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Glacial Retreat in the Pamir Mountains, Tajikistan

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A Literature Review

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Introduction

Tajikistan is a mostly mountainous country considered the main glacial center of Central Asia due to its orography. The country borders Uzbekistan in the north and Kyrgyzstan to the west. On its southern border is Afghanistan while to the east is China.

³ Glaciers are the wealth of Tajikistan, regulating not only its river flows but also the climate.

Glaciers occupy about 8,400 square kilometers of Tajikistan, a whopping 6% of the total land area.

In the recent past, Tajikistan has been witnessing massive glacial retreats drawing the attention of authorities and researchers. Of particular interest is the zone around Pamir Mountains, Hindu Kush and Karakoram. Historically, this area is known to have the highest accumulation of glaciers after the polar glaciers. However, observations have established massive glacial retreats in the region that threaten future hydrological cycles.

Research into glacial retreat of the Pamir Mountains has however been hit with challenges due to the nature of the glacial melts. In the Northern parts of the Pamir and Karakoram, there are decreasing runoff trends. Summer temperatures have also been decreasing in the region while precipitation rates are on the increase. In contrast, precipitation occurs in winter on the Southern parts of the Pamir. Contrary to the expectations, the increased precipitation does not reduce glacial retreat.

Aim of study

Several hypotheses have been raised over the different phenomenon observed in the Pamir region. For instance, researchers believe that the differences are as a result of hydrological and geographical formations of the regions. Others attribute the differences to the unpredictable surge glaciers prevalent in the region. Without a proper understanding of the phenomena, addressing the challenges of glacial melting can be challenging. This paper

seeks to establish the underlying causes of glacial melting in the Pamir region and its consequences to the communities downstream.

Key concepts: Glacial Retreat, Ice Surge, Snow stock

Methods

Some glaciated regions experience surge type glaciers. These are characterized by sudden and massive glacial movements after long periods of stability. The Pamir-Karakoram and Alaskan-Canadian regions experience these movements, unlike the glaciers of the Alps or the Antarctica. The instability of these glaciers makes it difficult to assess the climatic impacts of a region to the glaciers.

Given the abrupt movements, observations on glacial movements must be taken over a period of time in order to capture the changes. High Resolution satellites must also be used to capture any substantial changes on the moving glaciers. Existing literature has relied on high resolution sensing data to observe the short term movements of the glaciers. Digital Elevation Models are also analyzed to reveal any movements in glaciers. Differences in the elevation of a glacier over a period of time is an indication of a surge although these are more difficult to detect

To better grasp the underlying changes in glacial structures, it is imperative to compare data from current studies with studies in the past. Before the invention of high resolution recording instruments, researchers relied on photogrammetric surveys conducted over the areas of interest. Two of the mostly used studies were conducted in 1928 and 1958 over the Pamir Mountains (Knoche, Merz, Lindner, and Weise, 2017). These methodologies have been chosen for their coverage over a long period of time as essential for comparisons of glacial formations.

Results

Based on high resolution optical recording instruments, researchers were able to capture spatial glacier movements in the Pamir Mountain region. In a study by Kotlyakov and friends, it was found out that 55 glaciers surged in the region between 1973 and 2006 (Kayumov, 2010). The same study also revealed that 215 glaciers in the region were unstable. Another study revealed substantial changes in the elevation of glaciers along the Pamir- Karakorum and Himalaya range. Notably, the glaciers showed simultaneous thickening of the upper end and shortening on the tongues. This was a clear indication of glacial retreat over the periods observed.

In 1928, a photogrammetric survey over the Fedchenko-Tanimas region of the Pamir resulted to two detailed maps. These maps, drawn to a scale of 1: 50,000 have been instrumental in generating present day comparisons with positions of the past (Lambrecht, Mayer, Aizen, Floricioiu, and Surazakov, 2014). A similar study was conducted in 1958 in which baselines at an elevation of 5000 meters were captured. The 1958 study has been primarily used to compare glacier velocities.

After comparing historical mappings with data from remote sensing technologies, it was observed that some changes had occurred at the Fedchenko Glacial tongue (Lambrecht et al, 2014). However, it was observed that changes in the glacial tongue were not continuous. The glacial loss was high during all other periods except in the 1960s and between 2000 and 2007. The researchers also observed that some changes occurred in the upper side of the glacier but these are not homogenous.

Changes in surface elevation for debris-covered glaciers have been touted as a better indicator of climate changes than area changes. A comparison between historic data and current day studies shows that main elevation changes occur along the glacier rather than laterally (Kayumov, 2010). Between 1928 and 1958, the elevation was found to vary by

about 35 meters long a 28 kilometer stretch of glacier. Between 1958 and 2000, there were lower variations of elevation of up to 28 meters although this continued along a 58 kilometer stretch. In other words, the glaciers lost about 1 meter of elevation per year over the first 30 years studies. Within the latter four decades, the glaciers lost about 0.7 meters elevation per annum.

Over the last years, it has been observed that the Garmo glacier has retreated most over a 7 kilometer stretch. The Batrud Glacier has also retreated considerably over the lower end compared to its upper side that remains rather stable. Degradations of glaciers in Afghanistan are more intensive than in the Tajikistan by virtue of it being to the south.

Climatic Aspects of the Pamir Mountains

Apart from the glacial movements, researchers have also focused on the temperature changes in the Tajikistan region. An examination of climatic data shows that temperatures over the plains of Tajikistan increase at the rate of 0.1 to 0.2 degree Celsius per decade. In some regions such as Dushanbe, the changes were as high as 1 Celsius per decade. Within a 60 year period, the temperatures over the mountainous regions rose by 0.3 -0.5 degree Celsius.

An analysis of the annual precipitation patterns in the area has shown insignificant changes over the past few decades. Over the period analyzed, 1941- 1950 was the driest decade while 1990 and 1998 were the rainiest periods. On average, the annual precipitation amount has increased by 8 percent but reduced by 3 percent over the mountainous areas.

Another important climatic aspect is the pattern of snow stock as it contributes to the volume of flow in the rivers. An analysis shows that snows up to a range of 1000 meters melt quickly. On the other hand, snows between 1000 and 2000 meters lie for about 100 days between December and March (Kayumov, 2010). Snows 1000 meters higher last for 135

days between December and mid-March, while snows at 4000 meters high in the Pamir last permanently.

Discussion

¹ Changes in glacial elevation and volume are interpreted as changes in the mass of the glaciers, an indication of climatic change. However, ¹ surge type glaciers often show distinct mass redistributions and can thus not be used to indicate climatic changes. Studies have correctly attributed changes in surge glaciers to thermal and hydrological changes. These forces act primarily on the base of the glaciers thus making changes difficult to observe. For hydrological changes, basal melt waters result to high pressures at the base which causes the glaciers to slide at high velocities. On the other hand, thermally driven changes occur when there is a switch from cold to warm conditions at the base of the glaciers (Knoche et al, 2017). This leads to the subsequent existence of melt water and the resulting surges in glaciers. Hydrological and thermal glaciers could be the reason behind the different phenomenas in the north and south of Pamir.

Ice surges can be explained to consist of two phases. In the first phase, the higher regions reach fast speeds while the lower parts progress with increasing speeds. A surge occurs when there is compression between the fast flowing end and the slower bases (Wendt, Mayer, Lambrecht, and Floricioiu, 2017). Observations over the Pamir regions show numerous glaciers to have been unstable for prolonged periods. For instance, the Medvezhiy Glacier was observed to complete a surge cycle between 1973 and 1989. The Bivachny Glacier was also observed to surge in 1958, 1976- 1978, and in 2012 – 2015.

The glacial speed perceptions at the Gorbunov glacier demonstrate no pattern, indicating a steady circumstance. As a result, the volume in the upper piece of the ice sheet after 1958 must be identified with an expansion in ice dissolve or a decline in aggregation. Observations made later in 2009 and 2010 are about equivalent to the perceptions in the

previous years. The yearly speed example might be clarified by the advancement of the subglacial waste framework amid the summer.

High melt water flows lead to an expansion of subglacial seepage, while the development of the waste boulders falls behind. The expansion of subglacial water weight enhances the sliding speed. Along these lines the subglacial water weight decreases, as does the sliding speed. Amid the winter months the subglacial seepage framework adjusts to the reduced water supply, and the weight rises once more, which invigorates the basal sliding. With generally stable conditions, the decrease of ice thickness would result in lower ice speeds.

Conclusions

The unpredictable nature of surge glaciers explains the different phenomena between the north and south of Pamir Mountains. If these surges and glacier degradation continue at the present rate, it is feared that some of the glaciers of Tajikistan will have disappeared completely within 50 years. The continued glaciations will continue to affect river regimes within Obihingou, Kafirnigan, Karatag, and Zeravshan.

Glaciations will also lead to reduction of water stocks by 80 to 100 cubic kilometers. The intensive melting of mountain glaciers may lead to increased inflow to Vakhsh, Pyanj, and the Amudarya Rivers in the short term perspective. In the long term, however, inflows will be reduced due to increased glacial deficit. Communities and ecological relationships relying on these inflows will suffer most in the not too distant future.

Climate warming will also have its take on the freezing of mountainous lakes. Lakes are expected to melt earlier and freeze later, affecting the flow of rivers downstream. It is also expected that the increased rates of glacial melting may cause outbursts of glacial lakes located in high mountains. This has the effect of mud flows and floods to the valleys below.

As more and more melting water accumulates on the glaciers, their capacity to collapse and degrade goes higher.

The glacial melts of the Tajikistan Mountains will also affect the communities downstream that depend on the water flows for irrigation, energy production, and water supply. As glacial melts typically peak in the summer, when other water sources are typically low, the melts buffer dry stream conditions from happening. This is positive as long as the glacial melts do not cause flooding. However, this is unpredictable and is a potential source of panic to residents downstream.

It is evident from the studies that glacial melts result from complex processes that may be difficult to predict. As a result, it is hard to tell how much run off will be caused by glacial melt. As long as there is energy to melt the glaciers, runoff will continue to be expected in the Tajikistan Mountains. Given the expansive nature of the glaciers in the Pamir region, intervention to end glacial retreat calls for the efforts of everyone affected. In the first line should be territories that depend on the Pamir Mountains for water supply. These include countries in Central Asia such as Tajikistan, Kazakhstan, China, Uzbekistan, and India.

All countries in Asia should join hands in addressing the challenges affecting the region. For instance, the construction of dams along the river channels can reduce the damages associated with floods when huge glaciers melt. Unfortunately, such efforts from China have been met with severe objections especially from India who argue their water supply has been cut. A consensus should be sought to address the issue amicably as opposed to leaving the matter unaddressed.

With global warming being touted as the major cause of glacial melting, all human kind should participate in reducing it. For instance, only fuel sources with low carbon emissions should be used. The practice of deforestation should be discouraged with severe actions taken

on perpetrators. While we cannot control all processes that cause glacial melting, we can reduce the rate at which it occurs.

References

- Kayumov, A. (2010). Glaciers Resources of Tajikistan in Condition of the Climate Change. *State Agency for Hydrometeorology of Committee for Environmental Protection under the Government of the Republic of Tajikistan*.
- Knoche, M., Merz, R., Lindner, M., & Weise, S. M. (2017). Bridging Glaciological and Hydrological Trends in the Pamir Mountains, Central Asia. *Water*, 9(6), 422.
- Lambrecht, A., Mayer, C., Aizen, V., Floricioiu, D., & Surazakov, A. (2014). The evolution of Fedchenko glacier in the Pamir, Tajikistan, during the past eight decades. *Journal of Glaciology*, 60(220), 233-244.
- Wendt, A., Mayer, C., Lambrecht, A., & Floricioiu, D. (2017). A glacier surge of Bivachny Glacier, Pamir Mountains, observed by a time series of high-resolution digital elevation models and glacier velocities. *Remote Sensing*, 9(4), 388.

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