TC-319S

SUSTAINABLE GROUNDWATER DEVELOPMENT IN CAN THO CITY, MEKONG DELTA VIETNAM UNDER CLIMATE CHANGE

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In the Mekong Delta Vietnam (MDV), agriculture, especially rice, and aquaculture are considered staple food and a principal source of income to millions of smallholders (Van Kien et al., 2020). Also, agriculture production has a substantial contribution to the gross domestic product (GDP) of Viet Nam (Huong et al., 2021). For this, farmers are increasingly installing tube wells to support small-scale irrigation and provide supplemental water for agriculture in dry seasons. As a result, depletion in groundwater resources due to over-extraction in the aquifer in recent years is a serious threat to people's livelihood, farming systems, thereby affecting socio-economic growth (Vuong, 2013, Ha et al., 2015, Minderhoud et al., 2017). In addition to anthropogenic pressure, climate change is expected to worsen the impact because floods and droughts have led to water security issues in many parts of the MDV (Smajgl & Ward, 2013, Smajgl et al., 2015, Jin et al., 2018). One of severe areas is the delta aquifer in Can Tho city where is known as the center of the key economic region in the MDV (Moglia et al., 2012, Ngo et al., 2018). Thus, assessing sustainable groundwater development is crucial in the MDV in general and in Can Tho city in particular. In this study, the calibrated groundwater flow model MODFLOW from GMS (Groundwater Modeling System) software is constructed based on geo-hydrogeological data and calibrated by using measured monthly groundwater level series from January 2000 to December 2016 at 21 observation wells in Can Tho city and surrounding area. The impacts of groundwater abstraction to groundwater resources is significant through the following indexes including decrease of groundwater levels, changes of groundwater storage. The long-term extensive exploitation has depleted groundwater resources and caused several problems. In some places with heavy groundwater withdrawal, the water table dropped from 2-5m below the ground surface in 2000 to 15-21m below the surface in the early 2016s. Based on the estimated groundwater budget in 2016, there was 27% of groundwater abstraction comes from groundwater storage. Captured storage has been increasing dramatically since 2008 to catch up with the significant growth of groundwater abstraction. In other words, the over groundwater abstraction reduced the storage of the aquifer system and induced the decline of GWL significantly in the period of 17 years.

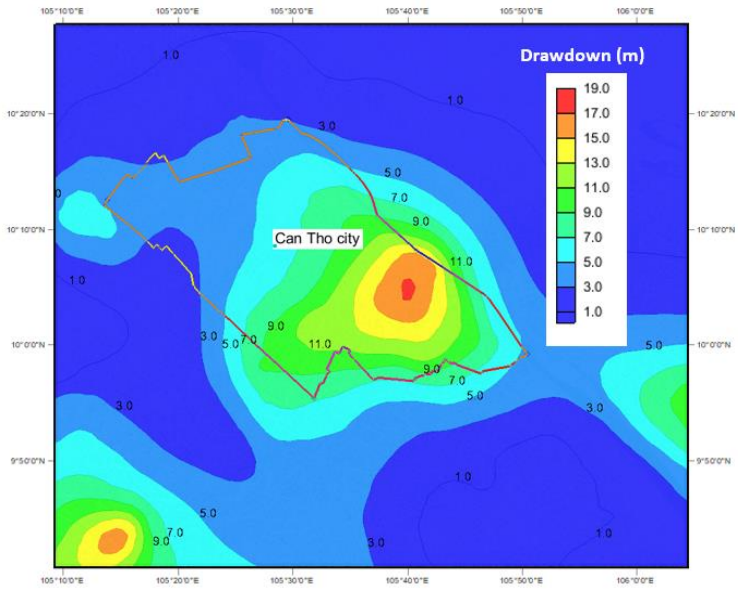
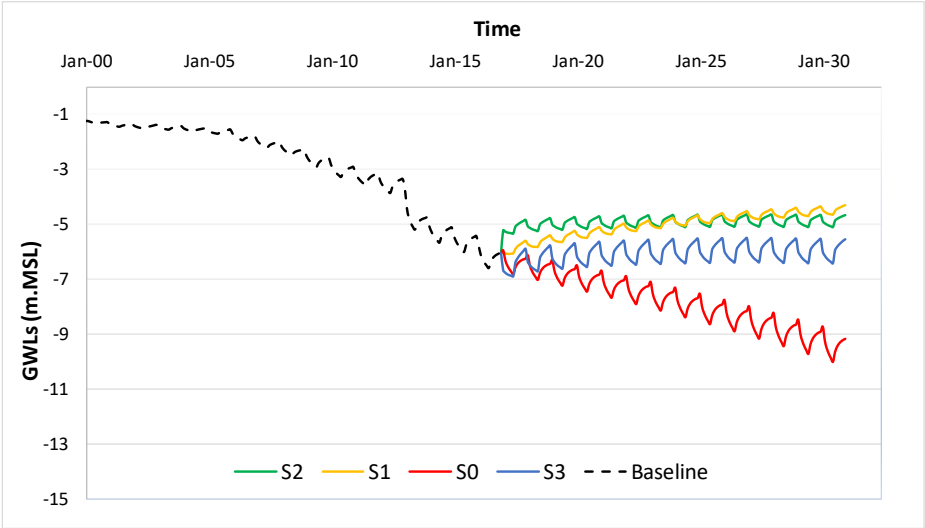
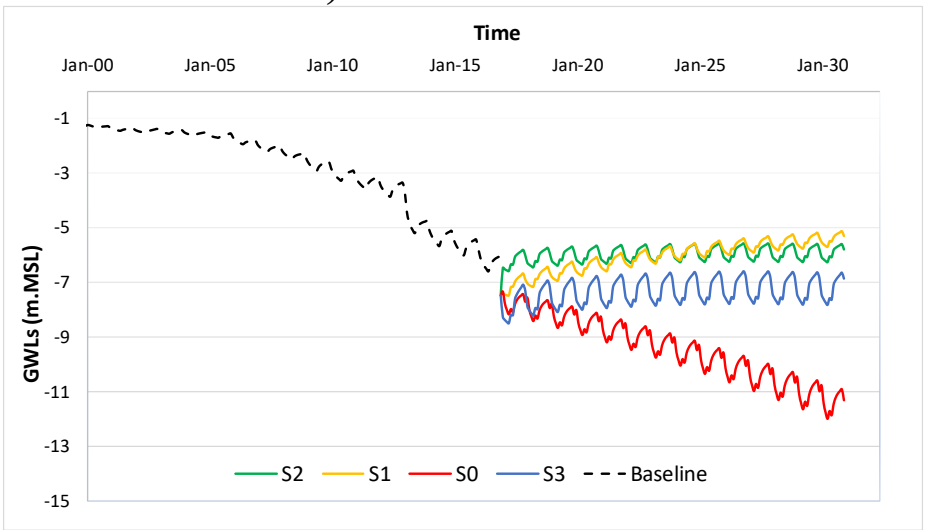


Figure 1 - Drawdown in the Upper-Middle Pleistocene aquifer (qp_{2-3}) from 2000 to 2016

Model results showed that groundwater system in Can Tho city has moved from a pristine system to a developed system then become a depleted system at present and the existing development of groundwater resources is unsustainable. The possible mitigation measures need to be identified for sustainable groundwater development of the Can Tho city in the respective environment and socio-economic contexts. Results of groundwater flow simulation from 2000 to 2016 showed a relatively high rate of groundwater level decline 0.44 m/year and 0.39 m/year in Upper-Middle Pleistocene aquifer (qp_{2-3}) and Upper Pliocene aquifer (n_{2-2}), respectively. With the current increasing demand for water use and projects for securing drinking water supply with installing new pumping wells in rural areas, groundwater abstraction will most likely increased. For better planning and management of groundwater resources in the province, the consequence of groundwater overexploitation must be analyzed along with possible mitigation measures. Therefore, three proposed management scenarios are business as usual (S0), reduction of abstraction (S1 = 40% of current abstraction, S=20% of current abstraction) and increase of groundwater recharge (S3). Future rainfall, minimum and maximum temperature was projected using two shared socioeconomic pathway-representative concentration pathway (SSP-RCP) scenarios namely: SSP126 and SSP585. The projected data together with some input maps such as land-use, topography, soil texture, slope and wind-speed maps were put in a hydrological model called WETSPASS to simulate the future groundwater recharge.



a) under SSP126 scenario



b) under SSP585 scenario

Figure 2 - Comparison the groundwater levels in mitigation and climate change scenarios

The impact of mitigation measures on groundwater resources will be estimated by considering the change in groundwater levels and translating the differences in groundwater levels into storage volume. Groundwater levels in all aquifers will continuously decrease under the business as usual scenario. Both the reduction of abstraction and increase of recharge will stop further decrease of groundwater levels, however, the reduction of abstraction is more effective to reverse the trend of groundwater level decline. In near future, by reducing groundwater abstraction is 145,000 m^3/d under SSP126 scenario and 125,000 m^3/d in SSP585, the decline in groundwater level and storage has been decreasing and stabilizing after 2-3 years. Reduced precipitation and combined with GW over-exploitation are having direct impacts on aquifers recharge, discharge and storage of the aquifer system in Can Tho city. These circumstances call to adaptive strategies from not only groundwater users but also government or stakeholder with the preservation and sustainable management of GW resources. A combined intervention of different mitigation measures will be proposed to achieve sustainable groundwater resources development in Can Tho city in the uncertain context of climate.

Keywords: sustainable groundwater development, groundwater model, mitigation measures.

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