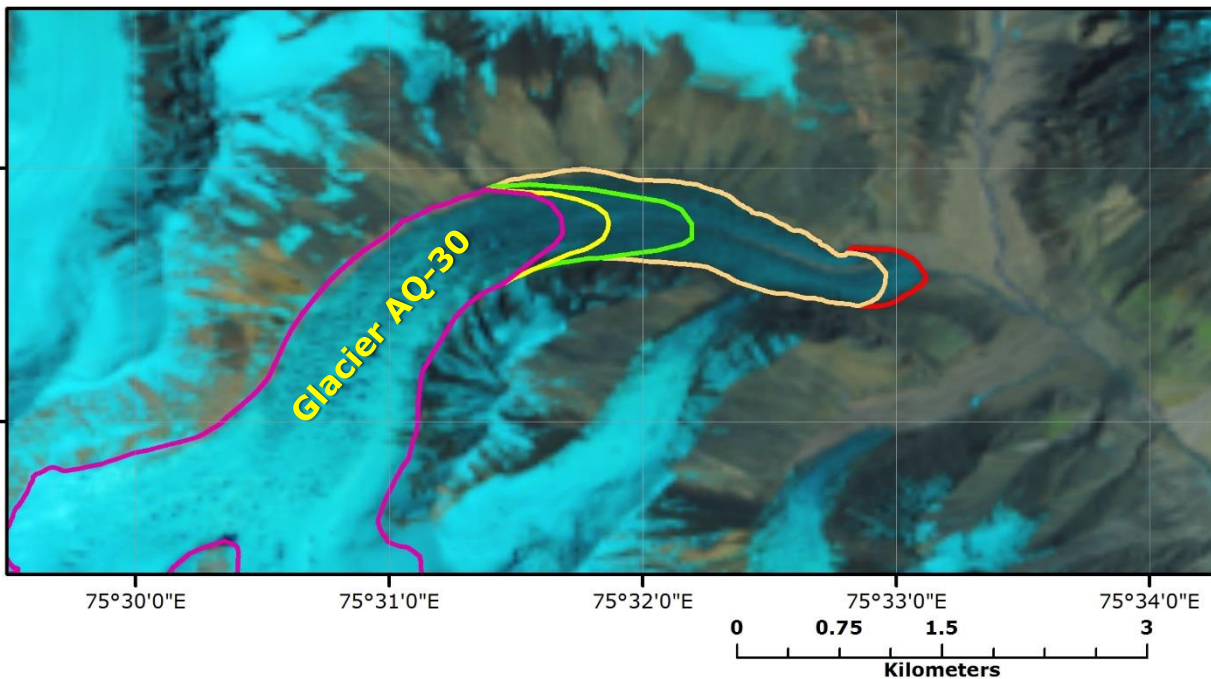
Glacier Boundary



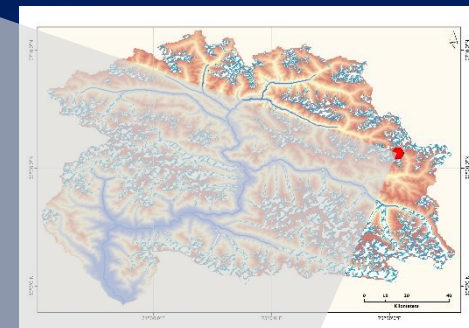
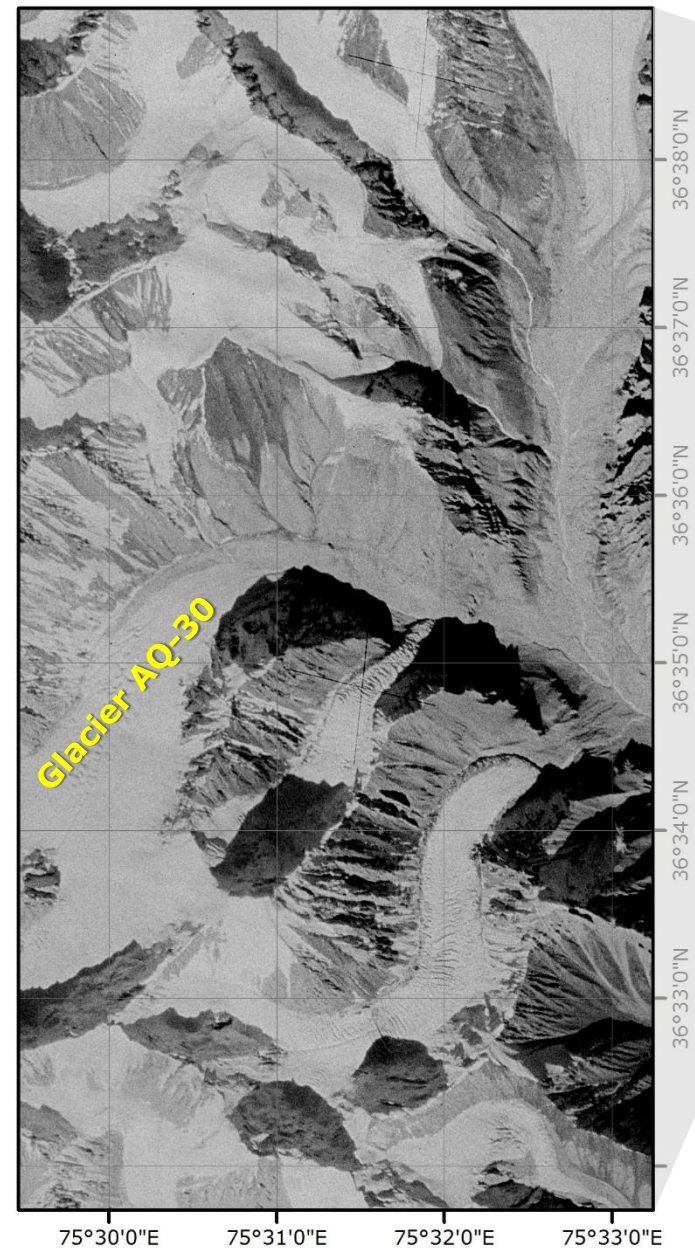
Landsat, 10-Sep-2014



Result



KH-9, 04-Aug-1973



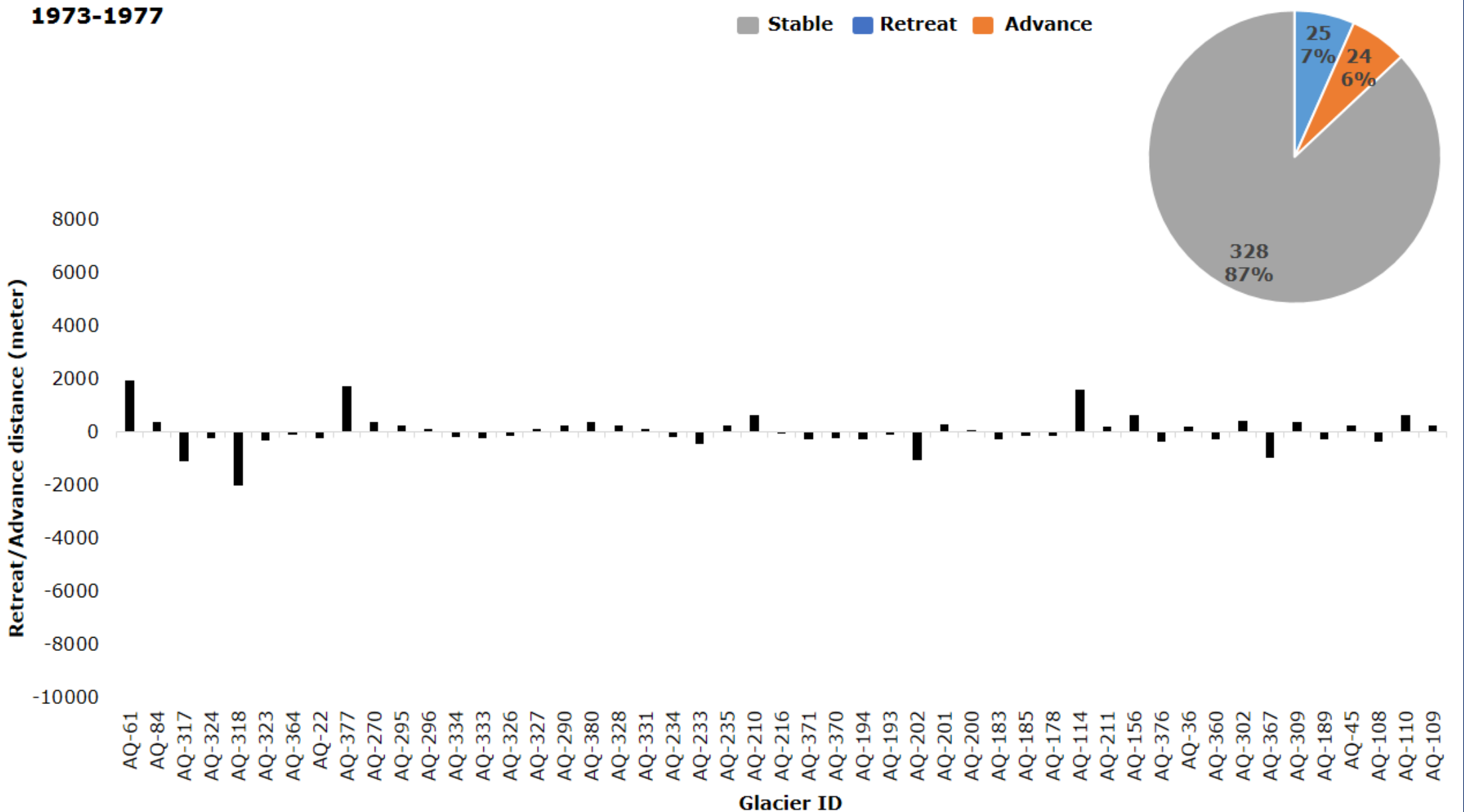
Analysis:

No changes in length observed from 1973 to 1977. advancing observed from 1977 to 2014 at an average rate of 15 m/y. An abrupt advancing found between 1998-2008 at the rate of 122 m/y

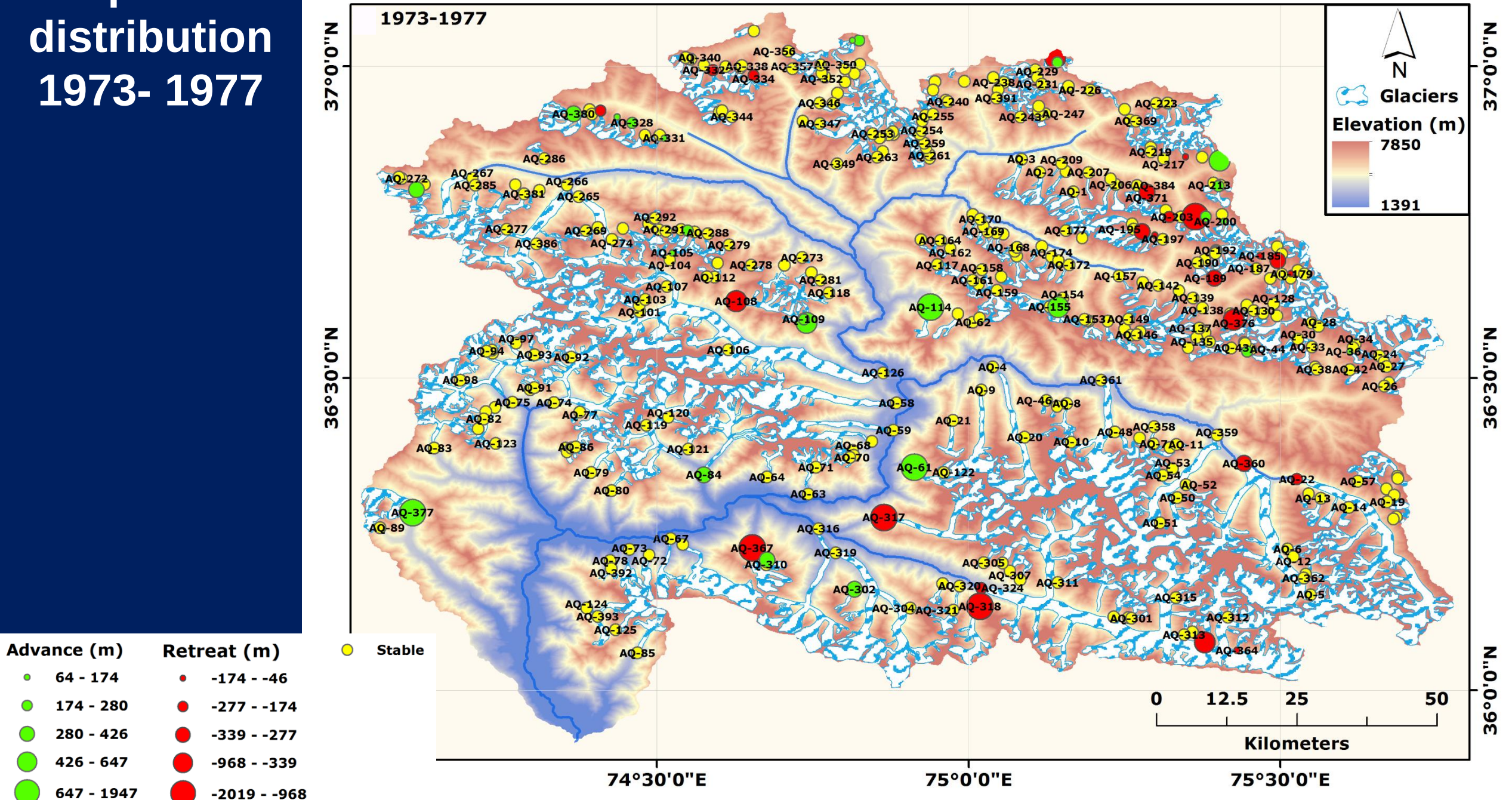
Glacier Boundary



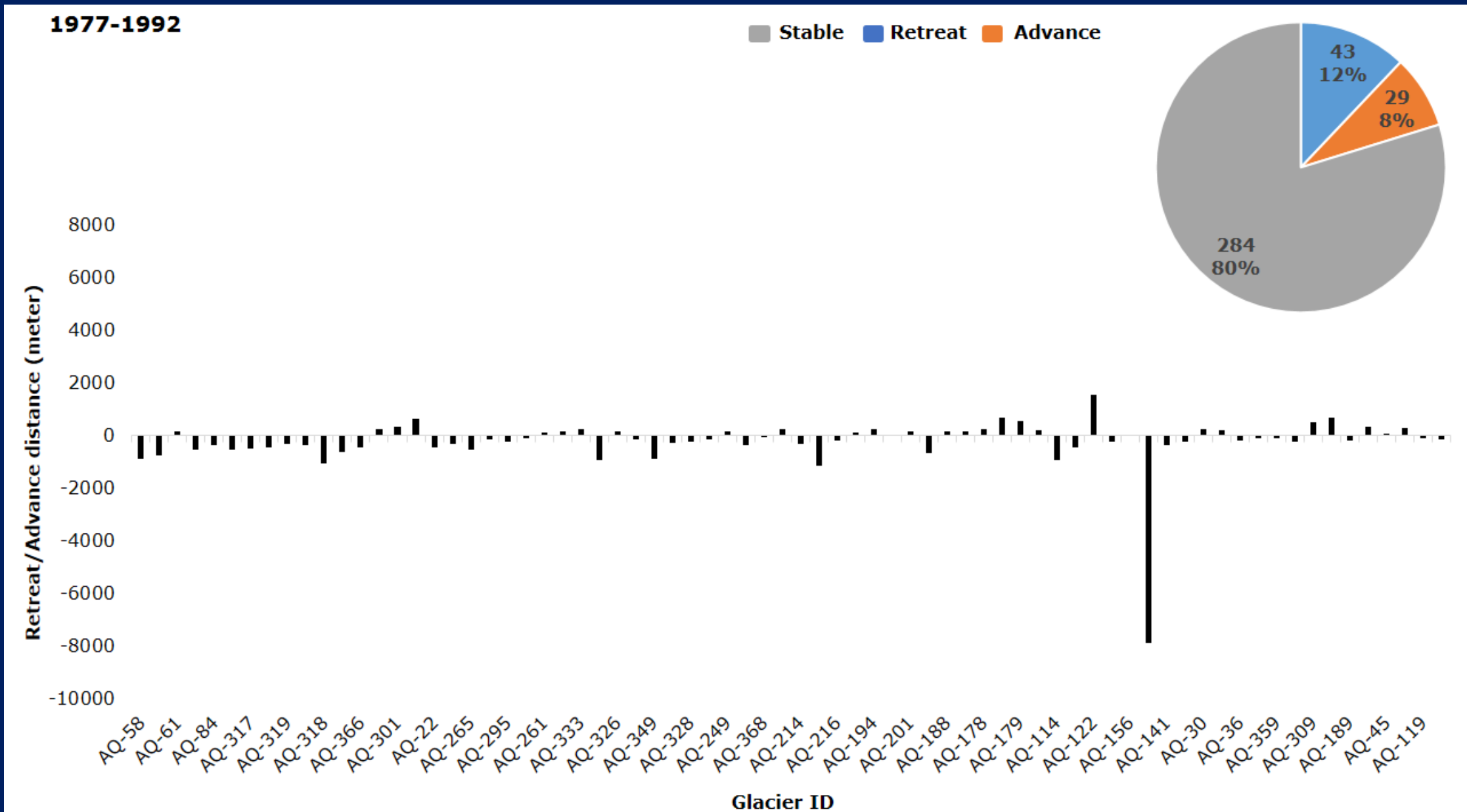
Statistical analysis of glaciers changes between 1973- 1977



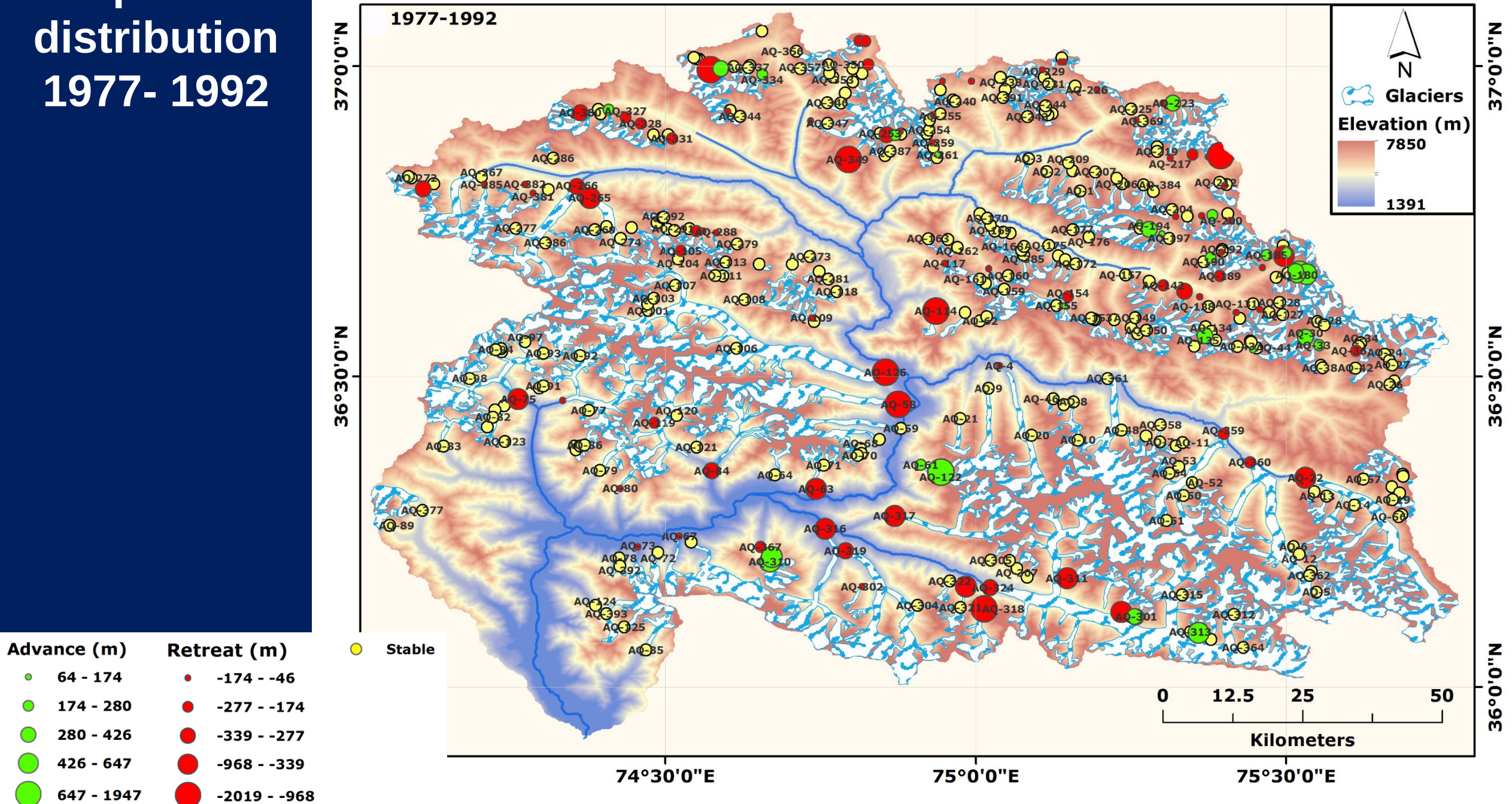
Spatial distribution 1973- 1977



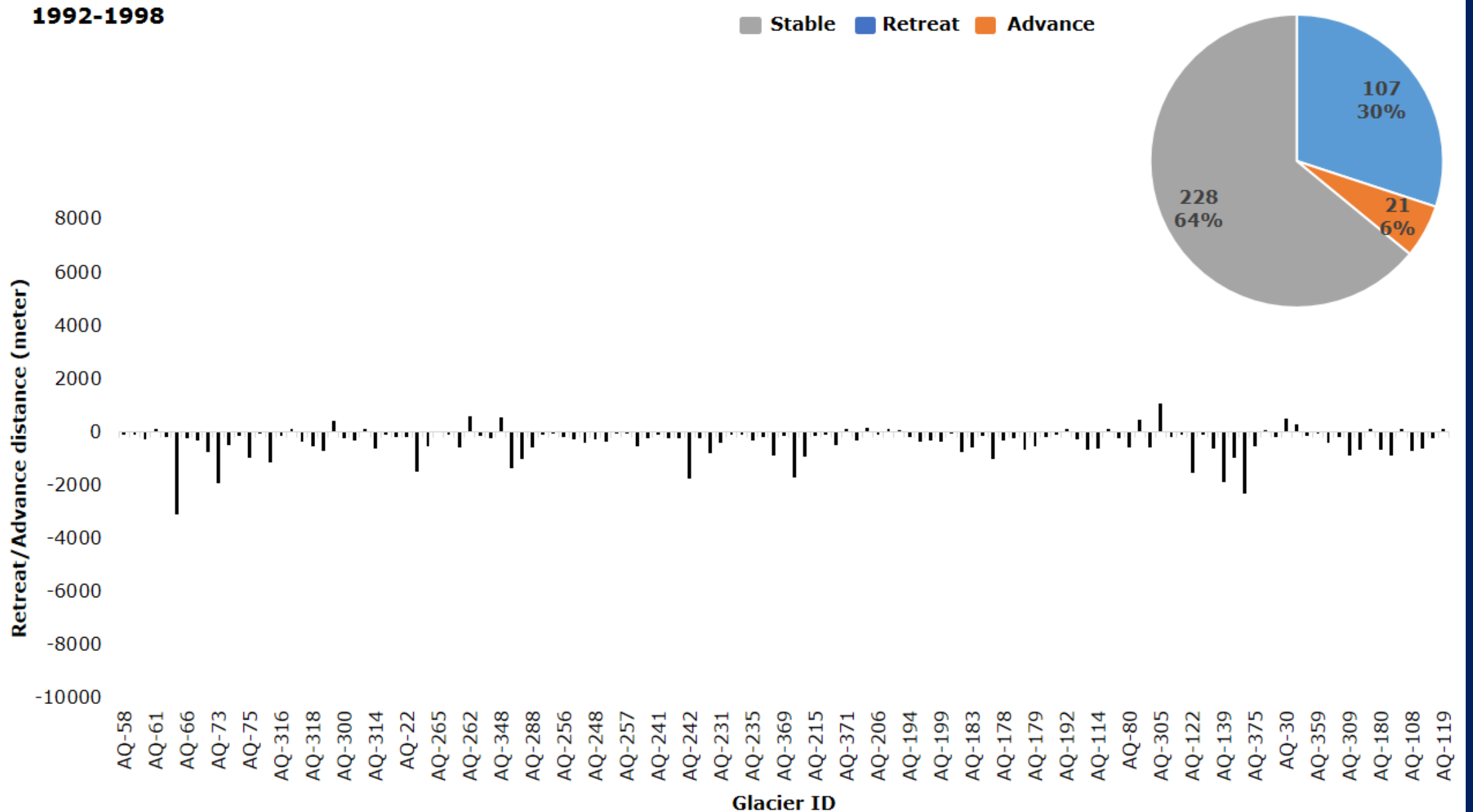
Statistical analysis of glaciers changes between 1977- 1992



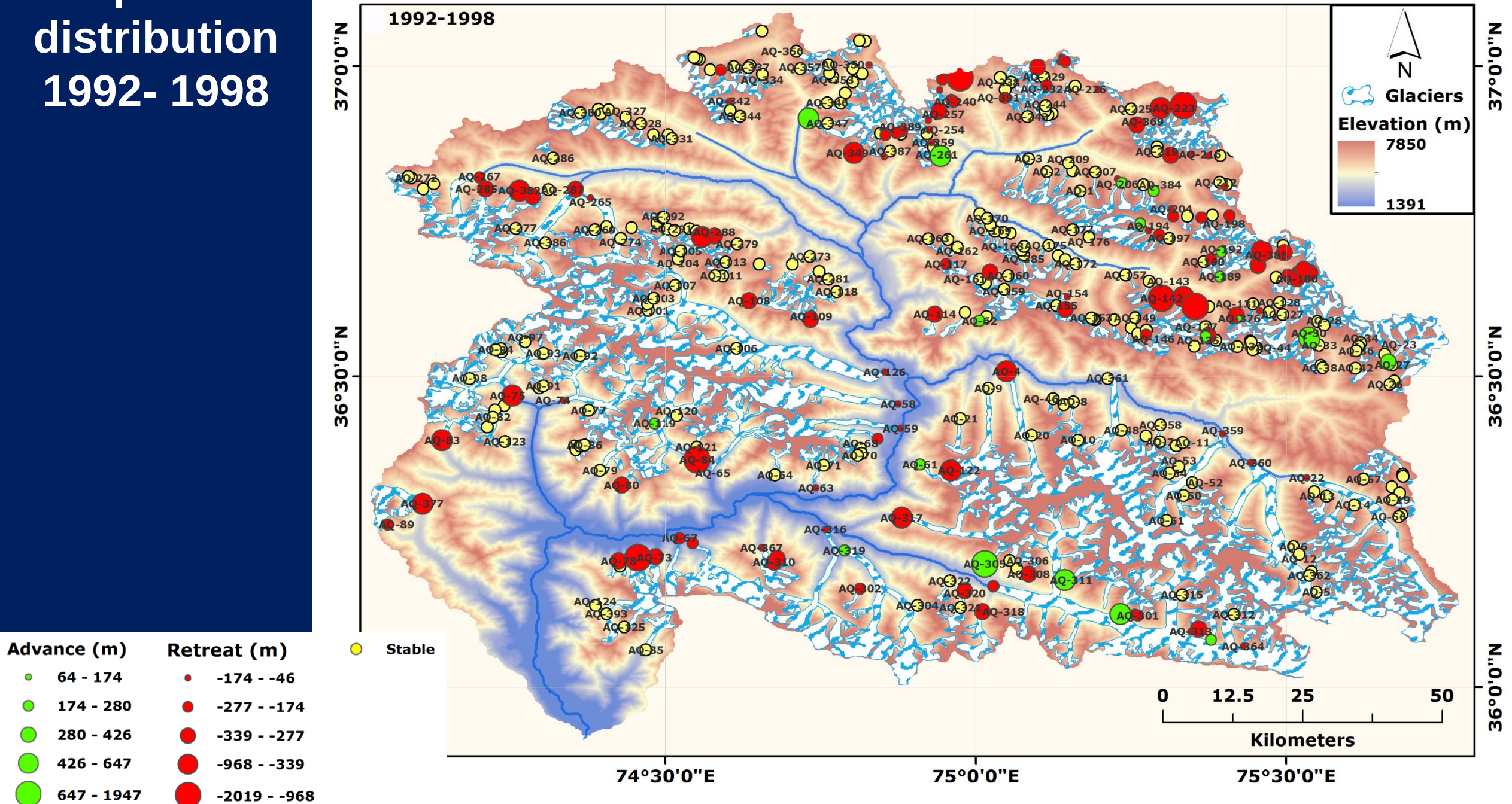
Spatial distribution 1977- 1992



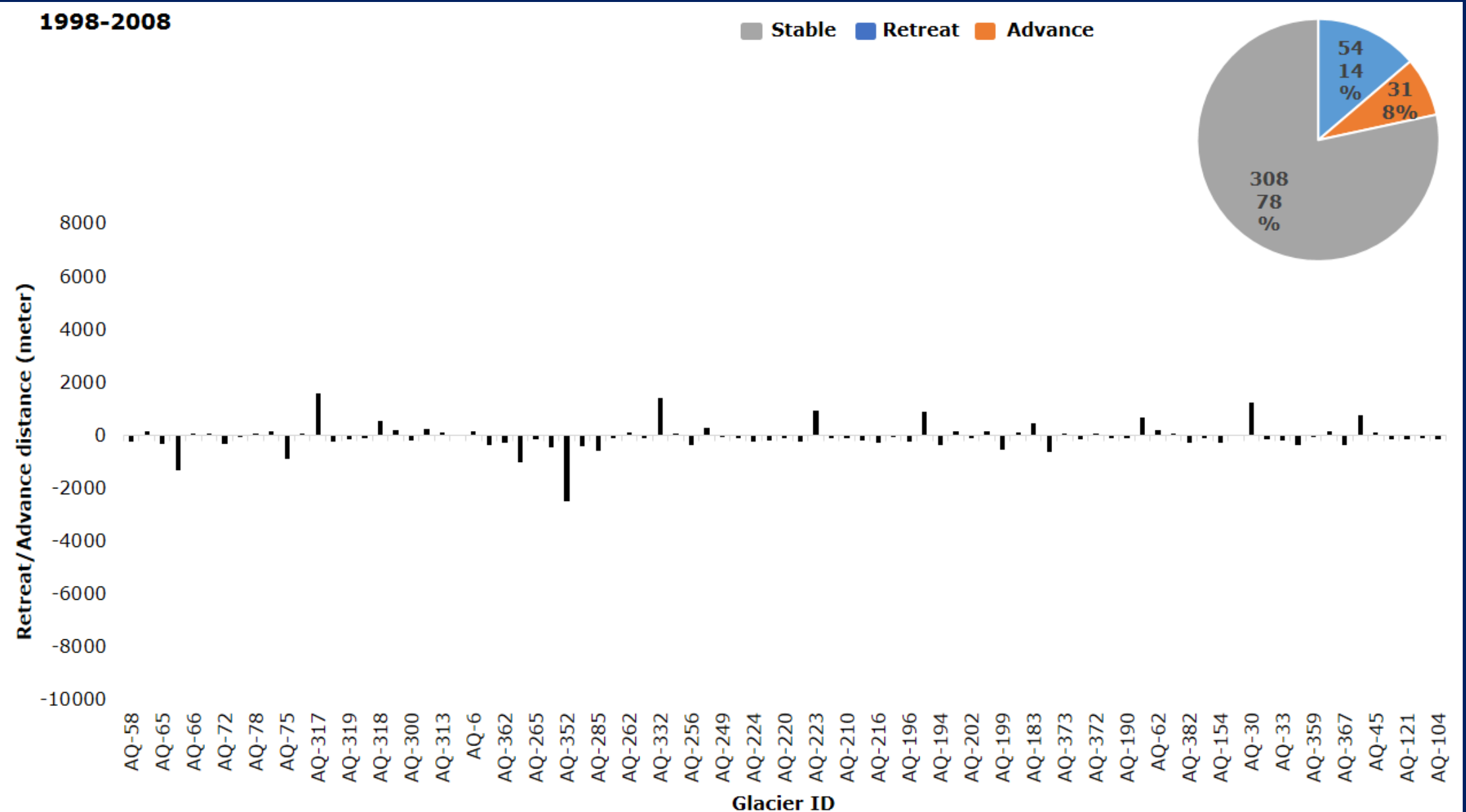
Statistical analysis of glaciers changes between 1992- 1998



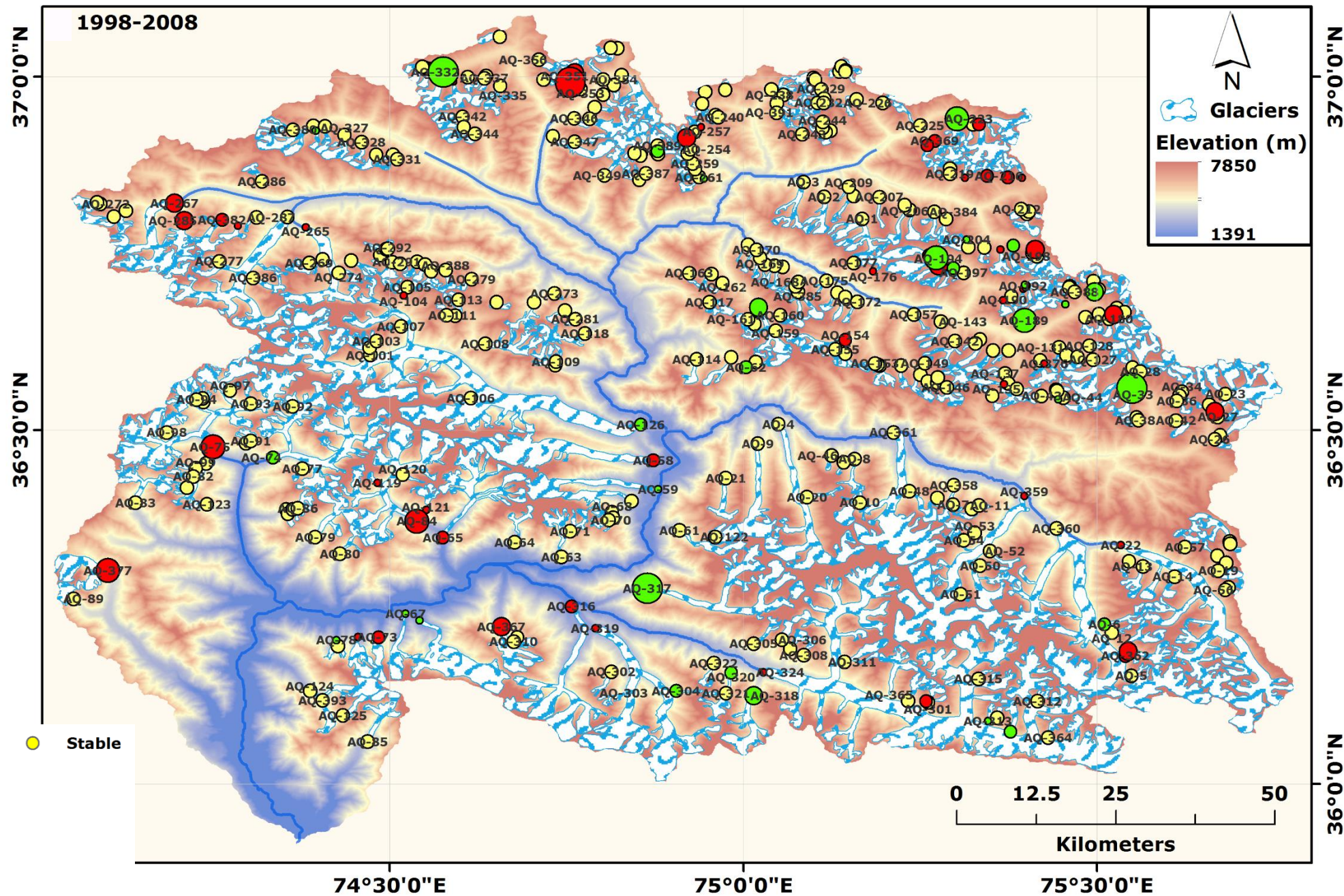
Spatial distribution 1992- 1998



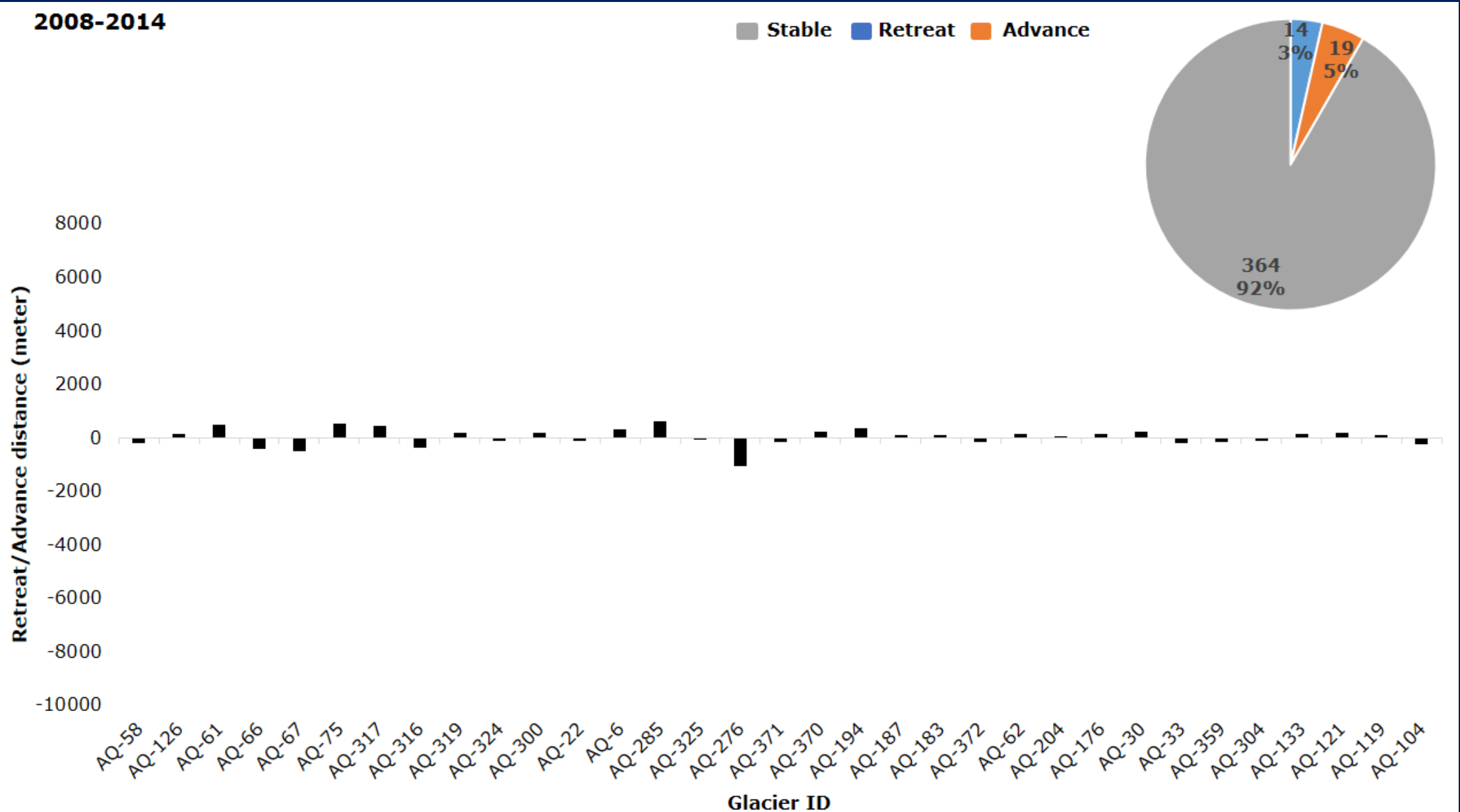
Statistical analysis of glaciers changes between 1998- 2008



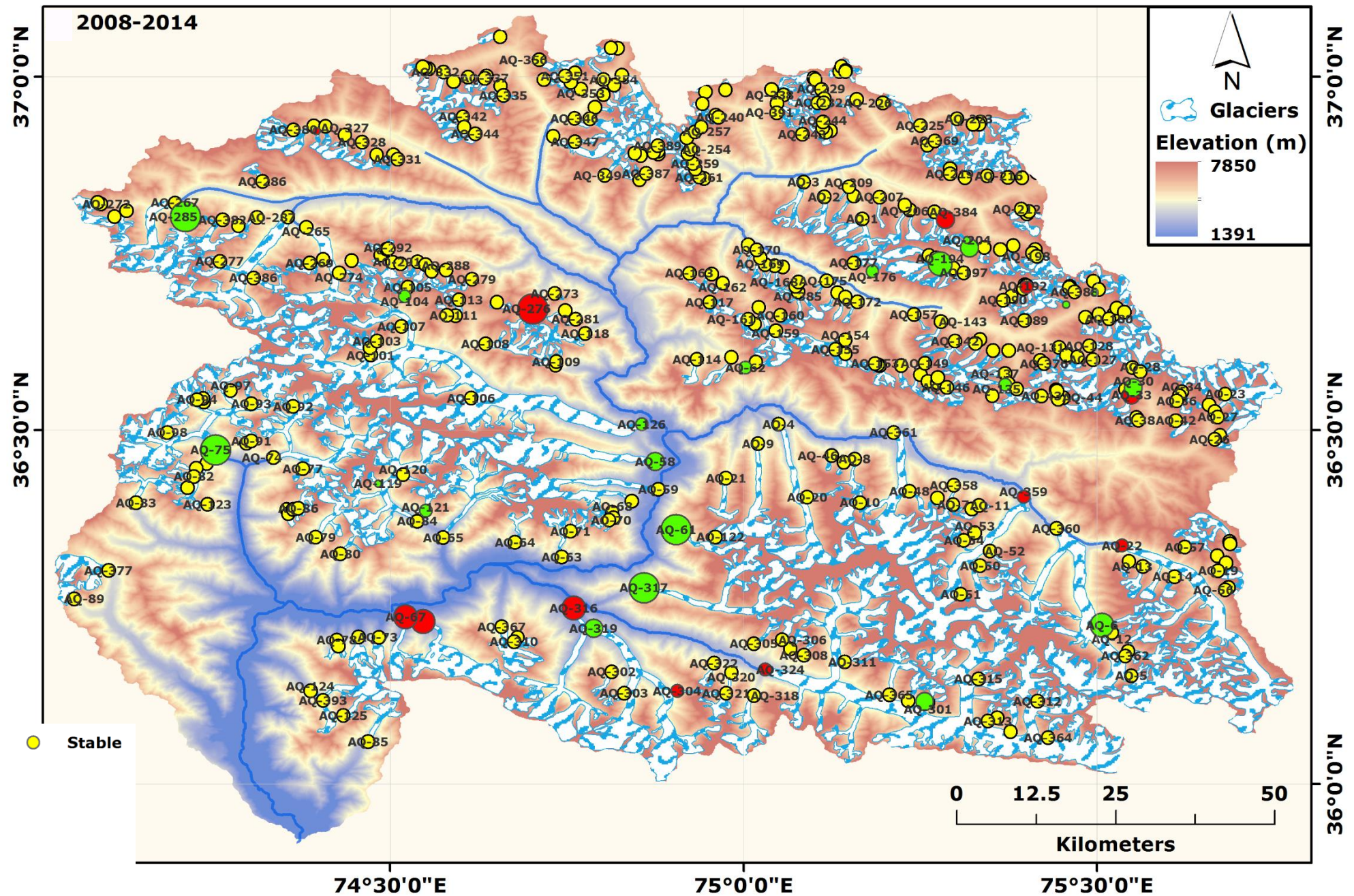
Spatial distribution 1998- 2008



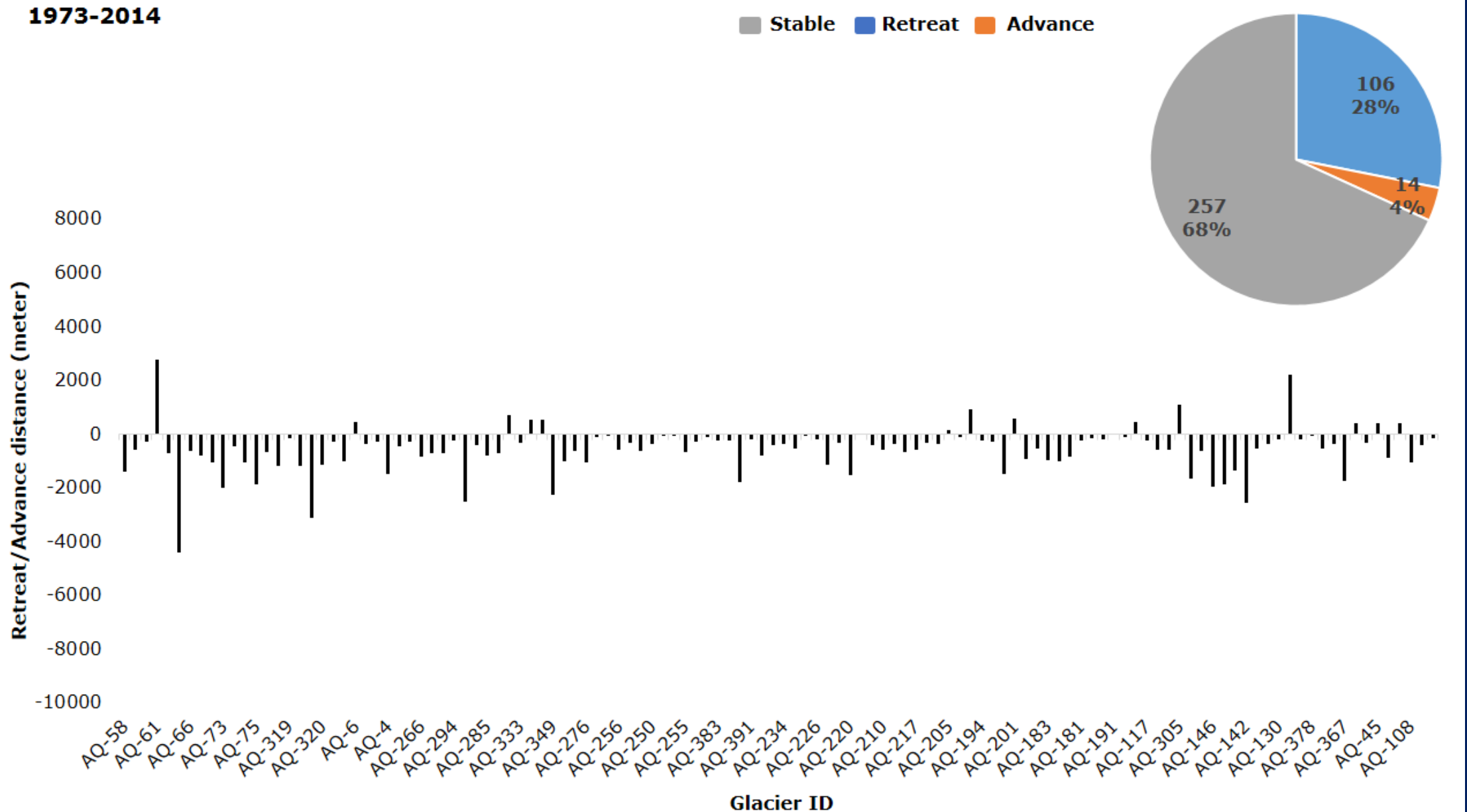
Statistical analysis of glaciers changes between 1998- 2008



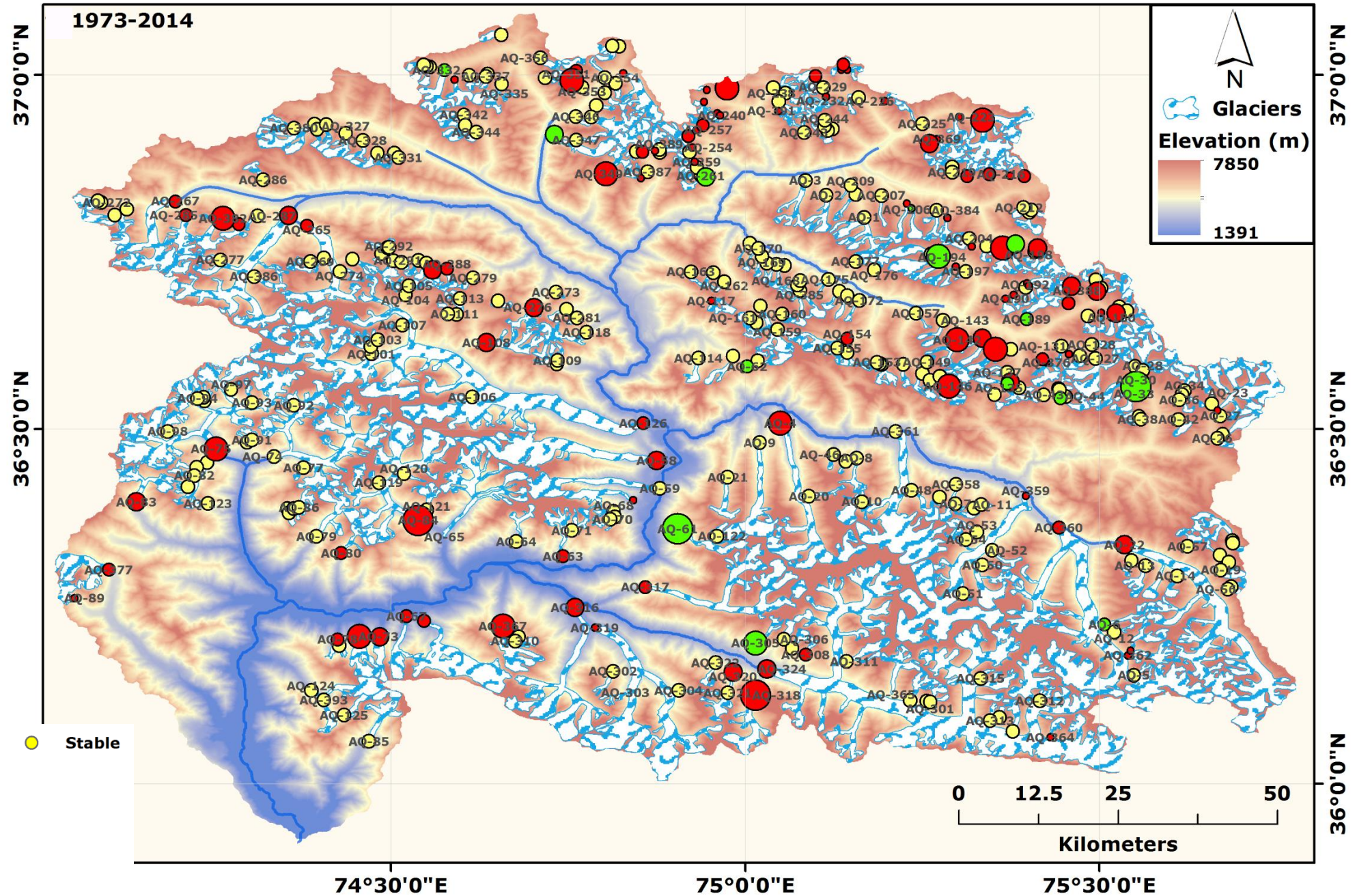
Spatial distribution 2008- 2014



Statistical analysis of glaciers changes between 1973- 2014



Spatial distribution 1973- 2014



Conclusion

- **Glaciers of various size and orientation have examined**
- **Our analysis reveals that the larger glaciers with lower terminus altitude don't show greater retreat distance**
- **The number of retreating glaciers during 1992-1998 is account for about 30% suggesting the glacier retreat was extensive**
- **An increase trend occurred in 1998-2008 (8%) and 2008-2014 (5%)**
- **The stability of the glacier appears to be associated with increased trend in winter precipitation**
- **The frequency of retreating glaciers is decreased and glaciers are in stable position**

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Thanks for your attention!