The Impact of Land Use and Climate Change on the Highly Risk Area of Saline Groundwater Intrusion and Highly Utilized Groundwater Resources in Northeast Thailand: Case Study Huai Toey Groundwater Sub-basin

Kewaree Pholkern[1]; Phayom Saraphirom[2]; Porntip Phontusang[1]

[1] Soil Science and Environment Department, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand

[2]Department of Agricultural Engineering, *Faculty of Engineering, Khon Kaen University, Khon Kaen 40002, Thailand*

Corresponding Author(s): kewaph@kku.ac.th

Groundwater, a crucial resource for various activities in northeastern Thailand, is under threat from the high risk of saline groundwater intrusion due to excessive groundwater abstraction. To ensure the sustainable development of groundwater resources, it is imperative to understand the hydrogeological characteristics of aquifers and their potential. The Huai Toei groundwater sub-basin was chosen as a case study due to its vulnerability to saltwater intrusion. This research aims to comprehensively study the hydrogeological environment and identify factors that could alter the hydrogeology system in the future. The study area was classified into two significant aquifers: the fractured rock aquifer and the unconsolidated rocks, which are underlain with the rock salt of the Maha Sarakham unit at depths of about 50-200 m from the ground surface. This rock salt is the source of saline groundwater in this area. The high groundwater extraction from groundwater wells with depths of 30 - 100 m.bgs results in the continuously decreasing groundwater level.

In 2022, a comprehensive investigation into groundwater use was conducted, revealing alarming results. The majority of the groundwater was used for agriculture (43.56 Mm^3/year), followed by service and industry (11.67 Mm^3/year) and water supply (3.03 Mm^3/year). The natural groundwater recharge was evaluated using numerical models (HELP3) with a set of data (soil, climate, land use, slope), which found that the natural groundwater recharge rate varied from 0 - 25% (ave. 8.71%) of annual rainfall and annual recharge is about 53.27 Mm^3/year. Therefore, the groundwater use in the study area is higher than that of natural groundwater recharge by about 5.18 Mm^3/year. The study area can be divided into the Tha Phra, Kosum Phisai, and Kut Rang sub-groundwater flow systems. The Tha Phra and Kut Rang sub-groundwater flow systems have more groundwater extraction than natural groundwater recharge; the groundwater level continuously decreases, and the spread of saline groundwater has increased, highlighting the urgent need for action to prevent further depletion and contamination of groundwater resources.

In the next 30 years (2052), the two projected future land uses were developed and showed an increase in urban and cassava areas; meanwhile, the paddy field tends to decrease in both projections. Future land use caused the decrease of future groundwater use to 50.61 Mm^3/year and 52.32 Mm^3/year in future land uses 1 and 2, respectively. However, groundwater use for service and industry tends to increase by about 143% in 2052, posing a significant challenge to the sustainability of groundwater resources. According to global climate models, the amount of precipitation and the number of rainy days will increase from the present. Based on future changes in land use, two projections, and potential climate change in 4 scenarios, the natural recharge of groundwater is projected to increase to an

average of 96.59 Mm^3/year, which is higher than the current level. This may cause the groundwater level in this area to increase and affect the groundwater flow direction and the spread of groundwater salinity in the future, highlighting the potential implications of the current situation.

Keywords: Rock Salt, Groundwater Recharge, Groundwater Extraction.