Coupled Analytic Element-Finite Volume Based Groundwater-Surface Water Interaction for Canal Command Systems

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ABSTRACT

Groundwater-surface water interaction process still remains challenging due to the complex nature of groundwater systems and large variation in surface water fluctuations. The application of regional scale coupled groundwater-surface water interaction model is difficult due to high computational requirement and data insufficiency. Groundwater plays an essential role in the interaction process to fulfil the irrigation requirement in water deprived areas. Water management in canal command areas is an important issue. Water is delivered in canal command system through a network of canals, distributaries and water courses. Tail-end farmers face water shortage due to uneven distribution of water. Thus, conjunctive water use is practised in canal command systems. The Damodar irrigation system is a canal command system situated in the eastern part of India. The Damodar irrigation system was initially designed to fulfil water requirement for Kharif and Rabi crops only. Every year canal water shortage is observed during "Boro Paddy" cultivation season (Jan-Apr). Thus, groundwater is the major source for irrigation water in the tail-end of Damodar command area. Damodar Left Bank Main Canal (LBMC) system located in the northern part of Damodar river is the study area of the present Thesis. The overall efficiency of the canal networks is decreasing year after year due to reduction in carrying capacity of the canals and unauthorized human interference. For a large portion of the command area in the tail-end reaches of this irrigation system, groundwater remains the only source to raise Boro rice. Area under Boro rice cultivation is typically increasing over the past few decades. Over-exploitation of groundwater is occurring which may affect the sustainable use of water resources. Thus, a comprehensive coupled model is required to simulate the canal command system by incorporating the processes: (a) saturated groundwater flow, (b) unsaturated flow and (c) overland flow. The work presented in this Thesis attempts to develop a coupled model that simulates saturated groundwater flow, unsaturated flow and overland flow for canal command system. Details of individual process-based models and coupled model are discussed. Capability of the coupled model is demonstrated for Damodar LBMC system under two canal regulation scenarios. A groundwater management model is also developed based on simulation optimization approach and tested for an illustrative aquifer.