Monitoring precious groundwater resources for arid agricultural regions

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Crops in Saudi Arabia are often irrigated via center pivots that tap underground aquifer sources, which are rapidly depleting. Credit: KAUST; Prof. McCabe's HALO Research Group

A framework designed to provide detailed information on agricultural groundwater use in arid regions has been developed by KAUST researchers in collaboration with the Saudi Ministry of Environment Water and Agriculture (MEWA).

"Groundwater is a precious resource, but we don't pay for it to grow our food, we just pump it out," says Oliver López, who worked on the project with KAUST's Matthew McCabe and co-workers. "When something is free, we are less likely to keep track of it, but it is critical that we measure groundwater extraction because it impacts both food and water security, not just regionally, but globally."

Saudi Arabia's farmland is often irrigated via center pivots that tap underground aquifer sources. The team has built a powerful tool that captures details of water use from the regional scale down to individual fields. This is the first operational system in the world for monitoring and modeling agricultural water use at such fine spatial and time scales, notes López.

The framework combines data from several sources, including the Landsat 8 satellite, weather prediction models and a land-surface hydrology model, to enhance the system's resolution and prediction accuracy.

"The satellite images show distinct patterns of active fields against the bare desert background, allowing us to identify individual center-pivot fields, even if they are irregular in shape and size," says López.

The team at KAUST built a powerful operational system for monitoring and modeling agricultural water use at fine spatial and time scales. Credit: KAUST; Prof. McCabe's HALO Research Group

The team derived crop evaporation rates, surface temperature and albedo, and crop growing patterns from the satellite data. They combined this information with a regional surface hydrology model to estimate the amount of water delivered to each field by the center pivots.

They evaluated the framework at a small-scale 40-field experimental facility in Al Kharj, before trialing it at the large scale in Al Jawf province, where it successfully estimated water use in over 5000 individual fields. The approach has since been applied nationally across more than 35,000 fields.

"Our framework has provided extensive field-scale estimates for 2015 that will serve as a benchmark for future comparisons," says López. "We hope our model offers a consistent and reliable tool that demonstrates the impact of water management policies and drives future decisions."

The team plans to integrate multiple satellite data sources to improve data-collection frequency and resolution, thus improving the framework's accuracy.

"A key goal of our research group is to monitor 'every field, everywhere, all the time'—a true Big Data analytics problem," says McCabe. "To address national and global food and water security concerns, we need local-level knowledge, delivered at the planetary scale."

More information: Oliver Miguel López Valencia et al. Mapping groundwater abstractions from irrigated agriculture: big data, inverse modeling, and a satellite–model fusion approach, *Hydrology and Earth System Sciences* (2020). DOI: 10.5194/hess-24-5251-2020

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