

# Sediment Sources and Delivery of Norwegian Mountain Rivers in a Changing Climate

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April 6, 2022

## Abstract

The projected climate change for Norway through the 21st century predicts that the temperature will increase by 4.5 °C. Events with heavy rainfall will be more intense and occur more frequently. Rainfloods will increase in magnitude and also occur more frequently. Extreme flooding and heavy rain will significantly impact the sediment dynamics in rivers. In the mountain areas, floods are often associated with erosion, transport and deposition of coarse sediment along the streams. These processes are related to bed load transport and pose a hazard in addition to the elevated water discharge and have to be included in management plans for river basins. This paper studies the bed load delivery from sources that contribute the most to the sediment budget in the Gudbrandsdalslågen river basin during the large magnitude floods in 2011 and 2013. More than 100 debris slides and debris flow were triggered in the tributary river Veikleåi by the heavy rain and snowmelt during these floods. The volume of the contribution from debris flows and erosion and deposition of the river bed was determined by subtracting digital elevation models acquired during repeated airborne LIDAR surveys. In the river Dørja the supply of sediment from a number of debris flows caused extensive aggradation and channel changes. In their new position, lateral erosion by these channels triggered slides on the adjacent slopes. The contributing volumes of debris flows, lateral erosion and river-bed erosion and deposition were determined from the LIDAR surveys. Relations obtained from studies of sediment transport in modern glacier rivers were used to obtain estimates of the ratio of bed load vs suspended load derived from the Pleistocene moraine deposits. Several monitoring stations using conventional methods for measuring bed load and suspended load recorded very large volumes of sediment delivery during both of the extreme floods. Implications for the future development of mitigation are discussed.

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