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ANALYSIS OF THE MELTING OF GLACIERS IN THE TERRITORY OF THE REPUBLIC OF TAJIKISTAN BASED ON REMOTE SENSING TECHNOLOGIES

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Abstract

The melting of glaciers is a clear indication of global warming, which is caused by human activities like burning fossil fuels and deforestation. This phenomenon has far-reaching consequences for our planet, including rising sea levels, changes in ocean currents, and altered weather patterns. It is crucial that we take immediate action to reduce our carbon footprint and prevent further damage to our planet's delicate ecosystems. The Pamir mountains range, located in Central Asia, is known for its vast glaciers that provide crucial water resources to the surrounding countries. However, due to global warming and other environmental factors, the glaciers are melting at an alarming rate. This has led to concerns about the impact on the ecosystem, as well as the availability of freshwater for human consumption and agricultural purposes. Remote sensing technologies have emerged as an essential tool for analyzing the melting of glaciers in the Pamir mountains range. Remote sensing technologies involve using instruments such as satellites, aircraft, and drones to gather data on various aspects of the earth's surface. These technologies can provide valuable information on glacier extent and thickness, changes in temperature and precipitation patterns, and other parameters that affect glacier melt. By analyzing this data over time, researchers can gain insights into how glaciers are changing and what factors are driving this change.

Keywords: Central Asia, Global change, Remote Sensing, Google Earth Pro.

Introduction. Tajikistan, a mountainous country in Central Asia, is home to more than 8,000 glaciers that provide water to millions of people downstream. These glaciers are rapidly melting due to global warming, which is causing significant environmental and socio-economic impacts in the region [2].

The melting of glaciers in Tajikistan has been a growing concern for many years. According to a report by the World Bank, the country's glaciers have lost almost 30% of their mass since the 1950s. This trend is expected to continue, with some experts predicting that most of Tajikistan's glaciers could disappear within the next few decades. Tajikistan has the largest glaciers in the Central Asian region. According to the "Center for the Study of Glaciers of Tajikistan", glaciers originating on the slopes of the Somoni peak reach a height of 7,400 meters above sea level, while in the basins of the Surkhob and Kafirnigan rivers rarely exceed 4,500-5,000 meters above sea level .

The largest glaciers of Tajikistan are confined to the glaciation knot at the junction of the highest ridges: Akademiya Nauk, Darvaz, Peter the Great, Vanch and Yazgulem. The largest glacier in Central Asia – Fedchenko – originates here. In total, there are 18 types of glaciers in the republic, the main share of which is concentrated in the east of the country.

The impact of melting glaciers in Tajikistan is significant. Firstly, it affects water availability for millions of people living downstream. The country relies heavily on its glaciers for irrigation and drinking water supply. As these glaciers melt away, there will be less water available for agriculture and domestic use. This can lead to food shortages and increased competition for limited water resources [2].

In addition to affecting water supply, melting glaciers also cause natural disasters such as floods and landslides. With less ice holding back the glacial lakes at higher elevations, there is an increased risk of sudden flood events downstream that can destroy homes and infrastructure.

Moreover, Tajikistan's economy heavily depends on hydropower generation from its rivers fed by glacier meltwater. However, with less glacial meltwater available due to glacier retreat and melting, there will be less electricity generation capacity available in the future. This can hamper economic growth and development in the country.

Furthermore, melting glaciers can also have serious environmental consequences such as changes in river ecosystems due to changes in water temperature and flow patterns. This can affect aquatic biodiversity and fisheries downstream.

Role of remote sensing. Remote sensing technologies have played a crucial role in detecting the melting glaciers of Tajikistan. Remote sensing refers to the use of sensors mounted on satellites or aircraft to gather information about the Earth's surface without physically being present. These sensors capture images in different wavelengths of light that can be used to identify changes in land cover, temperature and moisture content [1], [5].

One remote sensing technology that has been used extensively in Tajikistan is satellite imagery. The Moderate Resolution Imaging Spectroradiometer (MODIS) sensor on NASA's Terra and Aqua satellites provides daily coverage of the region at a spatial resolution of 250 meters. This allows scientists to monitor changes in glacier extent over time and estimate their volume and mass balance.

Another remote sensing technology that has been used is LiDAR (Light Detection and Ranging). LiDAR uses lasers to create high-resolution 3D maps of the Earth's surface. This technology has been used to measure the thickness of glaciers and detect changes in their elevation over time [3].

In addition to satellite imagery and LiDAR, ground-based measurements such as GPS surveys are also used to validate remote sensing data. By combining these different sources of information, scientists can create accurate models of glacier behavior and predict how they will respond to future climate change [4].

Data Collection. The data collected through remote sensing technologies has highlighted the rapid melting of Tajikistan's glaciers. According to a study published in the journal Environmental Research Letters, between 2000

and 2016, Tajikistan lost around 16% of its glacier volume due to melting. This has significant implications for the country's water security, as glaciers provide around 60% of its freshwater resources. This indicator can be clearly observed through remote sensing technologies. For this, we have chosen Google earth pro software in this research. Google Earth Pro is a free software that, although not a true GIS, allows visualization, assessment, overlay, and creation of geospatial data. This user-friendly resource is often a useful intermediary for learners who are interested in learning more about GIS and want to start with more basic processes and tools [5].

Results. Google earth pro also provides historical images, allowing us to visualize the changes since 1984. Google Earth Pro, Google Maps and Google Landsat Timelapse all allow you to access years of satellite, aerial and Street View imagery, which are an effective tool for demonstrating the development of cities, damage from natural disasters and changes in landscape over time. In this research, it can be seen that the results of the visualization and mapping of the consistent melting of snow and glaciers are as follows.

Conclusion. In conclusion, to mitigate the impacts of melting glaciers in Tajikistan, urgent action is needed both globally and locally. On a global level, reducing greenhouse gas emissions through measures such as transitioning to renewable energy sources and reducing deforestation can help slow down global warming. Locally, there needs to be better water management practices, including investing in water storage infrastructure such as dams and reservoirs, improving irrigation efficiency, and promoting sustainable agriculture practices.

The melting glaciers of Tajikistan pose a serious threat to the country's water security, economy, environment, and people's lives. The impact of glacier retreat and melting is already being felt in many parts of the country. It is time for urgent action to be taken to mitigate the impacts of climate change and protect Tajikistan's glaciers for future generations.

Remote sensing technologies have been instrumental in detecting the melting glaciers of Tajikistan. The data collected through these methods has provided valuable insights into the impact of climate change on the region's water resources. As the effects of climate change continue to intensify, it is imperative that remote sensing technologies are used to monitor and mitigate their impact on vulnerable regions like Tajikistan.

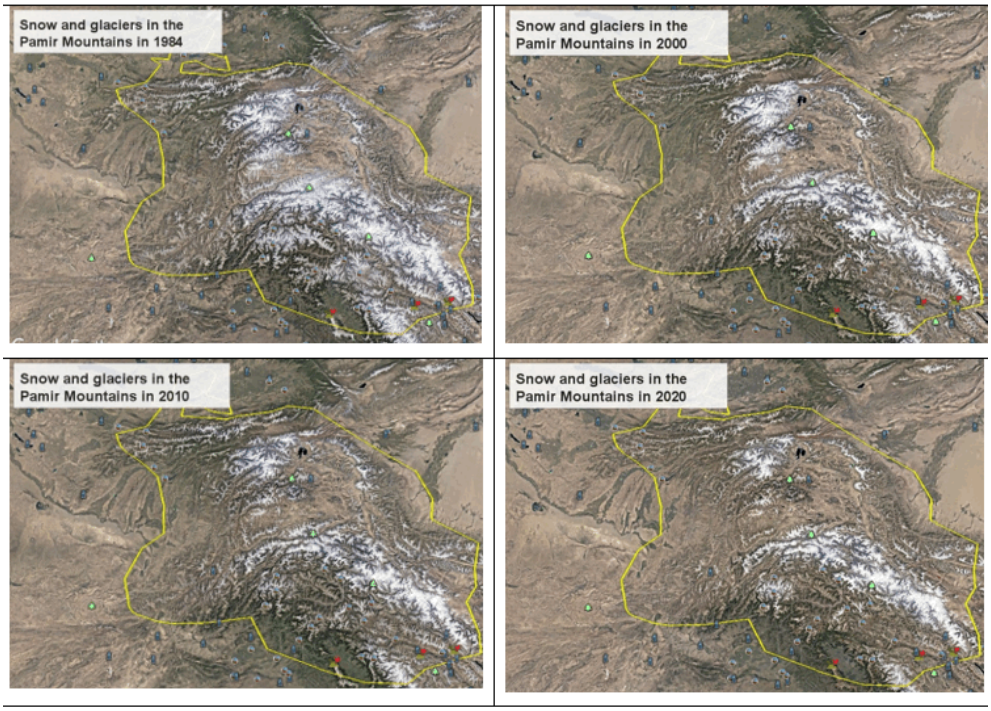

Figure 1. Dynamics of snow and glacier changes in the Pamir Mountains during time series.

Source: Google Earth Pro

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