Monitoring glacier lakes and outburst floods around Jostedalsbreen ice cap

Glacier lakes are evolving rapidly and are becoming more dynamic globally in response to climate change in recent years, posing risk of outburst floods to communities and infrastructures in their proximity (NVE, 2021a; Shugar et al., 2020). It is therefore crucial to understand their dynamics regarding their evolution, distribution and driving forces of rapid expansion to prepare the communities and planners to reduce the potential impacts of glacier lake outburst floods (GLOF) (Zhang, Chen, Tian, Liang, & Yang, 2020). However, the inaccessibility due to their remoteness and the lack of advanced technology to assess them remotely and more frequently had always been a challenge until the arrival of Copernicus Satellite Service (CSS) in 2015 which provides high spatial resolution (10 meter) and high temporal resolution (revisit time of 5 days) imageries of earth surfaces including glacier lakes, good enough to monitor them frequently and more precisely (ESA, n.d.). Thus, with the help of this service, the study aims to monitor the glacier lakes and answer the research question – "How do glacier lakes respond to changes in surface temperature?".

So far, in Norway, 147 GLOF events have been recorded since 1760 until 2021 with more frequent events in recent decades, majority of which happening in Jostedalsbreen region, the largest glacier ice cap in the continental Europe (NVE, 2021b). Surprisingly, besides annual inventory, there has not been much research done in this region regarding the changes in seasonal dynamics such as freezing and melting patterns, and seasonal fluctuation of water quantity along with annual expansion of glacier lakes. Therefore, the main objective of this research is to monitor the extent of glacier lakes during summer seasons in recent years (from 2015 to 2021) and assess their changes with respect to surface temperature.

The approach of the study is to calculate the Normalized Difference Water Index (NDWI) of imageries acquired from CSS, use a threshold NDWI value to separate the water pixels from non-water pixels and manually digitize where necessary to obtain the lake area. A threshold NDWI value which best represents the area of lakes and reduces the need for digitization is obtained with reference to manually digitized high resolution ortho-imagery of same lakes in Jostedalsbreen. Meanwhile, an over- or under-estimation of lake areas using the selected threshold value will be quantified in percentage and represented in the result.

The study is expected to obtain an annual trend of lake expansion along with changes in seasonal patterns. In addition, it is also expected to reveal the characteristics of lakes in terms of these changes regarding their specific location, size, and elevation. In the meantime, the study may have some limitations in acquisition of high-resolution images of glacier lakes due to the presence of clouds, shadows, and floating ices on lakes which may limit the quality and quantity of usable images. Therefore, the images are selected with very keen observation to maintain the quality of research.

Based on some literatures (Andreassen et al., 2021; Jackson & Ragulina, 2014; Nagy & Andreassen, 2019), I argue that the glacier lakes in Jostedalsbreen are becoming more dynamic in recent years, and thus my method is capable to assess this dynamism more accurately which can be used by the planners to take early actions against potential hazards. Eventually, the results of this study will be applicable to other parts of Norway as well as to other countries with similar climatic and geographical conditions.

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