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Varved lake sediment sequences and their relation to climate– controlled hydrological processes in proglacial lake Nigardsvatn, Western Norway

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Varved lake sediments can be used to reconstruct the amplitude of past climate variability. In this paper varved sediment sequences in proglacial lake Nigardsvatn is studied in order to reveal their correlation to climate– controlled hydrological processes. Lake Nigardsvatn receives its sediment supply from the Nigardsbreen glacier. This is an outlet glacier from the Jostedalsbre ice cap in Southern Norway. The sediment transport and water discharge of the meltwater river from this glacier have been measured since 1968 and are compared in this paper to the varve thicknesses and their composition and structure. Varve records can be precisely dated and thus provide high-resolution records. Sedimentation patterns and sediment composition will however influence their ability to reflect climatic changes in the lake catchment system. The effects of these factors are discussed in this paper. Special attention is given to large magnitude floods as they may provide markers that may be used for dating purposes. In 1979 a large magnitude flood caused by high rainfall and glacier melt affected the catchment area of lake Nigardsvatn. The high sediment transport during this event led to the creation of a distinct flood layer in the bed sediments. The characteristics of this flood layer were compared to layers deposited during years of more normal conditions. Particle-size distribution analysis was conducted on individual varves from sediment cores taken up from the lake in 2006. The downstream variation in sediment thickness was also studied for the flood layers in comparison to years with prevailing low water discharge, and a year with a long-lasting high water discharge due to glacial melt. The grain size of the flood layers was considerably coarser than the other annual layers and dominated over larger parts of the lake. Equations describing the variation in sedimentation thickness and grain size in comparison to downstream distance were developed for the annual layers and individual years. It was concluded from this study that large floods and years with long-lasting high water discharge can be recognized by thicker sediment deposits and contained coarser grain sizes, especially near the delta front. More organic sediment was found in the flood layers, around double of the concentrations found in the sediments deposited in the years before and after. The organic material is washed out from the non-glacial part of the catchment area during rainfall-induced floods. Chemical analyses revealed that the 1979 flood layer contained more Al, Ca, Cu, Fe, K, Mg, Mn, P, S and Zn than the other years, and the higher levels are believed to be due to the higher surface runoff during the flood. Iron oxides are especially visible when Fe is contained in higher concentrations, and this is a reason why this layer is distinguishable.