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# Computationally Efficient ANN as a Realistic Surrogate of MODFLOW-UZF for Integration with the GeoMODSIM River Basin Management Model

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**Abstract:** The productivity of irrigated agriculture in Colorado's Lower Arkansas River Basin (LARB), along with similar basins throughout the western U.S., is threatened by salinity and water logging problems resulting in reduced crop yields and abandoned cropland. In addition, over-irrigation and seepage from unlined canals has resulted in elevated concentrations of nutrients and trace elements, such as selenium, from underlying marine shales into groundwater and the river that exceed environmental standards. Intensive data collection and modeling efforts by Colorado State University in the LARB over the past 20 years have resulted in development of the river basin management model GeoMODSIM, along with calibrated, spatially-distributed regional-scale groundwater modeling based on MODFLOW-UZF for evaluation of best management practices (BMPs) for improving water quality and boosting productivity. GeoMODSIM simulates basin-wide water management strategies to offset impacts of altered return flow patterns resulting from BMP implementation. This is required to insure compliance with Colorado water right priorities and the Colorado-Kansas interstate compact. It is essential that the model is linked with MODFLOW-UZF for accurate modeling of the complex stream-aquifer system of the LARB. Unfortunately, integration of MODFLOW-UZF with GeoMODSIM is hampered by the intense computational requirements that render direct linkage intractable. An artificial neural network (ANN) has been successfully developed, trained, and tested to serve as an accurate and computationally efficient surrogate for MODFLOW-UZF that can be directly linked with GeoMODSIM. This permits assessment of basin-scale impacts of various BMP scenarios using input-output datasets generated from numerous MODFLOW-UZF simulations in the LARB.

***Keywords**:* machine learning; artificial neural networks; MODFLOW; river basin management; stream-aquifer interaction.