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Application of Electrical and Electromagnetic Methods to Quantify the Subsurface Salt Content of Salt Lakes

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Abstract Text:

The unique salt lakes of the Austrian National Park Neusiedler See - Seewinkel depend on subsurface salt and high groundwater levels. Capillary upward flow of groundwater caused by high evaporation transports salts to the surface. This key process of salination is threatened because of groundwater lowering and large-scale drainage measures starting over 100 years ago. Understanding the spatial and temporal changes in subsurface salt content is needed to successfully restore the salt lakes. To this end, we investigate the capability of electrical and electromagnetic methods based on the hypothesis that variations in electrical conductivity correlate to changes in the salt and water content. We used the electromagnetic method at low induction number (EMI) to understand the salt dynamics close to the surface with a high lateral resolution, while transient electromagnetic (TEM) soundings were conducted to gain information at larger depths, whereas the electrical resistivity tomography (ERT) is used for validation and monitoring purposes. EMI measurements were conducted to map large areas with a lateral resolution of 50 cm and in a bi-weekly monitoring. EMI monitoring data were collected along three profiles with 12 different configurations to reach a nominal depth of 6.7 m, while ERT monitoring profiles were designed to reach a depth of investigation of 12 m. We collected TEM data along the EMI profiles using a loop size of 2 m and 6 m and ERT data with the same temporal resolution as the EMI using an electrode separation of 1 m in two profiles and 0.5 m in one profile. We extracted soil samples for the quantitative interpretation of the electrical conductivity in terms of the salt content. Our results show the highest salt content between 1 and 2 m depth, which correlates with soil sample data. Ongoing EMI and ERT monitoring results reveal significant changes in the electrical conductivity, reflecting large dynamics of soil moisture and salt content, while the TEM and ERT results delineate the lower boundary of the corresponding aquifer at a depth of ca. 9 m.

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