Understanding the geomorphological processes of a glaciated region, Svalbard.

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Introduction:

Between the 28th June – 22nd July, we travelled to Longyearbyen, a settlement in the High Arctic to conduct research on the effects of increasing air temperatures on Arctic glaciers. All eight members carried out individual fieldwork on Longyearbreen glacier to assess the potential ramifications of climate change.

Research Aims:

- Assess the mass balance of Longyearbreen and its controlling factors
- Investigate the impact of debris on glacial melt
- Assess the impact of meltwater on glacial velocity
- Evaluate the efficiency of glacial hydrology
- Identify daily and seasonal cycles of sediment suspended in glacial meltwater streams.
- Assess the relationship between supraglacial and proglacial meltwater streams on Longyearbreen and Larsbreen
- Quantify ice surface elevation change and terminus retreat of Longyearbreen, Svalbard.
- Assess the volume of meltwater stored per day on Longyearbreen glacier.

Mass Balance Results:

12 plastic stakes were drilled into Longyearbreen glacier along the central line of the glacier to calculate average ice loss during the expedition. An additional two stakes were inserted laterally to assess how melt varied across the glacier. Exposure, snow depth and weather conditions were found to influence loss the most. (Figure 1).

The average daily melt for Longyearbreen glacier for the two week period commencing 04/07/17 was 5.23 centimetres. These results were found using 6 plastic tubes which were inserted at consistent intervals up the centre of the glacier. Temperature gauges were attached to these stakes and results show that melt was directly correlated to the temperature. Precipitation gauges, also fixed to the stakes, show a total of 14.95mm rainfall over the 14 day period.

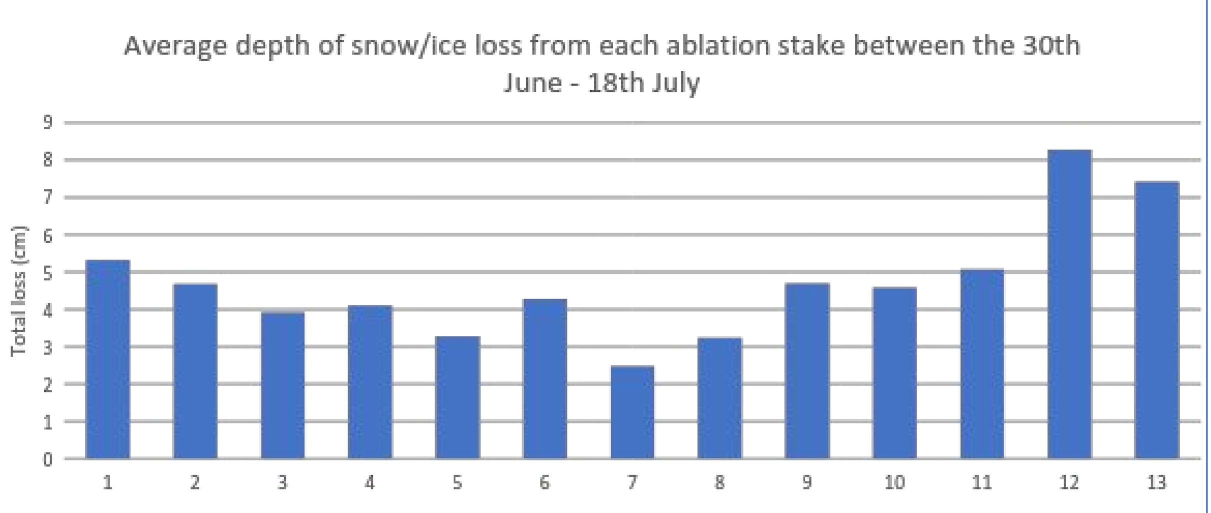

Figure 1: Average ice loss in Longyearbreen glacier over a 14-day period

Debris Cover Results:

Two groups of six glacial debris piles were constructed on the ice roughly 10 meters above the actual debris. Six of them were constructed with large loosely packed rocks, whilst the other six were mainly small tightly packed sediments. Melt stakes were planted in each pile with an extra one planted in an exposed area of ice next to the piles. The change in ice depth at each stake was measured in order to test a hypothesis linked to similar studies done on glaciers in other areas of the world. The highest melt rates were observed under 1cm of debris cover, as the lowest melt rates were measured on exposed ice.

Water Properties Results:

A total of 115 water samples were taken from a stream exiting the Longyearbreen glacier. These were filtered in order to determine the concentration of suspended sediment within each sample. The concentration of suspended sediment increased 4 fold from the start of the expedition to the end. This correlates with increased discharge seen over the research period.

The chemistry of the water present in the proglacial system, in front of the glacier, was analysed to determine the efficiency of the stream system. 57 samples showed a decrease in ion content, which indicates an efficient stream system within and under the glacier.

Surface Elevation Results:

The surface elevation of Longyearbreen glacier was measured using a Differential Global Positioning System (DGPS). The change in ice surface elevation is yet to be accurately calculated. However, visual analysis of both surface elevation and terminus position suggests that the glacier is shrinking in volume. the reasons for this change are still to be linked and the rate of change is not yet quantified.

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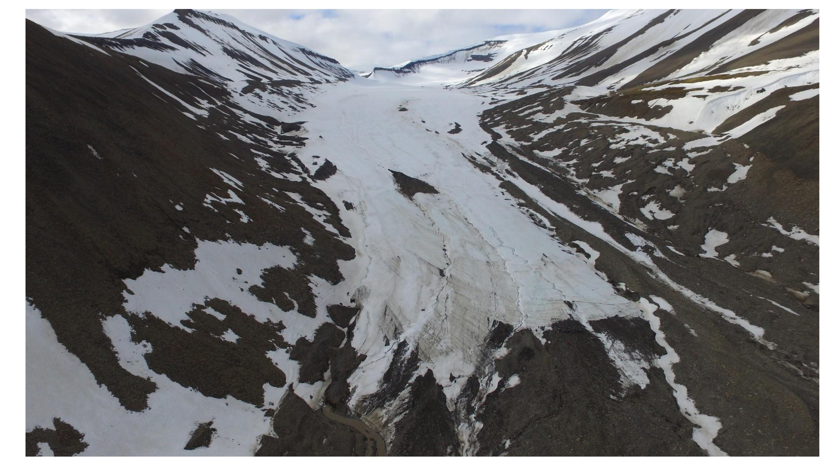
Stream Evolution Results:

Discharge of meltwater streams was measured in the supraglacial (on top of the glacier) and proglacial (in front of the glacier) areas of Longyearbreen and proglacial area of Larsbreen. Longyearbreen and Larsbreen proglacial stream discharge gradually increased, with some large daily increases. Longyearbreen discharge fluctuated in a daily cycle, yet increased overall throughout the research period. One Longyearbreen supraglacial stream discharge also gradually increases, however another stream discharge stays relatively the same throughout with only two large daily increases.

The number of supraglacial streams grew over the three week study period, from just 1 small stream to 5, ranging from around 10cm to over 1m in width. Channel cross-sectional area generally increased in size over the course of the study period, and stream shape constantly changed.



Conclusions:

1. Melt varied, but a pattern of increased loss the day after warmer temperatures and rain can be seen.
2. Discharge in proglacial meltwater streams increases within a season more than supraglacial meltwater streams.
3. Discharge and number of supraglacial streams increased over the time period, and are continually evolving in shape and size.
4. Sediment suspended in glacial meltwater streams increased during the study period. A clear daily cycle of suspended sediment was also identified.
5. Discharge of the Longyearbreen proglacial stream was far greater than the volume of glacier melt suggesting melt water input through mechanisms other than surface melt.
6. Hydrochemistry of the Longyearbreen proglacial stream suggests a developing efficient stream network beneath the glacier, which will impact the overall ice loss during a melt season.
7. Glacial melt was enhanced under debris thicknesses up to 1cm, whilst under thicker debris layers melt was suppressed, compared to exposed ice.
8. The surface elevation of Longyearbreen has decreased in the lower sections of the glacier.

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