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Measuring historic water levels of Lake Balaton and tributary wetlands using georeferenced maps

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Lake Balaton is a large and relatively shallow lake located in western Hungary. The lake is joined by small wetlands on the north shore and larger water-filled valleys on the south separated by and elevated sand bar. These wetlands are assumed to have been connected with Lake Balaton before the water level was artificially lowered in 1893. No regular measurements of the water level of the lake or these wetlands were carried out before the draining of the lake. Most of the wetlands were completely isolated from the water system of the lake after the water level change as roads, railway and holiday homes were built. The low valleys of the southern shore still hold many fishponds, swamps and wet meadows, which are important sanctuaries for rare wetland species, and are often less disturbed than the lake, which is a popular holiday resort. Hydrologic restoration of these wetlands is only possible if accurate information exists on the original, natural state. The 1776 Krieger-map and the first military survey (1782-1785) are the most accurate known maps of the original state of the Lake Balaton area. These maps were surveyed using triangulation and leveling, and are accurate enough to be compared with the present-day situation. Some of the depicted buildings and landmarks still survive and can be used as control points for georeferencing and correcting these maps. Since the bathymetry of the lake and the topography of the surrounding countryside have hardly changed, existing digital elevation models of the present-day relief could be compared to these georeferenced maps. The elevation profile of the lake shore and wetland borders can be calculated by tracing these lines on a Digital Elevation Model. The shore area of Lake Balaton has been filled in and changed, so present-day land topography can not be used to estimate the water level from the elevation profile of the shore line. However, the Krieger-map also shows bathymetric contours, and previous studies have shown that the topography of the lake floor has not changed measurably in the last hundred years.

The bathymetric contours of Lake Balaton depicted on the georeferenced Krieger-map were digitized and overlain on the present-day DEM of the lake floor. The elevation profile of these lines was used to calculate the original elevation of the water level of the lake with the accuracy of one meter. The height of the water table around the lake depends closely on the water level of the lake, but wetlands can retain water and thus sustain a higher water table in the tributary valleys than in the lake itself. In order to measure the elevation of the water table around the lake, the borders of the water-logged areas on the southern shore of the lake were also digitized from the sheets of the First Military Survey and traced on a DEM of the hills on the southern side of the lake.

The elevation of the water level in these wetlands was calculated based on these profiles. The water level in some valleys adjoining the lake is significantly higher than the water level of the lake itself, which shows that the water balance of these wetlands was mostly independent of the fluctuation of the lake. Some other large wetlands have borders that are in the same elevation as the shores of the lake itself, which shows that these wetlands are in close connection with the lake.

The mapping of these historic wetland properties provides a valuable guide for future habitat restoration efforts.