NUMERICAL GROUNDWATER MODELING OF PAHARPUR CANAL CAMMAND AREA, DERA ISMAIL KHAN, PAKISTAN

By

ANEELA KHAN

Department of Earth and Environmental Sciences
Bahria University, Islamabad

2013

NUMERICAL GROUNDWATER MODELING OF PAHARPUR CANAL CAMMAND AREA, DERA ISMAIL KHAN, PAKISTAN

A thesis submitted to Bahria University, Islamabad in partial fulfillment of the requirement for the degree of M.S in Geophysics

ANEELA KHAN

Department of Earth and Environmental Sciences
Bahria University, Islamabad

2013

Dedicated to

My Parents with Love and Gratitude

ABSTRACT

The study area Paharpur Canal Command area is located in Dera Ismail Khan District of Khyber Pakhtunkhwa province in Pakistan. The study area falls within longitude 70^{o} 55' to 71^{o} 18 East and latitude 31° 45' to 32° 25' North. Chashma Barrage is on the northern side of the study area and to the south is the city of Dera Ismail Khan. The eastern boundary is formed by the River Indus where the Paharpur Canal forms the western boundary. Several surveys have been carried out by WAPDA and reports have been written giving information related to the groundwater flow processes and resources in Dera Ismail Khan.

The main objective of this study is to analyze the groundwater flow system in Paharpur Canal Command area. Numerical three dimensional finite difference steady state (for the year 1980) as well as transient (for the year 1980-2010) flow models are prepared for the unconfined aquifers in the study area. The groundwater flow system in the area is modeled using MODFLOW 4.2.

The model development is carried out by defining the conceptual model of the study area from the data collected by the Meteorological Department, the Water and Power Development Authority (WAPDA) and the Indus River System Authority (IRSA). The conceptual model is transformed into a numeric model via MODFLOW.

The grid cell size of the model was taken 200 x 200 m. The area is modeled with a grid of 171 columns and 399 rows with three layers assigned on the basis of the varying hydraulic conductivity values. The upper 100 meters of the unconfined aquifer is modeled. Model area and the layer top elevation are delineated from topographic. The hydraulic conductivity values are determined from the literature review for the alluvial sediment aquifer. Recharge is taken as 7% of the annual rainfall and the evapotranspiration is calculated from the Thornthwaite equation. River Indus is assigned constant head boundary and stream boundary conditions have been applied to the Paharpur canal.

The steady state model is calibrated using observed hydraulic heads from 24 observation wells. The model is calibrated towards groundwater head observations by modifying the hydraulic conductivity using PEST. From the composite sensitivity graph it is inferred that the model is sensitive to changes in the hydraulic conductivity value in the first layer.

The steady state and transient simulation hydraulic heads contour maps shows that the general direction of groundwater flow is from northeast to south. The steady state water

table depth map show water logged regions in the upper and middle parts of the study area. The behavior of the unconfined aquifer under stresses such as pumping has been evaluated. By analyzing the successive time water table depth maps of the transient simulation (from the year 1980-2010) it is concluded that as a result of pumping the depth of the groundwater is increasing across the modeled region. The model has helped to understand the influence of the boundary conditions on the groundwater flow system in the study area.

ACKNOWLEDGMENTS

First of all I pay my humble thanks to Allah Almighty, who bestowed his blessings in completing my MS research work. I would like to thank my Supervisor Dr. Mohammad Zafar, Head of Department Earth and Environmental Sciences, Bahria University Islamabad, for his support and guidance, and Co-supervisor Dr. Anwar Qadir, Assistant Prof. Bahria University Islamabad, for his excellent guidance, encouragements and laying me on a sound foundation on groundwater modeling. I am very grateful to Prof. Dr. Tehseenullah Khan Bangash for his constructive comments and advice which helped me to come up in right direction of the research work.

My deep gratitude to all my respectable teachers who taught me at BS and MS level. Meteorological Department Islamabad, the Water and Power Development Authority and Indus River System Authority are acknowledged, who provided me with the data for model development. Many thanks to my friends and colleagues for their support and encouragements

Last but not the least gratitude to my parents and siblings for their invaluable support throughout my academic career.

CONTENTS

CHAPTER 3

MODEL CONCEPTUALISATION AND DEVELOPMENT

CHAPTER 4

CALIBRATION AND SENSITIVITY ANALYSIS

CHAPTER 5

NON-STEADY MODEL DEVELOPMENT

FIGURES

TABLES