ASSESSMENT OF SEAWATER INTRUSION IN MEKONG RIVER DELTA, VIETNAM IN THE CONTEXT OF CLIMATE CHANGE

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1. INTRODUCTION

1.1 Background and problem statement

Having the long coastline of more than 3000km, and lying in the tropical monsoon climate, Vietnam is usually influenced by natural disasters such as hurricane, storm surges. Furthermore, Vietnam is an agriculture country, and most of the water sources that serve for irrigation, are taken from rivers. Due to the seawater intrusion into the rivers, the quality of water supply sources will be affected seriously, especially in the dry season when the fresh water in the river will become scare.

The Mekong River starts in Phnom Penh, and divides into two branches: the right branch is the Bassac River called Hau River and the left branch is the Mekong called Tien River in. Both of them flow into the delta regions in southern Vietnam, each river has about 220-250 km long. The discharge of two rivers are very large, about 6,000 m³/s in the dry season, up to 120,000 m³/s in the rainy season. The Mekong River Delta is well known as the most productive agriculture zone of Vietnam. About 1.7 million ha out of 3.9 million ha of land in the Mekong River Delta were affected by salinity intrusion (Massoud, 1974; Wassmann et al, 2004; Vu, 2006). During dry season, the saltwater can intrude up to 60-70 km into the river. In the future, under the effect of climate change, sea level rise, the seawater intrusion problem will be much more serious.

1.2 Objective of the research

The main objective of the research is to evaluate the impacts of salinity intrusion into the main river in the Vietnam Mekong Delta. The specific aims of study are simulation of the salinity intrusion into the river in the context of climate change, sea level rise. Salinity intrusion maps will be built under the different climate change scenarios. Thought these maps, the distribution of salinity concentration along the longitudinal of rivers will be displayed

2. METHOD

Due to the characteristics of Mekong River in Vietnam such as: the bed slope is small; the flow changes gradually in space and time; the estuaries is partially-mixed estuaries and change to well-mixed estuaries when entering the river deeper which the distribution of seawater intrusion in river is longitudinal axis, the change of salinity in depth and horizontal can negligible, so the use of 1D Saint-Venant seems to be better than using 2D or 3D model. Furthermore, selecting whether to use a 1D, 2D, or 3D model depends on the water body, available field data and the answer desired, so with the condition of Mekong River data and the objective of research, 1D Saint-Venant equation will be used to calculate in this research.

3. MODEL DESCRIPTION

For the objective of this study, the hydro-dynamic module (HD) and advection-dispersion (AD) of Mike 11 will be used to compute salinity into river and estuaries.

MIKE 11 HD uses the two following basis equations including equation of continuity and equation of momentum:

$$\frac{\partial A}{\partial t}+\frac{\partial Q}{\partial x}=q \tag{1}$$

$$\frac{\partial Q}{\partial t}+\frac{\partial\left(\alpha\frac{Q^2}{A}\right)}{\partial x}+gA\frac{\partial h}{\partial x}+g\frac{gQ|Q|}{C^2AR}=0 \tag{2}$$

Where Q is discharge, A is the cross-sectional area, q is lateral inflow, C is Chezy roughness coefficient, R is hydraulic radius, and α is momentum correction coefficient.

The governing equation on MIKE 11 AD module is one dimensional equation of conservation of mass:

$$\frac{\partial AC}{\partial t}+\frac{\partial QC}{\partial x}+\frac{\partial}{\partial x}\left(AD\frac{\partial C}{\partial x}\right)=-AKC+C_2q \tag{3}$$

Where C is the concentration, D is the dispersion coefficient, A is the cross-sectional area, K is the linear decay coefficient, C2 is the source/sink concentration, q is the lateral inflow discharge, x is the space coordinate, and t is the time coordinate.

The solution of the equations of continuity and momentum is based on an implicit finite difference scheme developed by (Abbott and Ionescu 1967). The finite difference scheme used in MIKE 11 (6-point Abbott scheme), allows Courant numbers up to 10-20 if the flow is clearly sub-critical (Froude number less than 1). The simulation period is from 1 January 2013 to 30 June 2013 with the time step Δt= 30 minutes for HD module. The minimum spacing dx equals 1000m and maximum spacing dx equals to 10000m. The Manning coefficient n was assigned to all river branches with the value of 0.018 to 0.04 in HD module, and the initial condition is set up at 0.5m of water level for all the rivers

4. RESULTS AND DISCUSSIONS

4.1 Results

The HD module was calibrated with observed data from some stations in 2013. The calibrated parameter is Manning's roughness (n) of all rivers. To assess the model performance, we need to use a lot of model performance indexes such as: Nash-Sutcliffe efficiency (NASH), coefficient of determination R^2 (or goodness of fit), root mean square error (RMSE), F statistic, mean absolute error (MAE), Absolute Percent bias (APB), and so on.

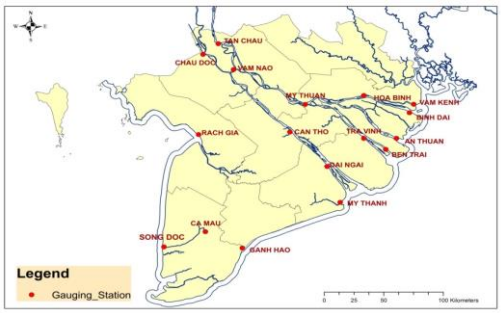

Fig. 1 Location of gauging stations in Mekong River Delta

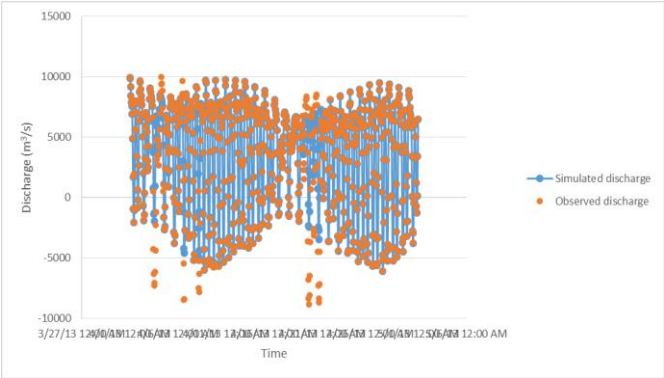

Fig. 2 Calibration of calculated and measured water level at My Thuan station with NASH =0.74,R^2=0.78,APB=9%

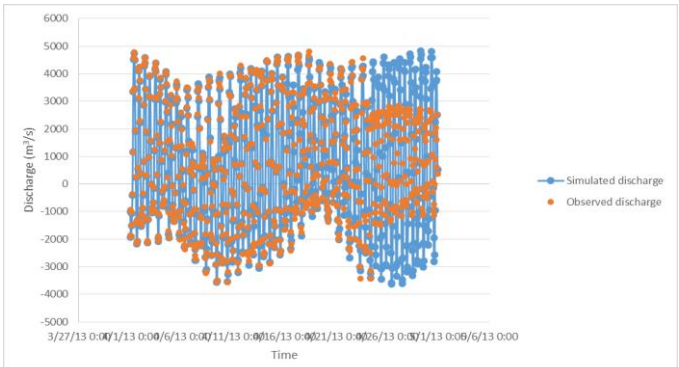

Fig. 3 Calibration of calculated and measured water level at Vam Nao station with NASH =0.80, R^2=0.82,APB=22%

4.2 Discussions

The modeling-based assessment of the hydrodynamic in the Mekong River is described in dry season, from January to June because the effect of seawater intrusion is the most serious during this period. Comparing the calibrated and validated model results of the discharge in 2013 with measured data leads to the following conclusions: The database used to simulate the hydraulic parameters in the Mekong River Basin has acceptable reliability; the results of calibrated and validated of flow in Mekong River Delta showed that the simulation results have the high reliability

Because of limited time, there is no calibrated results of salinity intrusion in this report. So in the next step, the salinity intrusion results will be validated and calibrated before applying to the case of climate change scenarios.

5. ACKNOWLEDGEMENT

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