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Suspended sediment dynamics and yields in a glacial fed river, Tasermiut fjord, SW Greenland

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Global climate change is impacting watershed hydrology and our use of water-related resources particularly in snow and glacier-fed drainage basins. Most glaciers are out of equilibrium with the current climate and they are slowly adjusting to seasonal changes in precipitation and higher temperatures by showing negative mass balance, significant volume loss and retreat in most areas. Rivers draining from the glaciers of the Greenland ice sheet are sensitive indicators of climate change and baseline data on their hydrology and sediment transport are important as they will allow current and future responses to climate change to be determined.

This study examined the suspended sediment dynamics and fluxes in an un-named glacier-fed river draining a 30 km2 catchment (22% ice covered) on the south side of Tasermiut fjord. A 5-min discharge, turbidity and air temperature record was maintained during the 2009 melt season from 25-Jul to 19-Aug which was supplemented by 402 water samples collected at 1 to 6-h intervals (which had their suspended sediment concentration, SSC, determined gravimetrically). Clear diurnal fluctuations in air temperature (AT), river discharge (Q) and SSC were observed and lag times between peak AT and peak Q range from 15-min to 15:20 h with a mean for the whole study of 03:36 h, suggesting that the glacial melt water travels at an average of 1.6 km/h. Over the 25-day study, a distinct change in the weather took place from predominantly sunny/clear weather (days 1-14, phase 1) to weather dominated by cloud (days 15-25, phase 2). Mean lag times in phase 1 were similar to those in the second (cloudy) phase 2, however 5-min data showed that ATmean rose from 10.2oC in phase 1 to 10.8oC in phase 2, whereas there was a much more significant difference in Qmean which rose from 3.4 to 4.8 m3/s and Qmax which rose from 4.9 to 6.8 m3/s, suggesting that the cloudy weather had relatively little influence on air temperatures, but a significant influence on river Q. The average glacier surface melt rate over the whole study period measured for 16 ablation stakes on a nearby unnamed glacier flowing into the Itillersuaq valley on the northwest side of Tasermiut fjord was 6.5 cm per day (24 hour period). The rate was slightly lower in Phase 1 at 6.0 cm/day and slightly higher in Phase 2 at 7.1 cm/day, which corroborates the river Q data. Mean SSC also increased from 30.5 mg/L in the sunny clear phase 1, to 35.2 mg/L in the cloudy second phase. The total suspended sediment load (SSL) for the study period was 348 t (average 14.1 t/day), equivalent to a suspended sediment yield of 86.1 t/km2/yr.

These data provide an important baseline from which the effects of future climate change on the hydrology and fluvial geomorphology of rivers in this region can be compared. The dataset may be useful for calibrating the effects on river flow and suspended sediment transport of global climate models which predict increased cloudiness.