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Assessing the impacts of shale gas development on the water-energy nexus across the semiarid Mexico's northeast

Saul Arciniega-Esparza[1], Agustín Breña-Naranjo[2], Antonio Hernández-Espriú[3], and Adrián Pedrozo-Acuña[2]

[1]Programa de Maestría y Doctorado en Ingeniería, Universidad Nacional Autónoma de México, Mexico City, Mexico
[2]Instituto Mexicano de Tecnología del Agua, Juitepec, Morelos, Mexico
[3]Facultad de Ingeniería, Universidad Nacional Autónoma de México, Mexico City, Mexico

An intensification of water use for hydraulic fracturing (HF) to extract oil and gas from deep shale formations has been observed during the last years across the USA, increasing concerns about water resources management in water-limited regions around the world. At the same time, HF has been associated to several environmental and water quality/quantity impacts in many developed plays of USA, China and Canada, nevertheless, assessing impacts on emergent plays involves several difficulties since future development of HF is generally unknown and because of the lack of local data to evaluate water resources baselines.

In this work, we present a framework that combines the use of remote sensing derived data to assess the baseline of water resources and the development and application of a statistical model to project the development of HF activities. Remote sensing and global land surface model products of precipitation (CHIRPS), evapotranspiration (MODIS), recharge (WaterGAP model), infiltration and runoff (MERRA) and water storage (GRACE) were used to estimate water availability and the hydrological response of watersheds and aquifers. Scenarios of HF were generated using a statistical model that simulates HF water requirements, hydrocarbon production, flowback-produced water and economic trends, among others factors that influence the HF development.

The proposed framework was applied to evaluate the impacts of HF development on the water energy-nexus at the transboundary Eagle Ford play, located across Mexico's northeast, a water-limited region that contains substantial reserves of shale gas.

Scenarios were generated following two economic projections and assuming water use trends and historical HF development from the Eagle Ford, Barnett and Haynesville plays, in Texas, which are geologically similar to the Mexican Eagle Ford play.

Results suggested that the higher impacts on the water-energy nexus in Mexico resulted from reported trends in Eagle Ford, Texas, with ~14,000 wells drilled in ten years and an accumulative water use volume of ~450 millions cubic meters, representing about ~69% of the annual groundwater concessions for municipal use.

The framework presented in this work can be used in other plays around the world to assess the impacts of HF on water resources and their implications in its water-energy nexus.