



# UTSA Geological Sciences

And

## Institute of Water Research, Sustainability and Policy (IWRSP)

*Seminar Presentation*

*By*

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*On*

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*“A use of multi-isotope (uranium, boron, and strontium) ratios to trace and quantify salinity contributions to Rio Grande river in Southwestern United States”*

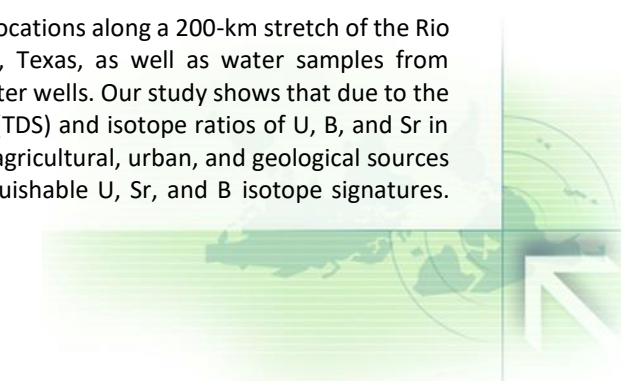
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### **Abstract**

In semi-arid to arid regions, both anthropogenic sources (urban and agriculture) and deeper Critical Zone (groundwater with long flow paths and water residence times) may play an important role in controlling chemical exports to rivers. Here, we combined two anthropogenic isotope tracers: uranium isotope ratios ( $^{234}\text{U}/^{238}\text{U}$ ) and boron isotope ratios ( $\delta^{11}\text{B}$ ), with the  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios to identify and quantify multiple solute (salinity) sources in the Rio Grande river in southern New Mexico and western Texas. The Rio Grande river is a major source of freshwater for irrigation and municipal uses in southwestern United States. There has been a large disagreement about the dominant salinity sources to the Rio Grande and particularly significant sources are of anthropogenic (agriculture practices and shallow groundwater flows, groundwater pumping, and urban developments) and/or geological (natural groundwater upwelling) origins.

Between 2014-2016, we collected monthly river samples at 15 locations along a 200-km stretch of the Rio Grande river from Elephant Butte Reservoir, New Mexico to El Paso, Texas, as well as water samples from agricultural canals and drains, urban effluents and drains, and groundwater wells. Our study shows that due to the presence of localized and multiple salinity inputs, total dissolved solids (TDS) and isotope ratios of U, B, and Sr in the Rio Grande river show high spatial and temporal variability. Several agricultural, urban, and geological sources of salinity in the Rio Grande watershed have characteristic and distinguishable U, Sr, and B isotope signatures.



Combining the multiple U, Sr, and B isotope and elemental signatures, we applied a multi-tracer mass balance approach to quantify the relative contributions of water mass from the identified various salinity end members along the 200-km stretch of the Rio Grande during different river flow seasons. Our results show that during irrigation (high river flow) seasons, the Rio Grande had uniform chemical and isotopic compositions, similar to the Elephant Butte reservoir where water is stored and well mixed, reflecting the dominant contribution from shallow Critical Zone in headwater regions in temperate southern Colorado and northern New Mexico. In non-irrigation (low flow) seasons when the river water is stored at Elephant Butte reservoir, the Rio Grande river at many downstream locations showed heterogeneous chemical and isotopic compositions, reflecting variable inputs from upwelling of groundwater (deeper CZ), displacement of shallow groundwater, agricultural return flows, and urban effluents. Our study highlights the needs of using multi-tracer approach to investigate multiple solutes and salinity sources in rivers with complex geology and human impacts.



Dr. Lin Ma is an associate professor in the Department of Earth, Environmental, and Resource Sciences at University of Texas at El Paso. Dr. Ma received his B.S. from University of Science and Technology in China and his Ph.D. from University of Michigan at Ann Arbor. His primary research focuses on understanding critical processes at our Earth's surface, more specifically in natural waters and soils that are integral parts of the Earth's near-surface layer, or the Critical Zone. Dr. Ma's research approach is developing and using a variety of novel isotope tools to study the Critical Zone: to quantify soil formation rates, to trace water flow paths and solute sources, and to study cycles and pathways of various critical elements in the environments.

