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Application of deep learning algorithms for the forecasting of electrical conductivity under different saline hydrogeochemical environments

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Groundwater constitutes the primary, if not the only source of freshwater in semi-arid coastal areas, which are experiencing rapid population and economic development. Therefore, efficient groundwater management in coastal aquifers is of paramount importance for socio-economic stability, but in the same time constitutes is challenging, since groundwater salinization (GS) phenomenon in coastal aquifers is a complex process driven by a wide variety of natural and anthropogenic stressors. The GS involves different mechanisms, including seawater intrusion due to over-exploitation of groundwater resources, existence of trapped seawater or connate saltwater, agricultural return flow and dissolution of evaporites, which might co-exist, thus increasing furthermore the complexity of simulation of GS and subsequently groundwater management. Groundwater electrical conductivity (EC) constitutes a physicochemical variable that can efficiently represent GS and it is widely applied in operational groundwater management, since it constitutes a measure of water suitability related to water uses (agricultural, domestic, etc.). The last years, artificial Intelligence (AI) has been widely used in modeling of non-linear hydrological systems. Based on the above, our study aims to simulate and forecast EC in two aquifer systems located in Mediterranean Region, which experience complex GS processes based on 5 deep learning algorithms, namely: 1) Multilayer Perceptron, 2) Long short-term memory, 3) Bidirectional LSTM, 4) Convolutional Neural Network and 5) Recurrent Neural Networks. For this, data from groundwater EC probes, combined to groundwater level and climate data (precipitation and air temperature) were used under different combinations of input variables and models' training times windows. Our results indicate that despite the co-existence of aquifer layers with different salinization states and different GS mechanisms, DL algorithms can efficiently simulate EC variation patterns and provide sufficient accuracy in 30-day forecast of EC, which can be considered of high importance from the point of view of groundwater management operations.

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