Geophysical Research Abstracts
Vol. 17, EGU2015-1203, 2015
EGU General Assembly 2015
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The impact of climate change on sediment delivery from the Jostedalsbreen ice cap, Southern Norway

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The Jostedalsbreen ice cap covers an area of around 500 km^2 with a maximum elevation of about 2000 m a.s.l. Several large outlet glaciers fall down from the upper plateau. The present sediment delivery from the ice cap is estimated to 194 000 t/yr corresponding to a mean sediment yield of 403 t/km^2yr.

The Nigardsbreen is one of the largest outlets from the ice cap, terminating around 345 m a.s.l. The sediment delivery from Nigardsbreen was measured during the years 1968 – 2013. An analysis gave as a result that the average of daily mean sediment transport Gs (kg/s) related to the average daily mean discharge Q (m^3/s) as: Gs = $0.0129 \times Q^{1.54}$. To apply this correlation to predict the future sediment transport, it is assumed that the character of the subglacial tunnel system persists as the glacier is melting back and convey sediments in the same way during the whole period. As the glacier is thinning below a critical threshold, the drainage system may be kept open throughout the season and water may melt out more sediment over a larger area.

The future runoff from Nigardsbreen catchment in western Norway is predicted for the period 2010-2100 using glacio-hydrological models simulating mass balance, runoff response as a function of altitude based on temperature and precipitation given by climate change scenario IPC4. They are coupled to a glacier scale model computing the length and volume change of the glaciers with time. The water discharge prediction was applied to compute the future sediment load. During the first half of the 21^{st} century, substantial variations in annual mean discharge and sediment transport will occur. A rising trend will start in 2030, culminating around 2090. During the last decade, a decrease will take place. By 2100 the glacier volume is reduced to 38% of the present.

Seismic surveys of the whole ice cap revealed that a number of overdeepenings occur beneath the glacier and about 50 lakes will be formed if the glacier melt away entirely. Only one small overdeepening has been observed beneath Nigardsbreen. Hence, sediment transport of this glacier will not be affected notecably. However, calving will become an important factor contributing to ablation for many other glaciers, for example, Tunsbergdalsbreen, Supphellebreen, Bøyabreen, etc. During calving, all the sediment in the glacier sole will melt out. However, a large amount of the sediment will be trapped in the proglacial lakes and not be delivered to the rivers downstream of the lakes.

Keywords: climate change, glacial sediment transport, proglacial lakes, glacier hydrology