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SOIL TYPE CLASSIFICATION FOR IDENTIFICATION OF SUITABILITY OF RESIDENTIAL AREAS USING THE SMCA METHOD IN PURBALINGGA REGENCY

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ABSTRACT: The assessment of land suitability for residential development is an important aspect of sustainable urban planning. This study uses spatial multi-criteria analysis (SMCA) as a tool to identify potential land suitable for the development of residential areas in Purbalingga Regency, by considering soil type as the main variable. The method used involves using a soil-type map of Purbalingga Regency in 2018 as basic data. The classification of soil types is carried out to determine the spatial distribution of soil-types in the region, which includes alluvial, andosol, gleisol, cambisol, Mediterranean, Oxisol, Regosol, Settlement, and Water Body soil types. This study focused on weighting soil types based on suitability for residential areas, where each soil type was scored based on its level of suitability: very inappropriate (score 1), not suitable (score 2), quite suitable (score 3), and very suitable (score 5). The results of the analysis showed that the type of cambisol soil dominates the area with an area of 33,499.934291 hectares. However, the suitability of settlements based on the type of land is generally included in the category of non-conforming. This indicates that although the type of cambisol soil has a large area, its characteristics are less supportive for the development of residential areas. This research can be the basis for determining the optimal location for the development of sustainable settlements in accordance with local land characteristics.

Keywords: Classification, soil-type, land suitability, SMCA, Purbalingga Regency

1. INTRODUCTION

Shelter as a basic human need is becoming a driving factor in the increase in demand for land, especially with the increase in population. Problems related to the availability of very limited land are not able to meet these needs. The imbalance between the demand for land for settlements and the availability of land can result in the conversion of land that was originally used for other purposes into settlement land. The impact of this phenomenon is felt not only in large cities, but also in suburban areas. The phenomenon of urban sprawl, described by Troy (1996), suggests that irregular settlement construction in the suburbs can disrupt urban structures and neighborhoods, as well as give rise to complex socio-economic problems. Therefore, regulation of settlement land use is crucial in maintaining environmental sustainability and ecosystem balance.

Land suitability analysis is one tool that can be used to overcome this challenge. By conducting a land suitability analysis, we can assess and identify potential land suitable for settlement development. This approach allows policymakers to better regulate land use, considering environmental, social, and economic aspects holistically. Thus, the application of land suitability analysis is important in maintaining land function, preventing uncontrolled urban sprawl, and supporting sustainable and planned urban planning.

Land suitability plays an important role in the planning and development process of the region, with objectives that have been identified in the literature. First, land suitability can help identify potential and characteristics of land that can be used for various purposes, such as settlement, agriculture, industry, or conservation (Hardjowigeno, 2003; Al-Vatia & Nugroho, 2019)[7,1]. Second, land suitability enables systematic comparisons between various proposed land uses, thus facilitating data and information-based decision making (Hardjowigeno, 2003; Al-Vatia & Nugroho, 2019)[7,1].

A commonly used approach in land suitability analysis is Spatial Multicriteria Analysis (SMCA), which allows the simultaneous use of multiple indicators to achieve a specific goal (Boggia et al., 2018)[3]. In the context of settlement development in Purbalingga Regency, this method is implemented by utilizing the Geographic Information System (GIS) and remote sensing (PJ) as spatial instruments. The integration of GIS and PJ enables a comprehensive analysis of environmental carrying capacity and land suitability, which are important aspects in regional planning (Shahabi &; Hashim, 2015; Haokip et al., 2021; Wang et al., 2017; Baja, Neswati, & Arif, 2019)[9,10,2]. Remote sensing technology, particularly using spacecraft, has brought significant advances in

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access to and understanding of spatial data required for multi-criteria analysis (Denis et al., 2017; Gorelick et al., 2017)[4]. This provides an opportunity to obtain accurate and detailed information about land, vegetation, and environmental conditions widely and efficiently.

Purbalingga Regency, as one of the districts in Central Java Province, has a significant population growth rate in 2020, amounting to 1.58% according to data from the Central Statistics Agency (BPS Purbalingga Regency in 2023 Figures). Rapid population growth often leads to an increase in demand for land for various purposes, including settlements. Analysis of land suitability for settlements in Purbalingga Regency was carried out by considering soil type variables taken from data released by the Ministry of Agriculture through the One Map Policy (KSP). The use of variable soil types as indicators of land suitability is important because soil type affects productivity, drainage, water availability, and various other aspects relevant to settlement development.

Therefore, this study aims to identify the variables of soil types in Purbalingga Regency and analyze the suitability of land for settlement based on these variables. By understanding the characteristics of the dominant soil types in the region, as well as evaluating the suitability of land for settlement based on these soil types, this research can provide valuable insights for urban planning and regional development in Purbalingga Regency.

2. RESEARCH METHODS

The location of the study was conducted in Purbalingga Regency, located in Central Java Province, Indonesia. Astronomically, Purbalingga Regency is located between 109° 11' E to 109° 35' E and 7° 10' S to 7° 29' LS. The region consists of 18 sub-districts and 239 villages , demonstrating significant geographical and demographic diversity. Geographically, Purbalingga Regency has clear boundaries. In the north, Purbalingga Regency is directly bordered by Pemalang Regency and Pekalongan Regency, while in the east it is bordered by Banjarnegara Regency. In the south, Purbalingga Regency is bordered by Banjarnegara Regency and Banyumas Regency, while in the west it is bordered by Banyumas Regency. These boundaries show the geographical proximity of Purbalingga Regency to various neighboring regions, which can affect the social, economic, and environmental dynamics in the region. The map of the research location is presented in Figure 1, which will provide a visual understanding of the relative position of the research in the context of Purbalingga Regency.

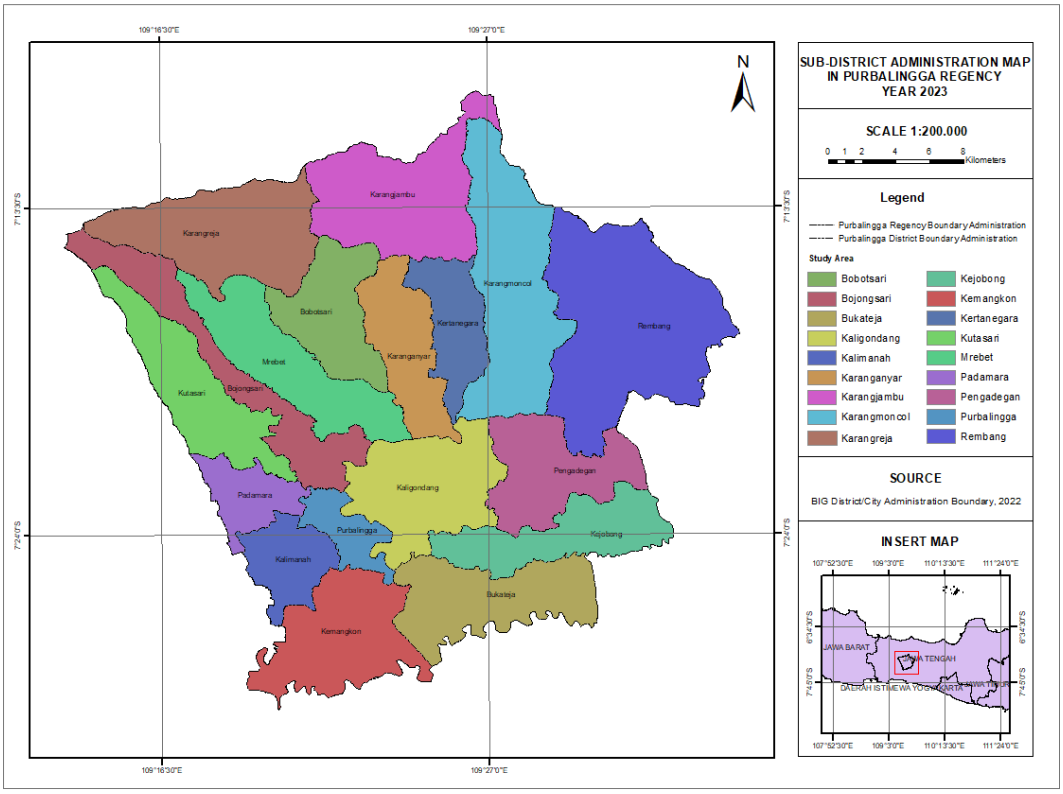

Fig.1 Map of the study area

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This study adopts a comprehensive approach in analyzing land suitability for settlement development in Purbalingga Regency. One of the variables used is natural physical factors, especially soil type. To simplify analysis, all existing soil type classes are merged into one soil type layer with one attribute column. This layer is then clipped based on the administrative boundaries of Purbalingga Regency, resulting in a relevant dataset. The classification of soil types is simplified based on elemental categories and juxtaposed with related reference sources to ensure the validity and consistency of the classification. Furthermore, each variable or map is given a score of 1-5 which reflects its importance to a particular goal in settlement development. This score allows prioritizing appropriate locations for settlement development taking into account the characteristics and potential of each variable.

The dataset that has been scored is reclassified into a residential area suitability index. This process produces a map of land suitability for settlement development with 5 classifications, namely Very Appropriate, Appropriate, Quite Appropriate, Not Appropriate, and Very Unsuitable. This map provides clear visual guidance on the most suitable and unsuitable locations for settlement development, so that it can be the basis for decision makers in regional planning. This complex research workflow is visually described in Figure 2, which helps to understand the steps taken from start to finish in the analysis of land suitability for settlement development in Purbalingga District.

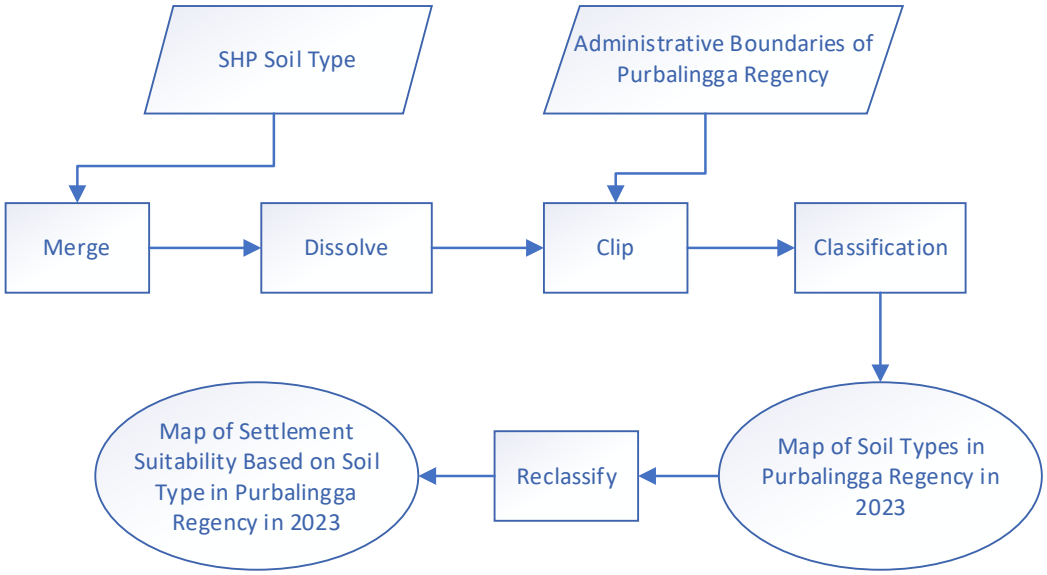

Fig.2 Research Workflow

3. RESULTS AND DISCUSSION

The classification of soil types in Purbalingga Regency reflects the characteristics of typical tropical soils. This research refers to soil type maps issued by the Ministry of Agriculture through the One Map Policy (KSP). The classification of soil types in Purbalingga Regency includes various soil types, including alluvial, andosol, gleisol, cambisol, Mediterranean, Oxysol, Regosol, as well as additional classifications such as Settlements and Water Bodies. The presence of these different soil types reflects the geological and topographical diversity of the region, which also affects the potential for land use and settlement development. The soil type map presented in Figure 3 is a visual representation of the spatial distribution of soil types in Purbalingga Regency.

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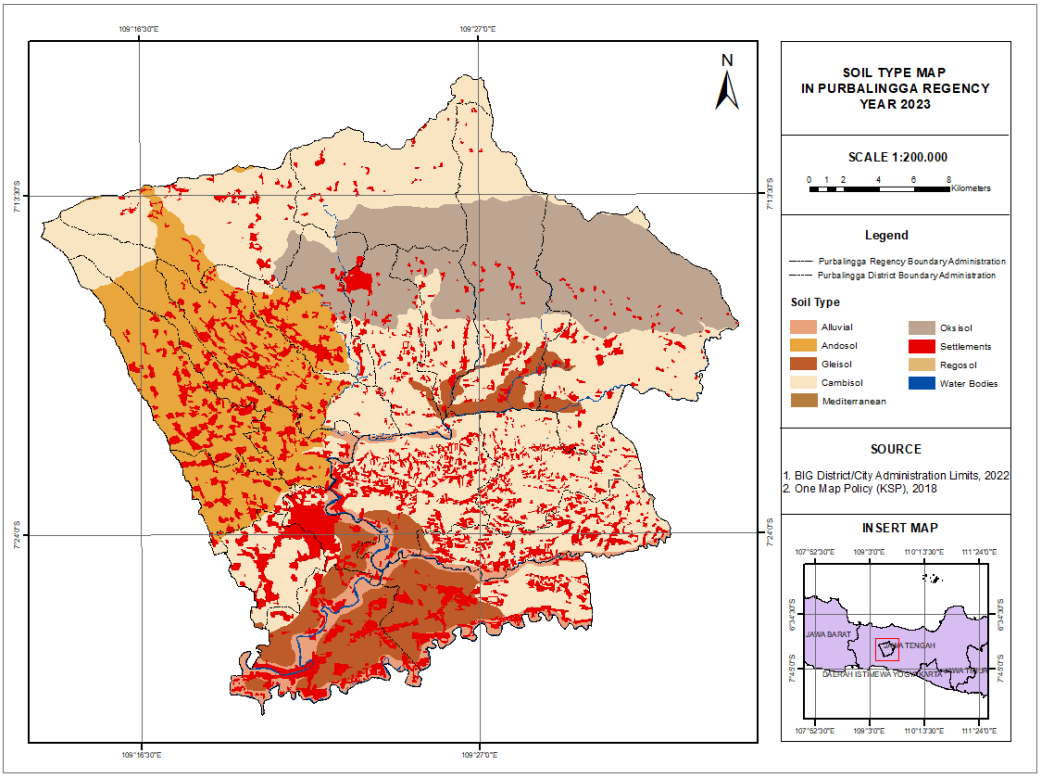

Fig.3 Map of Soil Types in Purbalingga Regency in 2023

This map is an important basis in the process of land suitability analysis, because it allows researchers to understand the distribution patterns of soil types and consider the unique characteristics of each soil type in determining land suitability for settlement development. By understanding the classification of soil types in Purbalingga Regency and utilizing the available soil type maps, this research can provide a better understanding of the potential of land for settlement development as well as help in establishing the right strategy in regional planning. The following distribution of scores, areas and categories of soil types in Purbalingga Regency are presented in Table 1.

Table 1 Distribution of scores, area and categories of soil types in Purbalingga Regency

Soil type	Score	Area (ha)	Category
Alluvial, Gleisol, Water bodies, Settlements	5	21359,33	Fits perfectly
Cambisol	4	33499,93	Appropriate
Mediterranean	3	6,45	Quite suitable
Andosol, Oksisol	2	25707,26	Not compliant
Regosol	1	0,02	Very inappropriate

Source: Data processing 2023

Spatial analysis of the classification of soil types in Purbalingga Regency shows that the type of cambisol soil dominates which covers an area of 33,499.93 ha. Followed by andosol and oxysol soil types with an area of 25,707.25 ha. Meanwhile, Alluvial, Gleisol, Water Body, and Settlement soil types have an area of 21,359.33 ha. As for the type of Mediterranean soil, which covers an area of 6.44 ha, and the type of regosol soil, the least area is only 0.02 ha. This data provides a clear picture of the spatial distribution of various types of soil in the area of Purbalingga Regency.

After classifying soil types, the next stage is to provide a weight or score to assess the suitability of settlement land. This process involves reclassifying land based on certain criteria, which are then grouped into five classes: highly fit, appropriate, moderately appropriate, non-conforming, and highly nonconforming. The presentation of information on the suitability of residential land based on soil type in Purbalingga Regency in 2023 can be found in Figure 4. This map provides a clear visual picture of the level of land suitability for settlement in the region, which can be an important guide for future urban planning and development.

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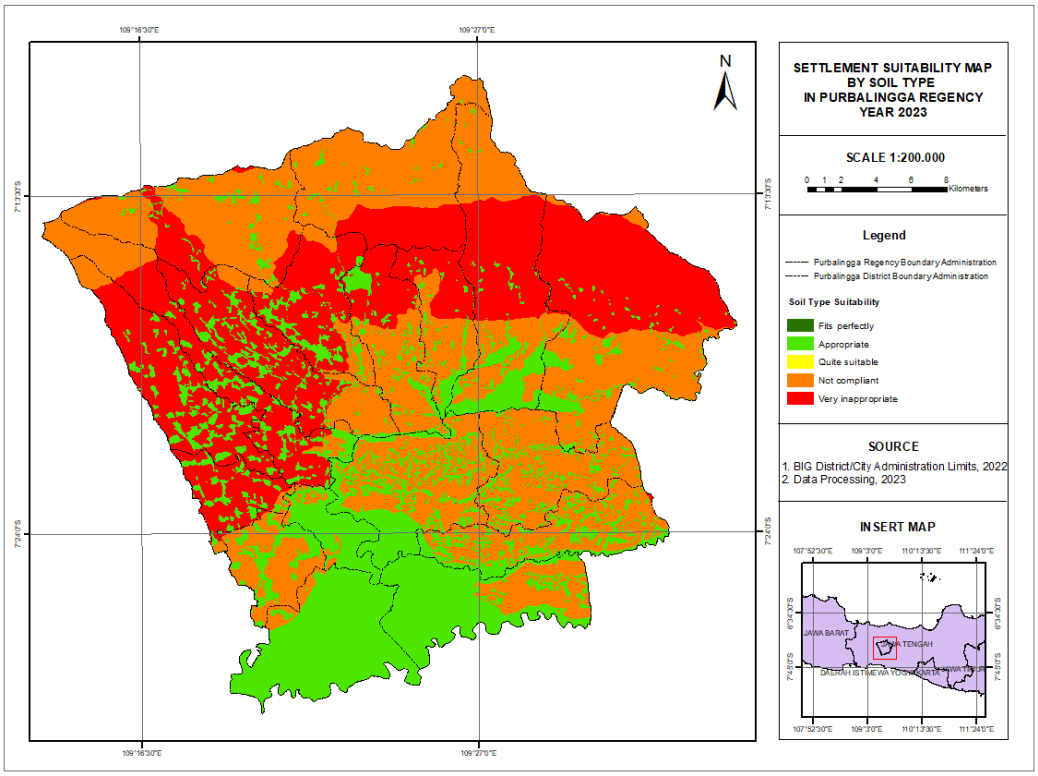

Fig.4 Map of Settlement Suitability Based on Land Type in Purbalingga Regency in 2023

The suitability of residential areas in Purbalingga Regency was evaluated based on soil type variables, which were then divided into five land suitability classes. The class includes categories: very incompatible with score 1, not corresponding to score 2, quite corresponding to score 3, and very corresponding to score 5. Analysis shows that residential areas in Purbalingga Regency are dominated by non-conforming categories, especially on land suitability maps that show the difficulty of developing residential areas in the area. Nevertheless, settlements are fairly evenly distributed throughout the Purbalingga Regency, with a significant tendency to occur in the southern part. This illustrates the challenges in the development and planning of residential areas that need to be seriously considered to achieve sustainable development.

4. CONCLUSION

Determining the suitability of residential land in Purbalingga Regency using the Spatial Multi-Criteria Analysis (SMCA) method requires various relevant input variables. One important variable is soil type, which is used as a basis in determining land suitability. Soil type maps are the main reference source in this analysis. The classification of soil types in Purbalingga Regency shows the dominance of kambisol soil types with an area of 33,499.93 hectares. However, although kambisol predominates, for the suitability of residential areas, this classification falls into the category of inappropriate. This highlights the importance of taking into account other factors such as topography, drainage, accessibility, and others in assessing the suitability of residential land holistically. Thus, a deep understanding of spatial conditions and variations in various factors is crucial in making sustainable urban planning decisions.

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