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Drivers of spatio-temporal salinity distribution in a hypersaline lake

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Increased salinisation of surface waters poses growing threats to agro- and aquatic ecosystems around the world. One extreme example is Lake Urmia, in northwestern Iran, which is one of the largest hypersaline lakes. Due to anthropogenic and climate-induced changes, the salinity of Lake Urmia has reached a maximum level of 420 PSU in recent years. This high salinity has endangered the food web and biodiversity in the regional ecosystem and caused an ecological regime shift. However, salinisation processes in the lake have not been well-explored yet. To address this, a combination of in-situ and remote sensing observations along with a numerical hydrodynamic model was used to study the salinity dynamics of the lake. To simulate the water salinity distribution, a three-dimensional hydrodynamic model of the lake was developed based on Finite Volume Community Ocean Model (FVCOM) and validated using field data. Wind field, heat flux, precipitation, and surface water evaporation were constructed based on meteorological data. The PHREEQC inverse modeling was then applied to obtain the precipitation and dissolution rates of minerals species. Simulated results indicate that the sedimentation and dissolution of minerals have a significant effect on the salinity levels of the lake. Although brine discharges of rivers to the lake increase the salinity of the lake, the elevated salinity of the lake is dominantly caused by the salt precipitation/dissolution processes. The results of this study provide a better understanding of the impact of precipitation and dissolution mechanisms on salinity dynamics in saltwater bodies.