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GIS ANALYSIS FOR GROUNDWATER EXPLORATION IN HARD ROCK TERRAINS: HUAI KRACHAO, KANCHANABURI, THAILAND

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Nowadays, climate change leads to many natural disasters, for example, thunderstorms, flooding, and drought around the world. Thailand also faces the same issues, especially in Huai Krachao Subdistrict, Kanchanaburi Province, western Thailand. Over the last 5 years, climate change has led to little precipitation in this region, with an annual average of less than 800 mm. Due to prolonged hot and dry conditions, this area is currently facing droughts. Under the circumstances, about 4,800 people are likely to be affected by climate change, causing water shortages for both domestic and agricultural uses. The water level in the Nong Na Talay reservoir – the only surface water storage in this area – continuously declines, resulting in an inadequate surface water supply during the dry season. Since the issues are getting worse than expected, the Department of Groundwater Resources has sent geologists who are responsible for exploring groundwater resources for detailed investigation. Managing surface water with supports from underlying groundwater resources might be one possible solution to prevent water shortages and reduce water stress in this area. Consequently, it would lead to achieving the United Nations' Sustainable Development Goal 6 (Clean Water and Sanitation) whenever people have access to clean and safe water. The recent study aims to delineate groundwater potential zones in the Huai Krachao area using the GIS-based analytical technique. The method provided the basic information and helpful guidelines for field surveys and were used as a tool to make decisions for site selection.

This area extends between latitudes 99°32'21"-99°41'21"N and longitudes 14°15'48"-14°26'36"E, covering an area of about 150 km^2. The study area is underlain by the Silurian-Devonian metamorphic rocks, including phyllite, slate, and quartzite in the west. On the opposite side, the Triassic granite is overlain by colluvial sediments with a thickness of approximately 2-5 m. In addition, large, long, and shallow fractures are predominantly presented in metamorphic rocks, while small, narrow, and deep ones are found in granite. Due to the challenges of groundwater drilling and development in hard rock terrains, more than 4,800 people are experiencing water scarcity and still need water for consumption, agriculture, and livestock. For this study, the geographic information system (GIS) was applied for groundwater resources investigation in hard rock terrains. The Analytic Hierarchy Process (AHP) was used as the decision-making tool for delineating groundwater potential zones based on weights derived from different parameters. There were nine significant parameters involved, consisting of geology, geomorphology, land use and land cover (LULC), slope angle, soil type, drainage density, rainfall, lineament density, and depth to groundwater. These input parameters were integrated using the Weighted Index Overlay Analysis (WIOA) to classify potential groundwater recharge zones, possibly define the groundwater extension, and consequently produce the groundwater potential index (GWPI) map.

Groundwater potential areas can be classified into three zones in accordance with GWPI values: high potential (GWPI > 6), moderate potential (GWPI = 6), and low potential (GWPI < 6) zones. The high potential zone covers an area of 31.2 km^2, accounting for roughly 20% of the study area. It is mostly occupied in the Silurian-Devonian metamorphic rocks and dominated by slopes and hills with an elevation of 82-116 m above MSL. This zone has a high rainfall rate (average 993-1,065 mm/year), high lineament density (>4 km/km^2), gentle slope (<10 degrees), and is mostly used for agriculture. The moderate potential zone covers an area of 62.5 km^2 or about 44% of the total area. It primarily lies within flat and low-lying areas (plains), covered by the Quaternary sediments with an elevation of 40-82 m above MSL. This zone is located in areas with a medium rainfall rate (average 1,012-1,017 mm/year) and a moderate to high density of lineament (>3 km/km^2), where the slope is less than 10 degrees, and most of the areas are currently in use for cultivation.

After obtaining the GWPI map, the accuracy of the map was verified by drilling 10 wells in total, including 5 wells located in two high potential zones, another 3 wells tested in the northwest, and the other drilled in the south. All wells are in the Silurian-Devonian metamorphic aquifer, with a depth ranging from 150 to 300 m. Groundwater aquifers were found in fracture zones at 66, 103-104, 111-117, 150-165, and 281-283 m deep, with an average well yield of 35-40 m^3/hr. In summary, groundwater development in hard rocks with complex geological structures is costly and time-consuming. Thus, the determination of groundwater drilling points must be accurate and precise. GIS was employed in this study as a tool to analyze all related parameters and then displayed a clear and easy-to-use map with high, moderate, and low groundwater potential zones. However, this integrated approach is based on reasonably valid input data. Variation occurs when input parameters are uncertain. In this case, for example, lineament density was not well determined because of the complexity and disconnectivity of the geological media. As lineaments were interpreted from surface features using remotely sensed data like the digital elevation model, they were difficult to determine precisely. Therefore, the procedure had to be followed by detailed geological and geophysical surveys to provide more information before selecting the drilling location. After the GWPI map has been proved and cross-checked by drilling data, the map is effective and capable of delineating the potential zones for groundwater development in the Huai Krachao area.

Keywords: AHP, Groundwater potential index (GWPI) map, Groundwater exploration in hard rock terrains

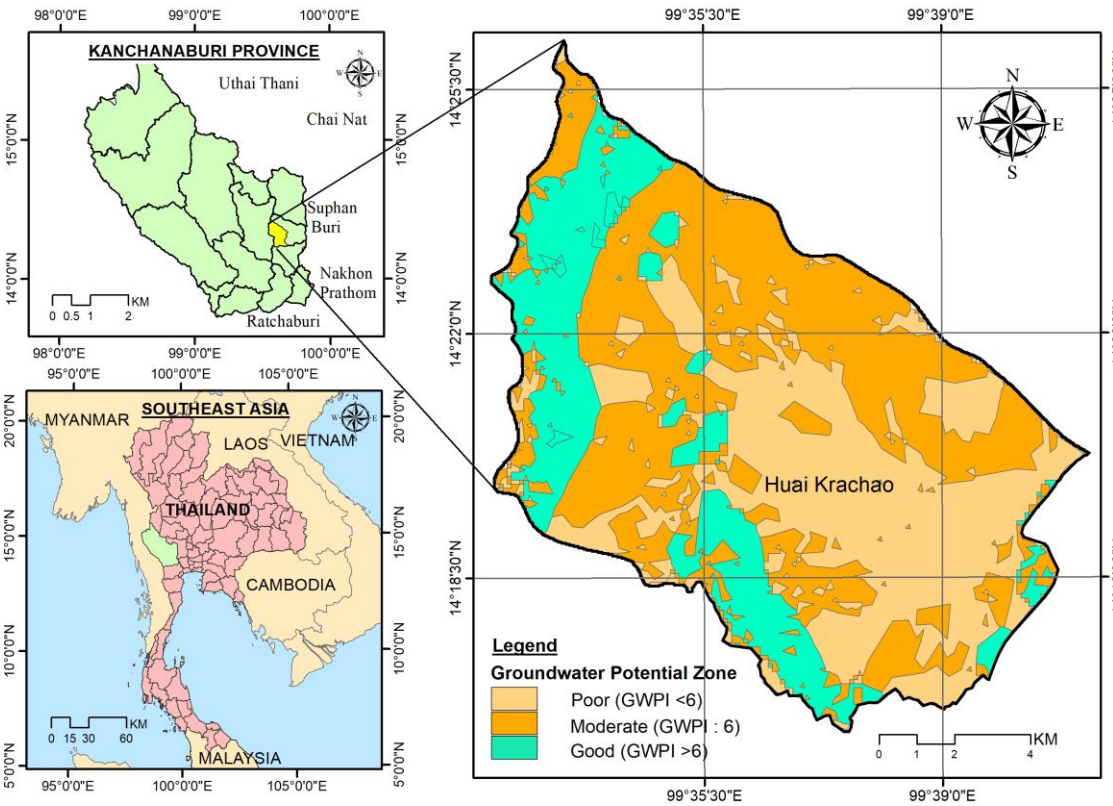

Fig. Groundwater potential zones showing the spatial distribution of groundwater potential index (GWPI)

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