INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	Bhrigumani Sharma
Roll Number	:	136104019
Programme of Study	:	Ph.D.

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Name of Thesis Supervisor(s)	:	Prof. (Dr.) Rajib Kumar Bhattacharjya
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SHORT ABSTRACT

Saltwater intrusion into coastal aquifers is the most widespread groundwater contamination problem that has become a considerable prominent concern faced by water resource planners worldwide. Therefore, efficient planning and management policies should be implemented in coastal aquifer systems to preserve them and continue utilizing available groundwater resources on a sustainable basis under the threat of saltwater intrusion. In this study, a series of physical experiments have been carried out in a laboratory-scale flow tank model to understand better the dynamics of this phenomenon in a coastal aquifer system under different scenarios. The variable-density flow and transport model FEMWATER is used to simulate the flow and transport processes for the laboratory-scale experiments conducted in the present study. The main goal of the simulations was to evaluate the consistency of the experimental results with the numerical predictions and explain the experimental results better. It has been found that the numerical predictions are in good agreement with all the experimental results. In addition, an image analysis technique is used to measure the salt concentration distribution field in the laboratory-scale aquifer model domain. A statistics-based error analysis method is also undertaken to assess the reliability of the method and to quantify the error associated with the measurements. Moreover, the toe length and the width of the mixing zone have been calculated using the image analysis technique for all the laboratory-scale experimental cases, and results are compared with the numerical predictions. The study shows the image analysis technique could be effectively used for quantification of the solute concentration distributions profile in laboratory-scale flow tank experiments. Furthermore, an effort has been made to investigate the behavior of saltwater intrusion dynamics under a groundwater circulation well with partial extraction of water using both experimental and numerical approaches. This work aims not only to cease the further migration of saltwater wedge towards inland but also to extract some percentages of water partially for human needs. The evaluation of the results indicates no further movement of saltwater intrusion wedge towards the inland side upon implementation of groundwater circulation well and acts as a hydraulic barrier in controlling saltwater intrusion in coastal aquifers. Different scenarios have also numerically been developed, and the model was simulated for all the scenarios to obtain the optimal percentage of the partial extraction. The present study reveals that the groundwater circulation well system with partial extraction can effectively mitigate the saltwater intrusion problem in coastal regions and could be considered one of the most efficient management strategies for controlling the problem.