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Unraveling fine sediment transport patterns along the Ohau Channel, NZ, using a dynamic penetrometer

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Until August 2008 Lake Rotorua (North Island, New Zealand) was directly connected to Lake Rotoiti via the Ohau Channel. To direct the nutrient-rich inflowing water from the Ohau Channel towards the Kaituna River outflow from Lake Rotoiti, a diversion wall (length: 1275m) was erected in 2008. In post-construction surveys, geotechnical in situ measurements have been undertaken with a dynamic penetrometer, the Nimrod, to characterize the upper sediment physical and mechanical strength properties, and to identify areas of sediment erosion and deposition. In 2009 and 2010, 88 sites were sampled in Lake Rotorua, and 71 in Lake Rotoiti. Eight of the positions were located in the Hamanana-Ohau area including the Ohau Channel entrance area (Lake Rotorua), and six of the positions represented the Ohau Delta and the area behind the diversion wall (Lake Rotoiti). The data confirmed fine sediment erosion in the Hamanana-Ohau region which resulted in dominance by coarse sands and a compacted sediment surface (deceleration of the probe, dec.=40-60g; estimated quasi-static bearing capacity considering changes of penetration velocity and penetration surface area, qsbc.=50-100 kPa). However, close to the Ohau Channel entrance the upper meter of the lake floor was highly flocculant and unconsolidated (dec.=1.8-2.1 g; qsbc.=2-3 kPa) corresponding to assorted fine sediments in this deposition area. For comparison, a cross-sectional survey across the lake gave values of dec.=3-3.5 g and qsbc.=3-5 kPa, in accordance with fine diatomaceous ooze dominating sediments at water depths > 10 m. Behind the diversion wall in Lake Rotoiti, we found sediment stratification, with a 20-40 cm flocculant upper layer (dec.=1-2 g; qsbc.≈3.2 kPa) overlying a hard substratum (dec.≈9 g; qsbc.≈10 kPa). Furthermore, a trend of a slightly harder sediment surface in the direct vicinity of the Ohau Channel outlet was observed. No stratification was observed in sediment profiles of the narrowest section of the diversion wall area close to the end of the wall. Comparisons of sediment strength values indicated that the top layer of the Ohau Channel entrance was mixed fine Lake Rotorua sediments (i.e. at the Ohau Channel entrance) and in Lake Rotoiti the sediments were more compacted (dec.=3-6g; qsbc.=2-8kPa). Thus, the top layer was likely associated with deposited fine sediments from Lake Rotorua whereas the deeper sediments likely represented the original Lake Rotoiti substrate especially near the center of the diversion wall area which was acting as a trap for fine sediments. The dynamic penetrometer surveys proved to be a suitable means to map areas of sediment erosion, remobilization and deposition. They provided important complementary information for the investigation of sediment transport patterns. The Ohau Channel region is of particular interest because of the potential risk of further sediment accumulation as a consequence of the installation of the diversion wall, which would decrease water depth is of interest. Repeat surveys could be used to assess this risk.