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Climato-hydrological changes and dam construction impact inferred from sediments of Sun Moon Lake, Taiwan

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This study aims to reveal the climato-hydrological record of the last 80 years, including the impact of artificial construction, in Sun Moon Lake, Taiwan.

Sun Moon Lake is the largest natural lake in central Taiwan. At the beginning of the 20th century, the lake was artificially transformed into a reservoir for a hydroelectric power plant. The construction of two dams (Shuishe and Toushe) and two waterway tunnels (Wujie and new Wujie tunnel) from the Zhuoshui River had a significant impact on the hydrological environment of the lake. Currently, water inflow and outflow at Sun Moon Lake are artificially controlled by the power plant. The water inflow contribution of the waterway tunnel into the lake is estimated to be approximately 40 times greater than the original (natural) catchment area of the lake.

Ten surface sediment cores were collected from Sun Moon Lake in 2007; two additional cores of length 44–92 cm were collected in 2008. The physical properties (water content, grain size, and grain density) of the 12 cores were analyzed.

The surface sediment consists of silt in the case of all cores. A clear boundary between sediments is observed in two cores collected from the western part of the lake. The lower layer consists of sediments deposited before construction of the dam in 1934 (pre-dam sediment); the upper layer corresponds to sediments deposited after construction (post-dam sediment). The pre-dam sediment has low density and is rich in organic matter (peat), suggesting that sediment inflow to the lake was much lower then than it is now. X-ray diffraction analysis indicates that the mineral composition of the pre-dam sediment is different from that of the post-dam sediment. The mineral composition of the post-dam sediment is uniform over the entire lake; this sediment corresponds to that deposited from the waterway tunnels. These results suggest that the dam construction had a large impact on the sedimentation in Sun Moon Lake and that the dominant sediment source changed from the original natural catchment to the waterway tunnels.

Age models of the post-dam sediment layer have been established on the basis of the temporal change in lake bathymetry. Sedimentation rate is high (0.4 m/year) in the eastern area and low (0.003 m/year) in the western area, suggesting a large contribution of sediment from tunnels located along the eastern shore. The fluctuations in grain size and water content appear to correspond to changes in precipitation and water inflow rate from the tunnels. This suggests that sedimentation has been impacted during the last several decades by natural hydrological and artificial factors.