

A multi-proxy lake core record from Lago Lungo, Rieti Basin, Lazio, Italy and its relation to human activities in the catchment during the last century

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The lakes of the Rieti Basin have experienced extensive human modification dating back to pre-Roman times, yet lake archives indicate that the most profound changes to the aquatic ecosystem have occurred during the last century. Analysis of the upper ~120 cm segment of a sediment core from Lago Lungo, dating back to ~1830 CE, show changes in water quality and hydrologic inflow largely attributed to 20th century reclamation and land use activities. Lago Lungo is a shallow, small, eutrophic, hard water lake situated in an intermontaine alluvial plain ~90 km NE of Rome. It is one of several remnant lakes in a poorly drained wetland area fed by numerous springs. Reclamation activities over the last century have substantially altered the drainage network affecting water delivery to the lakes and their connectivity. There are 3 interesting signals in the core. First, small *Stephanodiscus* species, associated with hypereutrophic conditions, appear after 1950, peak ~1990, and may be attributed to increased use of chemical fertilizers and intensification of local agriculture. Elemental proxies from scanning XRF data (abundances of Ti, Si/Ti, and Ca) are consistent with increased eutrophication starting ~1950. A decline in *Stephanodiscus* after 1990 reflects some improvement to the water quality following the lake's incorporation into a nature preserve and creation of a narrow vegetation buffer. Intermittent water quality measurements from 1982 onward corroborate the changes in trophic status interpreted from the core record. Second, a large change in the core stratigraphy, elemental geochemistry, and diatom composition occurs ~1940 and is associated with several major reclamation efforts, including the rerouting of the Santa Susanna channel, which redirected large volumes of artesian inflows away from the lakes and estuarine system. Upstream, dams on the Turano and Salto rivers were also constructed, further affecting hydrological inflows into the basin. From ~1900-1940 there is an abundance in *Aulacoseira*, which dominates the adjacent Lago di Ripasottile and may suggest increased connectivity between these two lakes prior to 1940. Third, the largest compositional change occurs ~1900, before which *Cyclotella distinguenda* and periphyton are larger components, and there is a lower ratio of diatom frustules to silt. Prior to ~1900, the lake may have received additional hydrological inputs, including drainage from wetlands that were diverted after 1900. Causally, we put forth 2 hypotheses for the abrupt shift ~1900. The first hypothesis relates to a period of increased seismic activity circa 1900, including the June 28 1898 earthquake that was felt strongly in the town of Rieti, ~10 km to the south of Lago Lungo. Seismic activity could have potentially impacted the plain to alter drainage patterns in basin. Alternatively, following the hypothesis of alternative stable states in lakes, the 1900 shift may simply represent an ecological change from a clear water state dominated by macroalgae and periphyton, to a turbid water state dominated by phytoplankton. In this alternative interpretation, the 1900 shift may represent the initial step in a 3-phased succession of lake eutrophication throughout the 1900s, where the initial step predated the 1940 reclamation efforts.