Aquat. Sci. 69 (2007) 179 – 198
1015-1621/07/020179-20
DOI 10.1007/s00027-007-0875-4
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Aquatic Sciences

Research Article

Effects of Alpine hydropower dams on particle transport and lacustrine sedimentation

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Received: 24 July 2006; revised manuscript accepted: 23 December 2006

Abstract. The effects of high-alpine hydropower damming on lacustrine sedimentation and transport of solid particles were investigated in the glaciated Grimsel area and in downstream Lake Brienz, providing quantitative denudation rates and sediment yield on a source-sink basis. A total of 271 kt/yr of solid particles entered the Grimsel reservoirs on average in the last 71 years, mostly by turbiditic underflows that focused sedimentation in depocenters upstream of obstacles such as bedrock ridges, submerged moraines, or dams. This is equivalent to a sediment yield of 2430 t/(km^{2}yr) in the catchment (111.5 km^2) or a denudation rate of 0.94 mm/yr. A total of 39 kt/yr of the fine fraction (<~4 μm) leave the reservoirs and are transported to downstream Lake Brienz, while 232 kt/yr of mostly coarse particles are retained, reducing total sediment input of the River Aare into Lake Brienz by two thirds. Modeling the particle budgets in the Aare with and without dams indicates that the fine fraction budgets are only slightly affected by damming, but that the reservoirs cause a shift in seasonal runoff timing resulting in increasing and decreasing particle transport in winter and summer, respectively. Thus, hydrodamming alters mostly deltaic sedimentation in Lake Brienz, where the coarse fraction is deposited, whereas fine grained distal sedimentation and varve formation on lateral slopes are less affected. All varved records of the reservoirs and Lake Brienz that provide sediment rates and grain size records on an annual basis indicate that climate is the main control on these proxies, while, for instance, the onset of pump storage activity in the reservoirs did not impose any significant change in lacustrine sedimentation pattern.

Key words. Sediment yield; reservoir lakes; lacustrine sedimentation; particle transport; erosion rates.

1. Introduction

Sediment yield, particle transport, and deposition in source-sink systems are sensitive to factors such as climatic conditions (e.g. temperature and precipitation), bedrock lithologies, topographic relief, and

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Published Online First: June 6, 2007