### Abstract

The presence of catchment areas is needed. Besides its function for groundwater conservation, this area also is used to reduce flood risks. The need for houses also encourages people to use qualified Catchment areas to be used as houses and does not consider its natural factors. It happens a lot in suburban areas such as East Jakarta that in early 2020 this area becomes one of the most affected areas due to the flood in DKI Jakarta. Due to the world pandemic, Covid-19, direct field research is hard to carry out, so this research using remote sensing applications and geographic information systems to identify areas that qualify as water catchment areas. In practice, it uses secondary data sourced from national institutions and agencies with direct access to the data. The results showed that 12.36% of the research areas did not meet the requirements as Catchment areas, 68.01% were sufficiently eligible, and 19.63% were highly qualified. However, in its utilization, only 22.06% of the total research area currently plays an active role as groundwater catchment areas because of the land cover dominated by built-up land. It can lead to various risks as flooding or a reduction in the volume of groundwater.

### INTRODUCTION

Given the low altitude of Jakarta which is quite low compared to the surrounding area, somehow it creates anxiety about the occurrence of floods. At the beginning of 2020, Jakarta and its surroundings experienced floods with varying elevation and areas. This triggered a feeling of unease for the community and also becomes a problem that must be found immediately how to anticipate it if happens again in the near future. According to BNPB, Saturday (8/2) in Kompas.com (2020), East Jakarta was the area that most affected by the flood with number of affected reaching around 20 districts. This study intends to determine the distribution of areas that meet the requirements to become a catchment area in Jakarta. The purpose of this study is to find out solutions how remote sensing method can be used to identify the...
distribution of water catchment area. The research was carried out by processing secondary data because limitations during the Covid-19 pandemic situation.

GEOLGY OF STUDY AREA

Remote Sensing

According to Lindgren in Sutanto (1986) remote sensing method is a technique developed for the acquisition and analysis about the visual information of the earth from the air or from space. Remote sensing techniques includes such as aerial photo analysis, as well as reflection of electromagnetic radiation from surface of the earth. The spectrum that is often used for remote sensing analysis is the visible spectrum which has a wavelength of 0.4 – 0.7m. This spectrum is called the visible spectrum because it can be captured directly by the human eye as a natural sensor.

Landsat 8 Imagery

Satellite imagery is a recorded image of an object of the surface of the earth captured by satellite. This image is low/medium resolution image, which is 30 meters that has been equipped with Band Quality Assessment (BQA) with important information such as clouds, vegetation, cloud shadows, water bodies, terrain of the earth and so on.

Water Catchment Area

According to ESDM department, Badan Geologi, Pusat Lingkungan Geologi (2007), the general characteristics of water catchment areas are:

- Has a general direction of groundwater flow vertically downwards
- Water infiltrates into the ground and fills groundwater table (aquifer)\
- The position of the phreatic face is relatively deep
- The position of the phreatic face is deeper than the isometric face in natural conditions
- Water infiltrate outcrop of rocks
- Hilly or mountainous areas
- Low addition chemical content of groundwater
- Relative groundwater age

METHODOLOGY

The research begins by collecting data from related institutions which are then called variables. This variable is processed and digitized so as to produce data with values and weighted according to their priorities. These data are then called parameters

Table 1. Weighted parameters of water catchment area (slightly modified from Departemen Energi dan Sumber Daya Mineral, Badan Geologi, Pusat Lingkungan Geologi, 2007).

| No | Parameters   | Weighted Values |
|----|--------------|-----------------|
| 1  | Permeability | 5               | Very High      |
Thus, as a result, the recharge rate value of the parameter is calculated using the formula:

\[
\text{Recharge rate} = K_b \times K_p + P_b \times P_p + T_b \times T_p + L_b \times L_p + M_b \times M_p
\]

Where:
- \( K \) : Permeability of the rock
- \( P \) : Rainfall intensity
- \( T \) : Land elevation
- \( L \) : Slope
- \( M \) : Depth of groundwater table
- \( b \) : Weight
- \( p \) : Parameter values

Afterwards, it is combined (overlayed) with the union feature in ArcGIS thus classified based on the distance between the highest and lowest recharge rate.

**Rock’s Permeability**

The classification is carried out according to permeability, which is largely determined from the texture and structure of each rock type. The greater the permeability and absorption coefficient, the greater the value.

**Table 2.** Class and weighted values of rock’s permeability (Departemen Energi dan Sumber Daya Mineral, Badan Geologi, Pusat Lingkungan Geologi, 2007)

| No | Rocks                        | Permeability (m/day) | Value | Weight |
|----|------------------------------|----------------------|-------|--------|
| 1  | Alluvial Deposits            | >103                 | 5     | 5      |
| 2  | Young Quaternary Deposits    | 101 – 103            | 4     | 5      |
| 3  | Old Quaternary Deposits      | 10-2 – 101           | 3     | 5      |
| 4  | Tertiary Deposits            | 10-4 – 10-2          | 2     | 5      |
| 5  | Intrusion                    | < 10-4               | 1     | 5      |

**Rainfall Intensity**
In terms of environmental carrying capacity, infiltration rate will be greater if it rains longer. The higher and longer the rain, that is because more water seeps into the ground.

**Table 3** Class and Rainfall intensity (with slide modification from Departemen Energi dan Sumber Daya Mineral, Badan Geologi, Pusat Lingkungan Geologi, 2007)

| No | Rainfall (mm3/thn) | Rainfall infiltration factor* | Value | Weight |
|----|-------------------|-------------------------------|-------|--------|
| 1  | > 2560            | > 3456                        | 5     | 4      |
| 2  | 2440 – 2560       | 3294 – 3456                   | 4     | 4      |
| 3  | 2320 – 2440       | 3132 – 3294                   | 3     | 4      |
| 4  | 2200 – 2320       | 2970 – 3132                   | 2     | 4      |
| 5  | < 2200            | < 2970                        | 1     | 4      |

*) Calculated based on average rain events in Jakarta 135 days / year

**Slope**

In the absorption of water, the greater the percentage or degree of the land slope itu means the smaller the amount of water that can infiltrate. But on the other hand, the land with higher slope value can act as a conservation area.

**Table 4.** Class and weighted values of slope (Departemen Energi dan Sumber Daya Mineral, Badan Geologi, Pusat Lingkungan Geologi, 2007)

| No | Slope (%) | Value | Weight |
|----|-----------|-------|--------|
| 1  | < 5       | 5     | 2      |
| 2  | 5 – 10    | 4     | 2      |
| 3  | 10 – 20   | 3     | 2      |
| 4  | 20 – 40   | 2     | 2      |
| 5  | >40       | 1     | 2      |

**Elevation**

According to PP no. 26 of 2008 concerning the RTRWN in a webinar delivered on June 23rd 2020, a good groundwater catchment area is a place with high topography so the water that infiltrates into the ground can be used in areas with a low topography. The classification is adjusted to the more preferable condition of the research area (Table 5).

**Table 5.** Class and weighted values of elevation (modified from Departemen Energi dan Sumber Daya Mineral, Badan Geologi, Pusat Lingkungan Geologi, 2007; Dinda P. et al, 2020)
### Depth of Groundwater Table

The greater the value of a depth of free groundwater table, thus the greater the opportunity for water to seep in compared to areas with relatively shallow groundwater levels (Table 6).

**Table 6.** Class and weighted values of Groundwater table’s depth (Departemen Energi dan Sumber Daya Mineral, Badan Geologi, Pusat Lingkungan Geologi, 2007)

| No | Kedalaman Muka Air Tanah (MBSL) | Value | Weight |
|----|--------------------------------|-------|--------|
| 1  | > 30                           | 5     | 1      |
| 2  | 20 – 30                        | 4     | 1      |
| 3  | 10 – 20                        | 3     | 1      |
| 4  | 5 – 10                         | 2     | 1      |
| 5  | < 5                            | 1     | 1      |

### RESULT AND DISCUSSION

**Permeability Map**

The rock’s permeability refers to the regional geological map of Jakarta and Kepulauan Seribu (turkandi, et al., 1999 in Info-Geospasial, 2020). The digitization is done by making polygons of Alluvium units and the other geological units cover the Alluvial fans. The alluvial fan consists of layered fine-grained tuff, sandy tuff and interbedded with conglomerate tuff which is thought to be the result of a volcano in Bogor. Thus, the assessment will be different for each unit.
Rainfall Intensity Map

Based on the results of data interpolation between station coordinates and rainfall intensity for the last 10 years, the following data were obtained:

Table 7. Rainfall intensity data input (BMKG, 2020; BPS, 2009-2019)

| Station                        | Coordinate X | Coordinate Y | Total rainfall per-year (mm³/year) |
|--------------------------------|--------------|--------------|-----------------------------------|
| Stasiun Meteorologi Kemayoran | 106,84       | -6,15559     | 2244,79                           |
| Halim Perdana Kusuma Jakarta  | 106,8893     | -6,27036     | 2707,731333                       |
| Stasiun Meteorologi Maritim Tanjung Priok | 106,8805 | -6,10781 | 1963,51                           |

After the coordinates of the weather stations and rainfall intensity data for 2009-2019 are interpolated, the rainfall intensity data is then digitized according to the interpolation results, which follows the limits of the classification values that have been classified.
Figure 2. Rainfall intensity map.

Slope Map

The slope map was created by processed DEM data using Slope Analysis feature in the ArcGIS 10.3 application. Then the color difference will be seen in areas that have different slopes according to the classification that has been discussed previously.
Land Elevation Map

In accordance to PP no. 26 of 2008 concerning the RTRWN which explains that areas with high elevations are a requirement to become better catchment areas. The elevation in each area will be different, so there are no special provisions or special classes that make a land good to be used as a catchment area. For this reason, the class division on this parameter was done by dividing the altitude classes from the DEM map according to the conditions and scale of the research area.
Figure 4. Land elevation map

Groundwater Level Map

Groundwater depth data was obtained from Dinas Perindustrian dan Energi of DKI Jakarta Province in 2014 which was accessed through the Geological and Groundwater Information Data System website for free. This data then rasterized and digitized using ArcGIS 10.3.
Figure 5. Groundwater depth map

Catchment Area Distribution Map of East Jakarta 2020

Areas that are highly qualified to become recharge area are the set of areas that have the highest recharge rate. On the other hand, regions with less qualifications are the set of regions that have the smallest recharge rate values (Table 8).

Table 8. Recharge rate classification

| No | Class value | Condition |
|----|-------------|-----------|
| 1  | <42         | Poor      |
| 2  | 42 – 51     | Fair      |
| 3  | >51         | Good      |

The results of this study indicate that 12.36% of the research area is an area that does not meet the requirement as a catchment area, the other 68.01% is sufficient to meet the requirements, while the remaining 19.63% is a highly qualified area.
CONCLUSION

Based on the research that has been done, several conclusions can be drawn, including the remote sensing method cabe used to identify the state / shape of the earth’s surface without direct observation on the field. With remote sensing, land cover conditions will be easily recognized by using the right spectrum so that it can be used to determine the catchment area that active. In addition, the East Jakarta area has an area of about 188.03 km$^2$ which can be divided into 3 regional classes with a distribution of 12.36% of the research area being an area that does not meet the requirements as a catchment area, the other 68.01% is quite eligible, while the remaining 19.63% is a highly qualified area.
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