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EARTH OBSERVATION SATELLITES COMBINED WITH IN SITU DATA FOR MODELLING THE ENVIRONMENTAL AND ANTHROPOGENIC WATER STRESSORS IN CHENNAI, INDIA

Abstract

Water security is a growing global concern. Depending on the geographical location, a complex set of stressors pose an imbalance in the water utilization and distribution mechanisms. Studies suggest that the global water crisis is driven not only by climate change, but also by population, economic growth, and poor water management. Surface and ground-water models using space or ground-based data continue to emerge. Traditional manual approaches based on field surveying with limited measuring equipment have also been adopted to assess the water body geometry and depth. However, these methods are labor-intensive and costly, and as currently delinked, do not provide synoptic views of the overall condition.

Here, we show that the earth observation satellite data, in combination with in-situ observations, can offer vital spatiotemporal information about the environmental and anthropogenic water stressors in the metropolitan city of Chennai, India. Using the Normalized Difference Water Index (NDWI) and Modified Normalized Differential Water Index (mNDWI) derived from LandSat and Sentinel-2A/B satellites, combined with in situ data from Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), revealing the spatiotemporal surface water reservoirs and built-up areas, and their heterogeneous distribution. These historical datasets are from the 1970s and at a spatial resolution between 10 and 60m. Ground-water levels and influxes and the possible seawater intrusion were also modeled using the electrical conductivity and chloride concentrations from Central Ground Water Board (CGWB) data. Simultaneously, environmental contributions were modeled with spatiotemporal temperature and rainfall data derived from Moderate Resolution Imaging Spectroradiometer (MODIS) and Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) satellites respectively, in combination with Indian Meteorological Department (IMD) data. Finally, anthropogenic factors were also considered in terms of population growth due to rapid urbanization and water abstraction with the Census and Chennai Metropolitan Development Authority (CMDA) data.

Therefore, the synoptic observations demonstrated by this unified approach outweighs the lack of critical considerations in individual fragmented models and allow the environmental and water boards to evaluate changes in the water stress conditions in near real-time and facilitate plausible strategies to address them. A possible future inclusion to this model is the real-time data obtained with a network of autonomous robotic surveyors for various environment and water measurements. This approach may help get closer to ensuring availability and sustainable management of water as per the United Nations' Sustainable Development Goal (SDG) 6.

Keywords: Earth observation - water security - climate - anthropology - UN's SDG 6