Landform Behaviors Under Climate Change Conditions Using Remote Sensing Method

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Abstract

This study investigates long-term climate change's impacts on landforms in Kaffiøyra, Svalbard, from 1985 to 2023, focusing on shorelines, glaciers, and outwash areas. Using remote sensing and GIS techniques to analyze Landsat imagery, we observed variable shoreline changes: land shorelines in Zones 1, 3, and 5 changed by -2.2 to +3.7 m/yr, indicating stability, while tidewater glacier shorelines in Zones 2 and 4 experienced significant erosion, ranging from -64.7 to +9.2 m/yr. Analysis of seven glacier termini revealed overall reductions in area, with the tidewater glacier terminus - Aavatsmarkbreen retaining only 32% of its original size and land glacier termini averaging 59.1% of their area. Notably, Aavatsmarkbreen's retreat rate was more than twice as fast as land glaciers, averaging 62.93 m/yr compared to 43.74 m/yr, highlighting the greater vulnerability of tidewater glaciers under similar climatic conditions. A negative correlation (coefficients between -0.65 and -0.73) was found between rising temperatures and the glacier area, emphasizing the impact of temperature increases on glacier retreat. The predictive model was built based on the correlation using temperature data from climate scenarios and observation station, indicating that only station data closely aligned with current conditions, underscoring the importance of reliable monitoring systems. Changes in outwash areas were insignificant, with an increase of less than 10%. This research highlights the relative stability of land shorelines, the significant retreat in glaciers, specifically in tidewater glaciers under consistent climate conditions, and the modest growth of outwash areas. Emphasizing the need for enhanced monitoring systems in the future to better understand and address the impacts of climate change on local scales.

Keywords: Climate change, Landsat images, Shoreline changes, Glacier retreats, Outwash, Glacier volume loss, Svalbard.