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A combination of Satellite Image, Soil Type, and Topography Data to Delineate Potential Area of Groundwater Recharge

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1. Introduction

Remote sensing technology has been successfully applied to Land Use and Land Cover classification (Moukana and Koike, 2008). Freely accessible remote sensing image data such as Landsat-8 and Digital Elevation Model data have been widely used for mapping land use and other spatial analyses. Landsat-8 launched in 2013, includes 11 spectral bands from visible to thermal infrared region. The satellite imagery is useful for mapping groundwater recharge areas (Masoud and Koike, 2006).

This study aims to specify groundwater recharge areas in the Madura Island area, East Java Province, Indonesia using Landsat 8 image set. The main reason of this selection is that this area needs much groundwater for agriculture and life necessities. However, groundwater system in this study area has not yet been clarified in detail.

2. Data and Methodology

2.1. Study area and data

The study area covers an area of approximately 5,379 km^2. As the main land cover types, five categories were selected: water bodies (W), tenuous vegetation (TV), settlement (S), bare land (B), and dense vegetation (DV). Soil types consist of four categories: chromic luvisols, lithosols, eutric fluvisols, and pellic verstisols.

Figure 1. Landsat-8 image covering the study area.

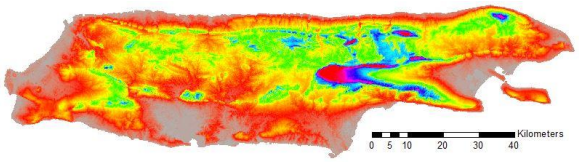

Figure 2. DEM data.

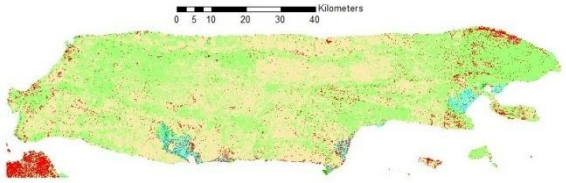

Figure 3. Land use/ land cover (LULC) map. Blue: agriculture, red: settlement, green: tenuous vegetation, yellow: bare land, purple: dense vegetation, and navy: water bodies.

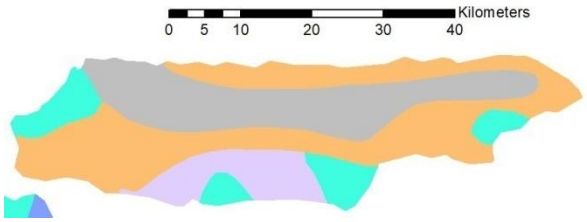

Figure 4. Soil type map. Orange: chromic luvisols, blue: eutric fluvisols, purple: pellic fluvisols, and grey: lithosols.

2.2 Methodology

Seven band data at 30 m spatial resolution (blue, green, red, NIR, SWIR 1, SWIR 2, Panchromatic) of Landsat-8 image acquired on 1st October 2019 and 29th September 2021 covering the study area (Fig. 1) are used for land cover mapping and visual interpretation for an object classification using Google Map. This remote sensing data is used to obtain various parameters of the groundwater potential. These parameters are then combined with other secondary data such as digital elevation model (DEM: Fig. 2), land use/land cover (LULC) map (Fig. 3), soil type (Fig. 4), and rainfall to produce a zoning map of groundwater potential. The above research flow is summarized in Figure 5.

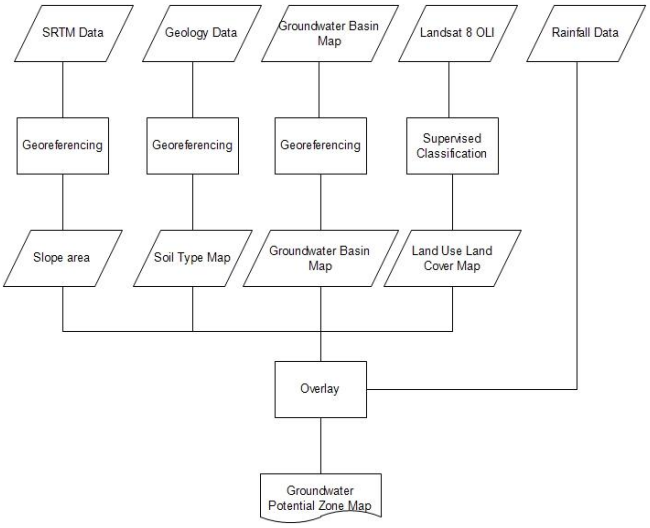

Figure 5. Research flowchart to produce a map of potential area of groundwater recharge.

3. Results

Based on the produced groundwater potential map (Fig. 6), it can be seen that Madura Island has a very high groundwater potential: 27.8%, high potential: 52.1%, relative low potential: 17.8%, low potential: 1.6% and very low potential: 0.64%. By this preliminary assessment, the study area has sufficient volume of groundwater to be used, which meets the needs of life and agricultural activities.

Moreover, the management of water resources including groundwater must be carried out based on the river area by the Central River Basin. There is a distinction between river basins and groundwater basins, necessitating separate management with the groundwater basins. In the Madura Island, the map of groundwater recharge potential zone provides information about the areas with large volume of groundwater. This map provides limited information regarding potential groundwater recharge areas. Nonetheless, this data can indicate a starting point for site determination in a series of groundwater studies. This data can also determine policies, such as groundwater conservation and land use planning.

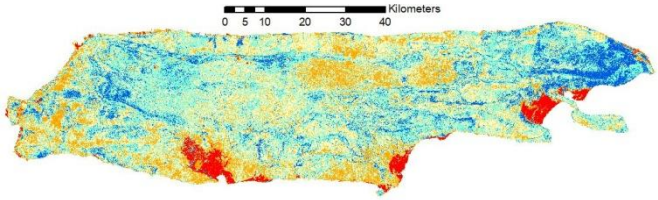

Figure 6. Potential recharge area map. Blue: very high potential, navy: high potential, yellow: relative, orange: low potential, and red: very low potential.

4. Summary

Our next step is use of field investigation data for accuracy improvement of the maps related to groundwater. The lack of field investigation data become the main reason of this low agreement value.

References

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