Distribution of land stability based on standard penetration value (SPT) with various depth in Semarang city, Indonesia

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Abstract. Land stability is one of the main determining factors for the bearing capacity of the environment. The land stability is influenced by the condition and characteristics of the resources in the environment. The supply capacity in terms of the level of land stability for spatial use allocation has been based on the capacity of land for agriculture and the physical aspects of the land. It accordance with the local regulation i.e. no. 17 of 2009. Land stability includes the ability of land for agriculture and the physical aspects of land, as well as the stratigraphy of subsurface soil mass, especially geological characteristic. The research was conducted in Semarang City Indonesia by drilling and standard penetration test (SPT) and taking 448 undisturbed samples (UDS’s) of soil that scattered in the research area. Analysis of UDS’s have been carried out in the laboratory to obtain comparisons with SPT values in determining the level of land stability both vertically and horizontally. Soil types obtained are clay, silt, silt-sand, sand, and sand stone with a level of consistency and density in accordance with the measured SPT. Land stability values ranged from 0.201 kg/cm\textsuperscript{2} - 14.248 kg/cm\textsuperscript{2} covering all types of soil with different consistencies and density. The distribution of land stability is given in an infographic to get an overview of the land stability levels geographically at a depth of 2.5m, 5.0m, 7.5m, and 10.0m. This infographic can be useful for spatial evaluation, engineering guidance, and environmental research in Semarang City, Indonesia.

1. Introduction
Land stability is the stability of the ability of the land which is the characteristic of land including soil properties, topography, drainage, and other environmental conditions to support life activities on a land. In urban areas, land stability becomes a limiting factor in fulfilling spatial use in accordance with land capabilities, so that there is suitability of a land with stable bearing capacity for certain spatial use [1]. Land stability as land mass forming a land does not only include the ability of the land for agriculture or physical aspects of land such as in the method of determining land capability but more to the composition of the soil mass below the surface which is geology characteristics [2]. The Standard Penetration Test (SPT) value is one of the geological parameters that can be used to describe soil characteristics which refers to the relationship between soil parameters so that it can provide an indication of land stability properties, specifically [3].
Semarang city has unique geographical characteristics where it is divided into two, both lowlands in the north and highlands in the south. The northern part is a lowland area on the north coast of Java Island. Industrial activities and urban public facilities such as offices, trade, services, education, health and transportation facilities are located in this area. Meanwhile, the southern part is a hilly area, which is used as conservation land, residential and educational areas. Geologically, Semarang plain comprises of river alluvial deposits, delta plain, and tidal deposits. These sediments consist of sand, silt, soft clay, gravel lens insertions and volcanic layers. As a coastal area, the Semarang plain is generally defined as an alluvial plain in the landform of sandy and clayey silts with high groundwater conditions. The terrestrial land is the dominant type of soft clay found in coastal areas with greater water content.

In spatial planning, an understanding of the physical characteristics of the city is needed in order to avoid the negative impact of urban development. Land use must be properly regulated so that it is in accordance with the city spatial plan. It is taking into account the balance of ecological aspects so that land quality does not decrease. Problems will arise when information on the stability of land stability is not available, which can cause confusion in determining the suitability of land use with the capacity of urban land. This research aims to describe the distribution of land stability infographically based on the SPT values in the administrative area of Semarang City, both horizontal distribution and vertical distribution geographically. This infographic distribution of land stability can be useful for spatial evaluation, engineering guidance, and research from an environmental perspective in Semarang City.

2. Methodology
The research was conducted in the administrative area of Semarang City which is geographically located at 6°50’ – 7°10’ of South Latitude and 109°50’ – 110°35’ of East Longitude. The west border is Kendal Regency, the east border is Demak Regency, the south border is Semarang Regency and the north is Java Sea with the length of 13.6 km. The height of Semarang City lies between 0.75 – 348.00 m [4]. Sampling was carried out between 1998 and December 2018. The soil and engineering properties of soil samples are tested in the laboratory.

2.1. Sample collection and preservation
The sample in this study are soil profiles vertically, SPT values, and undisturbed sample (UDS) of soil. Drilling has been carried out to obtain a vertical soil profile from 39 research sites with 112 drilling points. At the same time, 448 UDS’s and SPT measurements were taken. The procedure used is based on ASTM D1586 [5]. The UDS taken from drilling at depths up to 10 meters, with drilling points randomly determined at the research site. Than, determination of drilling points in one site is based on the homogeneity of soil types according to geological maps of Semarang City.

2.2. Analytical procedures
Drilling results were drawn on the drilling profile form and the SPT values were recorded. The UDS analyse were carried out in soil mechanics laboratory. The density test, plasticity limit test, grain size distribution test, and direct shear test were carried out in accordance with ASTM D2937, ASTM D4318, ASTM D1587 and ASTM D3080, respectively [6–9].

2.3. Land stability analysis and mapping
Geographical localization and drilling points where this study was conducted shown in Figure 1. Likewise with the SPT value measurement points and UDS points. The homogeneity of soil has been considered before determining the drilling point. At some sites more than one drilling point has been determined. It considers the density of land use by human.
Figure 1. Geographical localization and drilling points where this study was conducted

The SPT value is used to calculate the amount of land stability using the formula in equation (1).

\[ Q_{all} = N/F(K_d)(K_m) \]  

Equation (1) is a formula to calculate the land stability. \( Q_{all} \) refers to the land stability (kg/cm\(^2\)). \( K_d \) is a depth factor defined as \( 1+0.33D_f/B < 1.33 \). \( K_m \) is Meyerhof’s safety factor that has been set at 1.5. \( N/F \) is determined using Terzaghi and Peck’s graphs about the relationship of SPT with permit bearing capacity (Figure 2). \( B \) is one unit contact area < 1.2 meter. \( D_f \) is a contact area for vertical distance [10,11]. The calculating of the land stability were carried out using Microsoft Excel software [12]. The results of plasticity test, grain size test, density test, and shear strength test can be used as a comparison for description of the obtained drill profile and SPT results.

Figure 2. Graph of relationship between permit bearing capacity and SPT value

Mapping of land stability and soil profile into simulation infographics using ArcGIS 10.3 software with geostatistical methods [13]. The depth zonation is determined at 4 depth levels, which is 2.5m, 5.0m, 7.5m, and 10.0m and the soil profiles are plotted based on the drilling profile form. The interpolation of the intermediate zone between two different types of soil material is determined by overlapping of the geological map, the soil zonation map from previous studies, and the topographic map of Semarang City.
3. Results and Discussions

3.1. Geology of Semarang City

Geologically, Semarang consist of basic sedimentary breccia rocks, sedimentation rocks, volcanic breccias, alluvium surface deposits, Ungaran volcanic deposits, mariner layers. Alluvium surface deposition, Ungaran volcanic deposit, mariner layer dominates the lowland soil structure while the basic sedimentary breccia rocks, sedimentation rocks, volcanic breccia dominate the hilly area. Plains are found in the lowlands i.e. Tanah Mas, Tambak Lorok, Bandarharjo, Kaligawe. Then, swamp areas i.e. Simpang Lima, Singosari. Hilly area are found in the Bendan Duwur area, Tinjomoyo, Gunungpati, Sekaran, Manyaran, Candi, Gombel.

The growth process of its formation can be categorized in the period between 500 - 900, between 900 - 1500 and between 1500-1700. In the years 500 - 900 is a stage before alluvial plains, where is includes Candi plateau as the foot of Mount Ungaran on the north coast. The coast encompasses the areas of Mrican, Mugas, Gunung Sawo, west of Gajah Mungkur, Karang Kumpul, Sampangan on Kaligaring river border a cross to Wotgandul, Simongan, turning west along Krapyak hills to Jraakah.

In the period 900 - 1500 was formation of alluvial plains. The sediments were formed based on sediment originating from the slopes of Ungaran hills through Kali Kreo, Kali Kripik, Kaligarang. At this time dukuh has been known to its inhabitants in alluvial plains, especially along Semarang River i.e. Gisikdrono, Tirang Ampel, Jurang Suru, Labu Api, Tinjomoyo, Wotgaleh, Gajah Mungkur, Sejonilo and Gedung Batu. In the period 1500 - 1700 was embryo formation period of Semarang City until now. At the beginning of 1500 the coastline of Semarang had reached around the road of R. Patah, Kaligawe, Pengapon, Poncol, Kampung Cina Bubakan, Kampung Melayu Darat [14–16].

3.2. Distribution of land stability

Based on the measured SPT value and laboratory analysis of UDS, the geological parameters can be compiled. They are volume weight $\gamma$ (g/cm³), cohesion c (kg/cm²), shear angle $\Phi$ (degrees), plasticity limit (%), grain size distribution (%), and SPT value. The parameters is used to calculate the land stability Qall (kg/cm²).

Soil types have been grouped based on various depths. Each soil type has a specific range of values according to real conditions in the field (in situ). In hilly areas with a soil layer depth of up to 5 meters, it tends to be dominated by new weathered material. This can be seen from a low value of SPT which can be interpreted as very soft or very loose to rather soft or rather hard. Whereas at depths of up to 10 meters the soil layer tends to be massive and stable which is characterized by high SPT value. It can be interpreted as rather hard or rather dense to very hard or very dense. Correlation analysis between depth, SPT value, and land stability parameters has been carried out in other studies. The results of the correlation analysis have shown that depth, SPT value, and soil type have a correlation with land stability parameters [17].

The results of land stability calculations that have been carried out at various depths can be seen in Table 1. The dominant soil types within the administrative area of Semarang City have been described. 4 levels of depth from the local surface have been determined which is 2.5m, 5.0m, 7.5m, and 10.0m. It can be interpreted as a geological analysis vertically. Furthermore, land stability is the value of the bearing capacity of a land itself, where the value of the bearing capacity of the land is the maximum workload that it can hold without failing land stability by the land.

Table 1. The results of UDS analysis and distribution of land stability values at various depths based on SPT

| Depth (m) | Type of Soil       | SPT Value | Volume Weight (g) | Cohesion (c) | Friction Angle (\(\Phi\)) | Land Stability (Qall) |
|----------|--------------------|-----------|-------------------|--------------|--------------------------|-----------------------|
| 2.50     | Clay very soft     | 1 - 2     | 1.52 – 1.61       | 0.10 – 0.23  | 4.50 – 14.39             | 0.201 – 0.406         |
|          | Clay rather soft   | 4 - 8     | 1.62 – 1.75       | 0.14 – 0.17  | 12.09 – 14.85            | 0.712 – 2.643         |
|          | Clay rather hard   | 8 - 14    | 1.62 – 1.64       | 0.16 – 0.19  | 10.32 – 18.63            | 2.643 – 5.095         |
| Depth (m) | Type of Soil         | SPT value | Volume Weight (g/cm³) | Cohesion (c) (kg/cm²) | Friction Angle (Φ) (degree) | Land Stability (Qa) (kg/cm²) |
|----------|----------------------|-----------|-----------------------|-----------------------|-----------------------------|------------------------------|
|          | Silt soft            | 2 - 4     | 1.65 - 1.73           | 0.12 - 0.23           | 13.36 - 21.49               | 0.312 - 0.710                |
|          | Sand rather loose    | 9 - 10    | 1.77 - 1.85           | 0.03 - 0.07           | 19.33 - 28.03               | 2.439 - 5.085                |
|          | Sand dense           | 30 - 50   | 1.85 - 1.93           | 0.01 - 0.03           | 28.03 - 33.33               | 6.916 - 12.408               |
|          | Sand very dense      | 50 - 55   | 1.96 - 1.99           | 0.00 - 0.03           | 33.33 - 41.00               | 13.731 - 14.036              |
|          | Clay very soft       | 1 - 2     | 1.52 - 1.61           | 0.10 - 0.20           | 6.50 - 12.58                | 0.406 - 0.712                |
|          | Clay soft            | 2 - 4     | 1.58 - 1.62           | 0.11 - 0.14           | 7.64 - 12.50                | 0.712 - 2.643                |
|          | Clay rather soft     | 4 - 8     | 1.52 - 1.63           | 0.15 - 0.17           | 12.09 - 15.06               | 2.643 - 5.095                |
|          | Clay rather hard     | 8 - 14    | 1.66 - 1.69           | 0.16 - 0.17           | 13.34 - 15.06               | 5.899 - 8.849                |
| 5.00     | Clay very hard       | 17 - 29   | 1.69 - 2.06           | 0.17 - 0.26           | 17.92 - 26.60               | 9.256 - 12.603               |
|          | Silt soft            | 2 - 4     | 1.63 - 1.69           | 0.12 - 0.16           | 13.36 - 16.50               | 0.313 - 0.710                |
|          | Silt rather soft     | 4 - 5     | 1.65 - 1.69           | 0.16 - 0.23           | 17.21 - 23.54               | 0.710 - 0.913                |
|          | Silt Sand rather dense | 10 - 14 | 1.69 - 1.76          | 0.14 - 0.16           | 22.41 - 27.80               | 2.833 - 3.573                |
|          | Sand very loose      | 3 - 8     | 1.70 - 1.76           | 0.07 - 0.14           | 23.55 - 27.91               | 0.313 - 0.460                |
|          | Sand rather loose    | 9 - 10    | 1.77 - 1.85           | 0.03 - 0.08           | 19.33 - 28.03               | 2.439 - 5.085                |
|          | Sand rather dense    | 10 - 30   | 1.85 - 1.90           | 0.02 - 0.06           | 20.06 - 29.51               | 4.373 - 5.593                |
|          | Sand dense           | 30 - 50   | 1.88 - 1.93           | 0.01 - 0.02           | 29.51 - 33.33               | 6.916 - 12.408               |
| 7.50     | Sand very dense      | 50 - 55   | 1.96 - 2.01           | 0.01 - 0.02           | 33.33 - 41.00               | 13.731 - 14.036              |
|          | Clay very soft       | 1 - 2     | 1.52 - 1.61           | 0.10 - 0.23           | 4.50 - 14.39                | 0.201 - 0.406                |
|          | Clay soft            | 2 - 4     | 1.58 - 1.62           | 0.11 - 0.23           | 12.58 - 14.50               | 0.406 - 0.712                |
|          | Clay rather soft     | 4 - 8     | 1.52 - 1.62           | 0.14 - 0.21           | 7.64 - 17.88                | 0.712 - 2.643                |
|          | Clay rather hard     | 8 - 14    | 1.65 - 1.69           | 0.14 - 0.17           | 12.09 - 17.92               | 2.643 - 5.095                |
|          | Clay hard            | 17 - 29   | 1.63 - 1.69           | 0.15 - 0.21           | 15.73 - 17.92               | 5.899 - 8.849                |
|          | Clay very hard       | 32 - 40   | 1.69 - 2.06           | 0.17 - 0.26           | 17.92 - 26.60               | 9.256 - 12.603               |
|          | Silt soft            | 2 - 4     | 1.70 - 1.73           | 0.10 - 0.12           | 13.36 - 14.39               | 0.313 - 0.710                |
|          | Silt rather dense    | 8 - 16    | 1.70 - 1.74           | 0.10 - 0.22           | 17.83 - 25.02               | 2.723 - 5.290                |
|          | Silt Sand loose      | 9 - 10    | 1.71 - 1.75           | 0.11 - 0.17           | 15.40 - 27.50               | 0.404 - 0.434                |
|          | Silt Sand rather dense | 10 - 30 | 1.76 - 1.82          | 0.04 - 0.11           | 27.80 - 28.26               | 2.833 - 3.573                |
|          | Sand loose           | 9 - 10    | 1.70 - 1.85           | 0.05 - 0.10           | 25.63 - 26.72               | 0.404 - 0.435                |
|          | Sand rather dense    | 10 - 30   | 1.85 - 1.90           | 0.02 - 0.06           | 20.06 - 26.51               | 4.373 - 5.593                |
|          | Sand dense           | 30 - 50   | 1.93 - 1.95           | 0.01 - 0.02           | 28.86 - 33.33               | 6.916 - 12.408               |
|          | Sand very dense      | 50 - 55   | 1.96 - 2.10           | 0.00                 | 33.33 - 36.00               | 13.731 - 14.036              |
| 10.00    | Rock very compact    | 56 - 60   | 2.12 - 2.35           | 0.00                 | 36.00 - 47.00               | 14.036 - 14.240              |

Geographically, information about the distribution of land stability values in Semarang City is presented in Figure 3. This geographic information is vertically divided into 4 depth levels. Horizontally, distribution analysis shows that soil types with a certain consistency and density can affect land stability. Each depth level can be overlapped with the sub-district to simplify the description of the geological conditions of a district.
Determination of the bearing capacity of the land is measured through the capacity of the natural environment and resources to support human life in that space for their existence. The amount of capacity will be influenced by the circumstances and characteristics of the resources in the environment. One of the factors is the ability of the land to allocate environmental uses. The bearing capacity of land is a major factor in determining the bearing capacity of the environment. Other factors, namely the ratio between availability and demand for land and water will never exist if the bearing capacity of the land is unstable.

Figure 3. Distribution of land stability values overlapping with the sub-district at various depths.

The bearing capacity of land is usually based on the ability of land for agriculture which is the characteristic of land which includes soil properties, topography, drainage, and other environmental conditions to support life on a land. Land stability is not sufficient only to measured from the factors, but there are main factors of land capability i.e. geological characteristics factors i.e. the soil mass properties that forming land which is the determining factor for overall the land stability capabilities.

The real phenomena that occurs in the lower part of the land as a result of natural processes or human engineering is the occurrence of subsidence. It cause failure the bearing capacity of the land and damage to the environment. This phenomenon is more of a problem related to the stratigraphy of subsurface soil masses or geological characteristics. In this study, a calculation analysis has been carried out to determine the value of the allowable bearing capacity of the land in terms of the maximum workload that can hold without failing the bearing capacity by the land.

This is a novelty in this research, which contributes to indicators of land stability values for land utilization allocation and determining the bearing capacity of the environment. Another novelty in this study is to provide a symbiotic contribution related to the geological characteristic parameters of subsurface which have not been found in the geological map of Semarang city. The development of Semarang City as the capital of Central Java absolutely requires areas that are ready to build facilities and infrastructure for the community. Furthermore, land engineering will continue to be carried out for vulnerable areas to be engineered into fully ready-to-build areas along with the infrastructure. The land engineering and construction planning are influenced by the characteristics of the local land where
conditions vary widely. Effectiveness will be obtained if it is known for certain that the properties of soil that forming the land i.e. soil properties and engineering properties where in certain zones will be required in planning so that optimal results will be obtained. The results of this study can be used as a control over land use to suit the bearing capacity of the existing land. Than, structural failure of the infrastructure due to subsidence in the very soft to soft zones will never occur. This has been anticipated since the design. Provinces that have a strategic role at the national scale have real consequences for increasing population and consumption of natural resources. Regional economic growth has not contributed significantly to environmental sustainability issues. Therefore, development must consider the bearing capacity where the population lives so that the concept of sustainability can be implemented [18].

The master plan as a product of spatial planning must consider various strategic issues, including the issue of environmental sustainability. The policy plans and programs in the master plan must consider the bearing capacity of the environment through a Strategic Environmental Assessment (SEA). The concept of bearing capacity through the implementation of SEA is not easily integrated in spatial planning, considering the challenges faced are the difficulty of integration and synchronization between SEA and the substance of the spatial plan, studies that focus on the environment that do not consider social and economic goals, and the process of formulating policies, plans, and long-term spatial planning programs. One of the indicators of land bearing capacity on workload to determine the bearing capacity of the environment has been given in this study. The results of this study can be used as a reference in formulating practical spatial policies, and also as a reference frame for the development planning process in Semarang City.

Spatial planning is expected to facilitate climate change adaptation by directing future spatial and infrastructure development away from zones exposed to climate-related hazards in the coastal plains [19]. The study attempts to confirm this understanding by mapping the effects of various spatial plans on the north coast of Java, Indonesia. First, this study maps coastal hazard levels for the 2010 base year using a GIS-based inundation model. The overlay in the GIS shows the effect of the spatial plan for the projection year 2030. This makes it possible to calculate the economic losses from planned developments. The case studies show that the current provincial spatial plan points to a continuing trend towards land use conversion along the north coast of Java in the future. This could significantly reduce regional capacity to deal with exposures to coastal inundation. This analysis also shows that a total area of 55,220 ha of land prone to inundation, consisting of protected areas (1,488 ha), fish ponds (32,916 ha) and agricultural land (20,814 ha), has been planned for conversion to industry (13,399 ha) and settlements (41,821 ha). As such, these areas are also vulnerable to inundation by 2030. This change has the potential to cause economic losses of USD 246.6 billion. The spatial plans issued by the national and provincial governments to regulate future land use on the north coast of Java have not yet integrated measures against the hazards associated with global sea level rise. Meanwhile, many existing developments have been influenced by coastal inundation. Rather than reducing exposure to coastal flooding hazards, case studies show that spatial planning can even increase the risk of climate-related hazards, rising global sea levels and causing higher economic losses. These findings provide a different perspective on the role of spatial planning for climate change adaptation from what is stated in the literature. The results of this study can be used as a reference in the analysis of areas that have the potential to risk inundation, especially in relation to the variable of land assignment in areas prone to inundation risk.

At a depth of 10.00 m, there is a very soft clay zone with a land stability value of 0.201 kg/cm² in Tugu, Semarang Barat, Semarang Utara, Semarang Timur, Gayamsari, and Genuk districts which are included in the Service Center System Development area intended for transportation, trade and services, offices and industry [20]. Meanwhile, soft clay zones with a stability value of 0.406 – 0.712 kg/cm² are found in the districts of Semarang Barat, Semarang Utara, Semarang Tengah, Semarang Timur, Gayamsari, Genuk and Semarang Selatan districts, with the designation of transportation, offices, trade and services. For the classification of land stability values from 0.406 – 0.712 kg/cm², i.e. soft silt found in a small part of Ngaliyan, Semarang Barat, Semarang Selatan and Semarang Tengah districts,
designated for industry, offices, trade and services, transportation. Geomorphologically, the clay zone is very soft to soft clay and some of the soft silt zone is a plain area, namely an area with low relief with a shallow valley or in the form of an elevation of approximately +6.25 sea level, otherwise known as the lowland.

The hilly area are slightly undulating with a height difference ranging from 5 – 75m [21]. Soil types and mass properties at a depth of 10.00 m from the surface are different, where dominated by silt-sand loose, rather hard clay, rather dense sand to dense sand with land stability values of 0.404 - 12.408 kg/cm² found in Ngalian, Semarang Barat, Semarang Selatan, Gajah Mungkur, Candisari, Tembalang, and Pedurungan districts. This area is designated for industry, offices, trade and services, education, police and sports. On steep hilly sections with a height difference of 75 – 400 m, it is found dense sand to very dense sand, rather hard clay to very hard clay, rather dense silt-sand, sand stone with land stability values of 2.648 – 14.240 kg/cm², found in Mijen, Ngalian, Gunungpati, Gajahmungkur, Banyumanik, Tembalang districts. This area is designated for public service offices, industry, education, offices, trade and services, military offices.

In the rather soft to rather hard clay zone there are in Ngaliyan, Semarang Barat, Genuk, Pedurungan, Tembalang with a land stability value of 0.712 - 5.095 kg/cm², it is intended for low building loads up to 4 floors, it can still be done with a shallow foundation to a little deep or wells type foundation. In the sand zone, especially very loose sand with soft clay, the land stability value is 0.404 - 4.035 kg/cm², found in Semarang Barat. The dominant silt-sand, sand, gravel zone is generally found in the hilly area. It starts from rather dense to very dense levels. Furthermore, the compact gravel sand zone, with land stability values of 2.833 - 12.408 kg/cm² and land stability values of 13.731 - 14.240 kg/cm² are scattered in the Mijen, Gunungpati, Banyumanik, Tembalang, Candisari, Gajahmungkur, Semarang Selatan, Semarang Barat, Ngalian districts. While the sand-gravel zone is very dense in Gajahmungkur district. In the dominant silt-sand zone, the land stability value is relatively large at a depth of 10.00 m from the ground surface, so that the type of land engineering for construction and infrastructure is relatively unspecified.

4. Conclusions
The composition of soil types in Semarang City is dominated by clay, silt, silt-sand, sand, and sand stone with a level of consistency and density that corresponds to the value of measured SPT. The consistency and density may varies from very soft or very loose to very hard or very dense. Furthermore, based on the vertical soil profile obtained in the study, information can be compiled geographically about the distribution of land stability, both horizontal distribution and vertical distribution. This infographic clearly provides information on the zone classification of the permitted land stability values in Semarang City. Land stability is the value of the bearing capacity of a land itself, where the value of the bearing capacity of land is a maximum work load that can hold without failure of land stability by environment. The value of land stability in Semarang City is 0.201 kg/cm² - 14.248 kg/cm².

Mapping of land stability values has shown that horizontally the value of land stability is correlated with the consistency of soil types. Meanwhile, the vertical value of land stability is correlated with depth. However, overall it can be said that soil types dominate the value of land stability in a land. Overlapping with an administrative area such as sub-district can be used to describe the area geologically.

The land stability infographic of Semarang City can be useful for spatial evaluation in an environmental perspective which is useful as (1) a determinant of environmental bearing capacity based on the ability of the land to regulate spatial use, (2) an instrument for evaluating spatial use so that land use is in accordance with land bearing capacity, (3) a reference in making decisions on land use planning and infrastructure design and the basis for evaluating land engineering in a building permit application, (4) a basis for preparing a frame of reference for the development planning process in Semarang City, so that it can achieved an efficient and effective planning product.
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