



Quantifying Surface Water and Ground Water Interactions using a Coupled SWAT_FEM Model: Implications of Management Practices on Hydrological Processes in Irrigated River Basins

Pooja P. Preetha¹ · Naveen Joseph² · Balaji Narasimhan³

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Abstract

This study coupled the Soil and Water Assessment Tool (SWAT) with a ground water finite element model (FEM) with the enhancements of multiple interface conversions and management practices. The coupled model, SWAT_FEM was applied to assess the hydrology of the Chennai River basin in India, a coastal zone with significant irrigation. The SWAT_FEM enhanced the predictions of stream flows and ground water levels (R^2 :0.69,0.81; Nash Sutcliffe Efficiency (NSE):0.64,0.74) compared to the standalone model, SWAT (R^2 :0.64,0.66; NSE:0.60,0.63) respectively. The coupled model produced an all-inclusive representation of the impacts of management practices on the hydrological processes and generated insights into the spatiotemporal patterns of the surface water and ground water interactions in the study area. The results showed that the interactions of surface water and ground water were significant in the mainstream of Chennai River basin. The seasonal ground water levels obtained with the SWAT_FEM model reinforced the increases in exorbitant ground water abstraction rates (9%–44%) with the introduction of management practices including reservoirs, pond irrigation, and agricultural water use. The results emphasized that if the ground water demand continued to increase, accelerated and unregulated ground water extraction is bound to happen shortly to suffice the water use, which can bring about environmental problems to this basin. Overall, this study demonstrated the applicability of the SWAT_FEM model and its value to the water resources management in irrigated areas with management practices. The developed model can be utilized in water resources assessment tools for effective predictions of ground water contributions in river basins.

Keywords Stream flow · Ground water level · Surface water and ground water interaction · Chennai River basin · FEM · SWAT

Highlights

- This study developed a coupled model to quantify surface and ground water interactions in irrigated river basins
- The SWAT_FEM model improved the hydrological predictions compared to the standalone SWAT model
- A novel approach on how management practices would impact surface water and ground water potential is proposed
- Extreme seasonal ground water fluctuations were predicted with management practices in the basin
- The implications of SWAT_FEM model into ground water assessments and water resources management is evaluated

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