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ANALYSIS OF LAND SUBSIDENCE RELATIONSHIP WITH GROUNDWATER TABLE DEPLETION IN SOUTH JAKARTA

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ABSTRACT

Increased development activities and urbanization in South Jakarta have increased groundwater extraction. Continuous withdrawal of groundwater with poor management can cause a decrease in the groundwater level and trigger a subsidence. Therefore, a study is needed regarding the relationship of land subsidence with the decrease in groundwater levels that occur in South Jakarta. This research was conducted using secondary data in the form of drill log data to determine subsurface lithology, land subsidence measurement data using the GPS geodetic method, and groundwater level data in monitoring wells in Jakarta. The results of the study show that surface sediment deposits are dominated by a layer of clay which is still unconsolidated and relatively thickened to the north with a thickness of more than 300 m. This condition shows that the sediment layers in Jakarta are still undergoing a compaction process so that naturally subsidence occurs in the soil surface. Subsidence in the land surface in South Jakarta has a fairly strong correlation with the decline in the groundwater level, which is equal to 0.504, which means it has a fairly strong degree of correlation of 50.4%.

Keywords: Correlation, Lithology, Land subsidence, Groundwater Level

INTRODUCTION

Data from BPS (Central Statistics Agency) of DKI Jakarta Province in 2019 shows that the total population of South Jakarta City reaches 2,264,700 people, with a population growth rate per year reaching 1.18% and a population density per km2 of 14,675. With such a large population, the intake of groundwater for home and industrial needs is increasing. This is reinforced by data from the DKI Jakarta Industry and Energy Office, that South Jakarta is the area that uses the highest groundwater in Jakarta. The South Jakarta region uses half of the total groundwater use in Jakarta of 4,348,123 m3 in 2018 and 3,768,226 m3 in 2019. This is because South Jakarta has many office buildings and settlements (H Z Abidin, Andreas, Gumilar, & Wibowo, 2015).

Based on this data, it can be seen that the problem of groundwater in South Jakarta is so complex. Urban development causes groundwater consumption to rise sharply. Continuous groundwater intake with poor management and exceeding the groundwater balance balance can lead to a decrease in groundwater levels (MAT) and trigger sustained subsidence. Therefore, research is needed on the relationship between land subsidence and groundwater subsidence that occurs in South Jakarta (Fachri & Djuhaeni, n.d.).

Regional Geology

In the Geological Map sheet of Jakarta and the Thousand Islands, the Jakarta City area is

composed by the youngest to the oldest, namely alluvium, coastal deposits, alluvium fans, and Banten tuffs (Turkandi, Sidarto, & Hadiwidjoyo, 1992). Alluvium in the form of clay, silt, sand, gravel to chunks; Deposits beach feeders in the form of fine to coarse sand, well sorted, with mollusk shells; alluvium fans are layered fine tuffs and sandbar tuffs interspersed with conglomerate tuffs; and Banten tuf in the form of tuff, pumice tuff, and tufan sandstone. In general, geology in Jakarta consists of young quaternary-aged alluvium deposits. In general, these deposits have not been well compressed, so they are still experiencing natural compaction (Yuwono, 2013).

RESEARCH METHODS

This study was conducted using secondary data from the Groundwater Conservation Center in the form of drill log data to determine subsurface lithology, geodetic measurement data for the Jakarta GPS survey in 2015-2018 to determine the value of land subsidence, and groundwater level data on 15 monitoring wells in Jakarta. For more details, the research method can be seen in Figure 1.

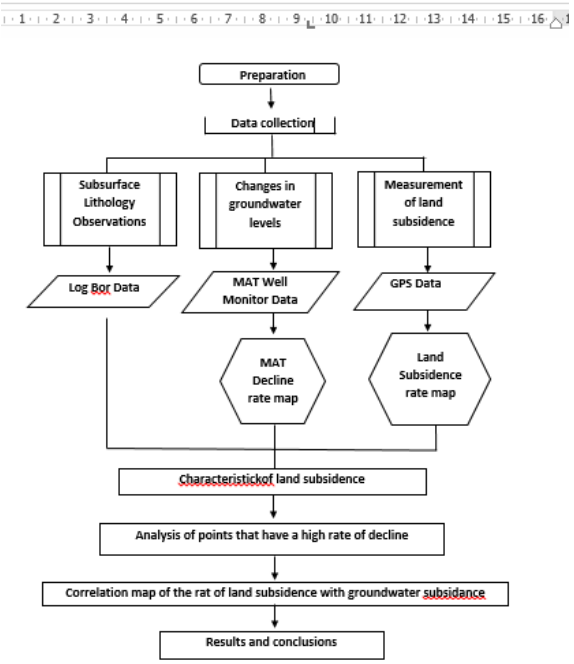

Figure 1
Research flowchart

RESULTS AND DISCUSSION

In this chapter, it will be divided into four sub-chapters, namely the correlation of drilling data, observations of soil subsidence, observations of groundwater levels, and the correlation of the rate of land subsidence with groundwater subsidence (Lubis, 2018).

Correlation of Drilling Data

Core drilling was carried out by a team of the Groundwater Conservation Agency in 2014. Based on the results and processing of these data, the profile and characteristics of each rock layer from 5 drill points in Jakarta were obtained. Namely the drill points PSM-01, PJR-01, MGB-01, CLC-01, and PGB-01. The location of this drill point can be seen in Figure 2.

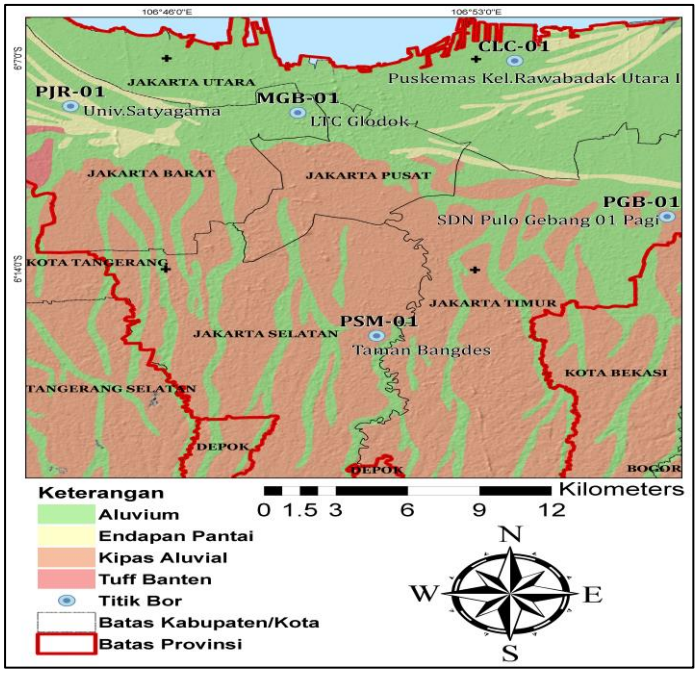

Figure 2
Location of drill points in the Jakarta regional geological map modification from (Turkandi et al., 1992)

This correlation of drilling data was carried out based on the linking of the same lithological units, by matching the lithology of the PSM-01 borehole to the other four boreholes contained in the drilling results report. This aims to determine the severity and thickness of the sedimentary layer that is still in an unconsolidated condition. The cross-sectional description of the results of the correlation of the PSM-01 well to other wells is as follows.

Correlation of PSM-01 Drill Point to PJR-01

The correlation at the drill point PSM-01 to PJR-01 can be seen in Figure 3. It shows that surface sedimentary deposits dominated by clay layers thickened to the northwest with a thickness of 75.5 m. This is in accordance with the deposition control in the Jakarta basin which is directed from south to north.

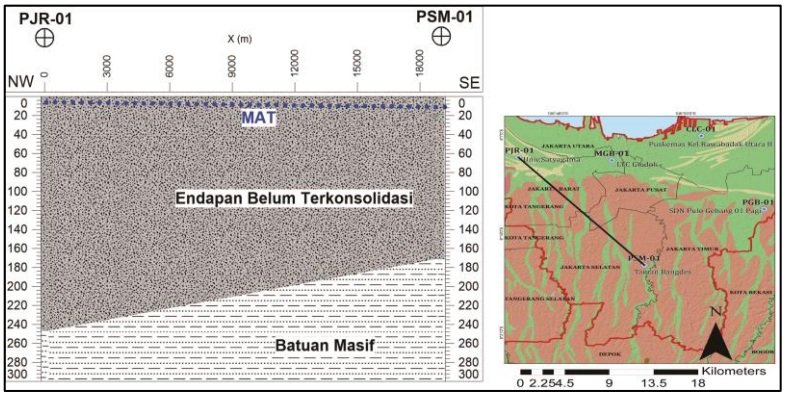

Figure 3
Correlation of drill point PSM-01 to PJR-01

Correlation of PSM-01 Drill Point to MGB-01

The correlation at the drill point PSM-01 to MGB-01 can be seen in Figure 4. It shows that surface sedimentary deposits dominated by clay layers thickened to the northwest with a thickness of 87 m.

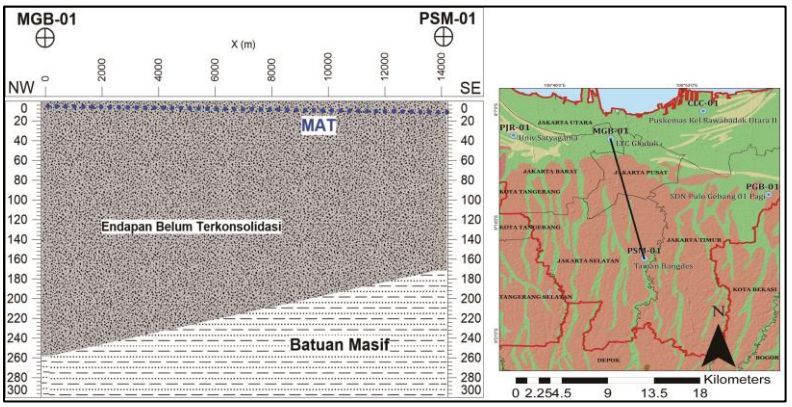

Figure 4
Correlation of drill points PSM-01 to MGB-01

Correlation of PSM-01 Drill Point to CLC-01

The correlation at the drill point PSM-01 to CLC-01 can be seen in Figure 5. It shows that surface sedimentary deposits dominated by clay layers thicken to the northeast with a thickness above 300 m.

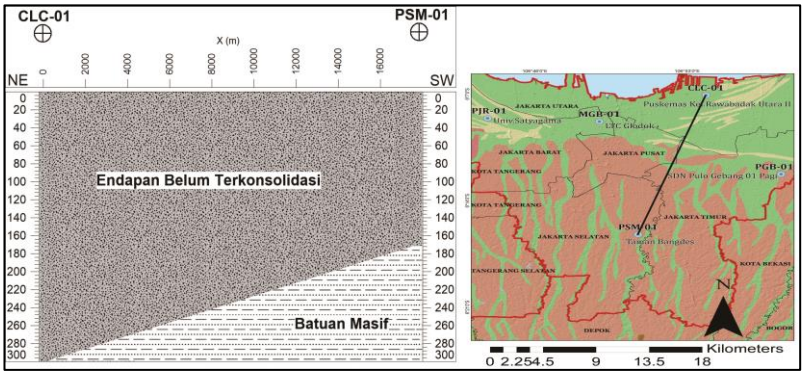

Figure 5
Correlation of drill point PSM-01 to CLC-01

Correlation of PSM-01 Drill Point to PGB-01

The correlation at the drill point PSM-01 to PGB-01 can be seen in Figure 6. It shows that surface sedimentary deposits dominated by clay layers thicken to the northeast with a thickness above 300 m.

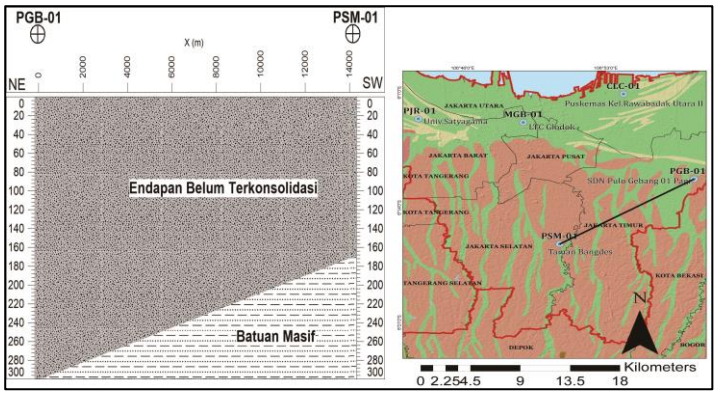

Figure 6
Lithological correlation of drill point PSM-01 to PGB-01

Observations of Land Subsidence

The identification of land subsidence areas can be seen from the value of the rate of land subsidence that occurs in the city of South Jakarta. The value of the rate of land subsidence was obtained from Jakarta GPS measurement data for the 2015-2018 period by the Groundwater Conservation Center (Hasanuddin Z Abidin, 2007). From this data, it can be seen the value of land subsidence every year from 62 GPS station points spread across Jakarta and its surroundings. The distribution of data values is then made a contour which is presented in the land subsidence rate map. From the land subsidence rate map, it shows that the high rate of land subsidence between 12-18 cm / year is in part of the Pesanggrahan and Bintaro Villages (Pesanggrahan District); Kelurahan Kebayoran Lama Selatan, Kebayoran Lama Utara, and Pondok Pinang (Kebayoran Lama District). It can be seen in Figure 7.

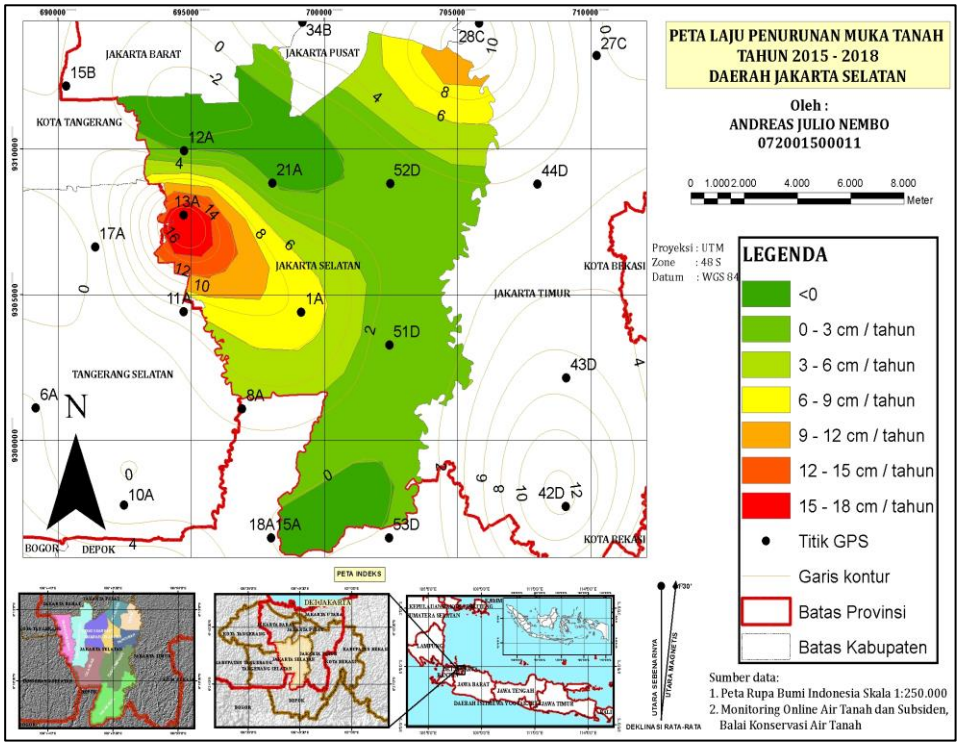

Figure 7
Land subsidence rate map of the study area

Groundwater Level Observations

The data used is data from 15 monitoring well points spread across Jakarta. This data is in the form of groundwater level depth from 2016-2021, so that the value of changes in groundwater levels can be known every year, and a contour is made which is presented in the Groundwater Level Reduction Rate Map (Ramadhanis, Prasetyo, & Yuwono, 2017). The results of the plotting of the monitoring well point show that the rate of subsidence of groundwater levels is height between 3 m - 4 m/year increases to the northeastern part of South Jakarta City. As seen in Figure 8.

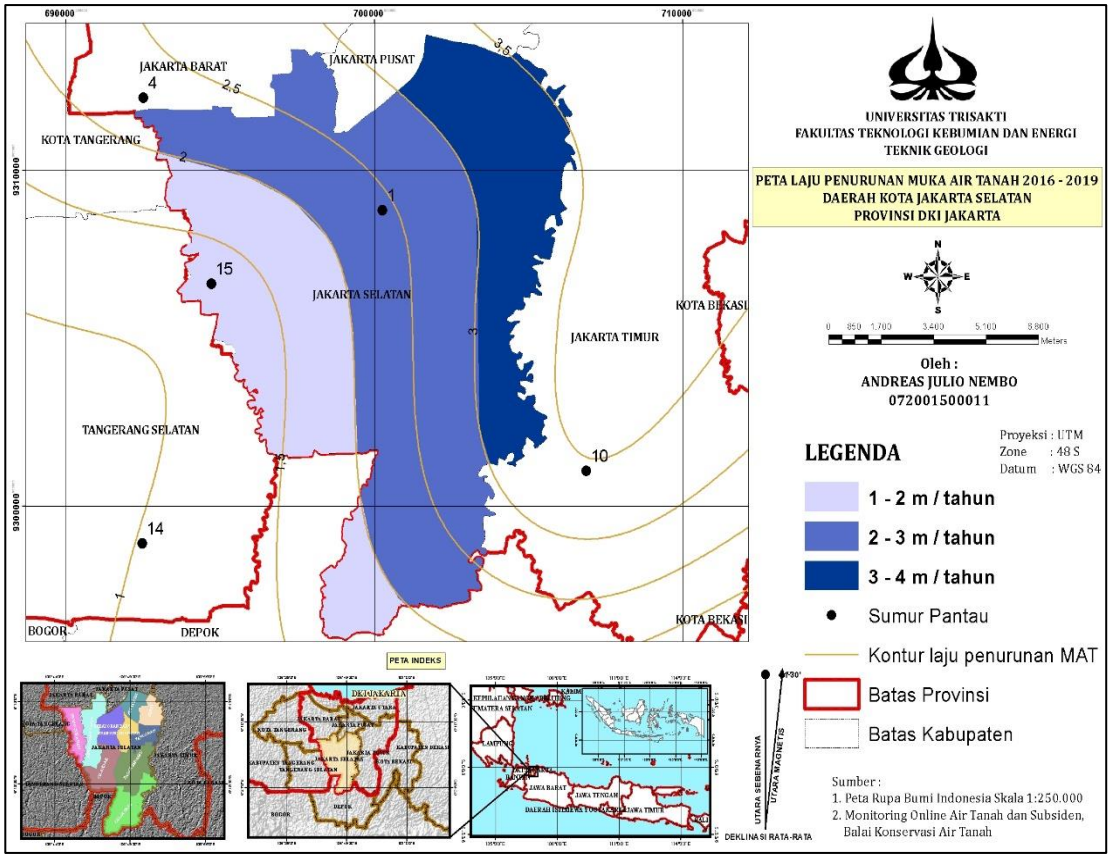

Figure 8
Map of groundwater subsidence rates of the study area

Correlation of Soil Subsidence Rate with Groundwater Level Subsidence

A map of the correlation of land subsidence with groundwater subsidence can be seen in Figure 9. It can be seen that points that experience high land subsidence such as points 13 A and 1 A are in areas that have a fairly high decrease in groundwater levels. Point 13 A located in Pesanggrahan Village experienced a land subsidence of 17.5 cm / year located in an area that has a fairly high groundwater subsidence value of 1.45 m / year. Point 1 A located in Cilandak Barat Village experienced a land subsidence of 7.4 cm / year located in an area that has a fairly high groundwater level decrease value of 1.95 m / year. There are also points that do not experience significant land subsidence such as points 52 D, 51 D, and 21 A are in areas that have high groundwater subsidence values. Point 52 D which is located in Tegal Parang Sub-District has experienced land subsidence of 0.4 cm/year and is located in an area with a decrease in groundwater level of 2.84 m/year. Point 51 D which is in the Kebagusan Village has experienced land subsidence of 0.7 cm/year and is

located in an area that has a groundwater level decrease of 2.8 m/year. Point 21A which is in Kramat Pela Sub-District does not experience land subsidence and is located in an area that has a groundwater level decrease of 2.05 m/year.The correlation value between the rate of land subsidence and the decrease in groundwater level was 0.504. It can be seen in Figure 10.

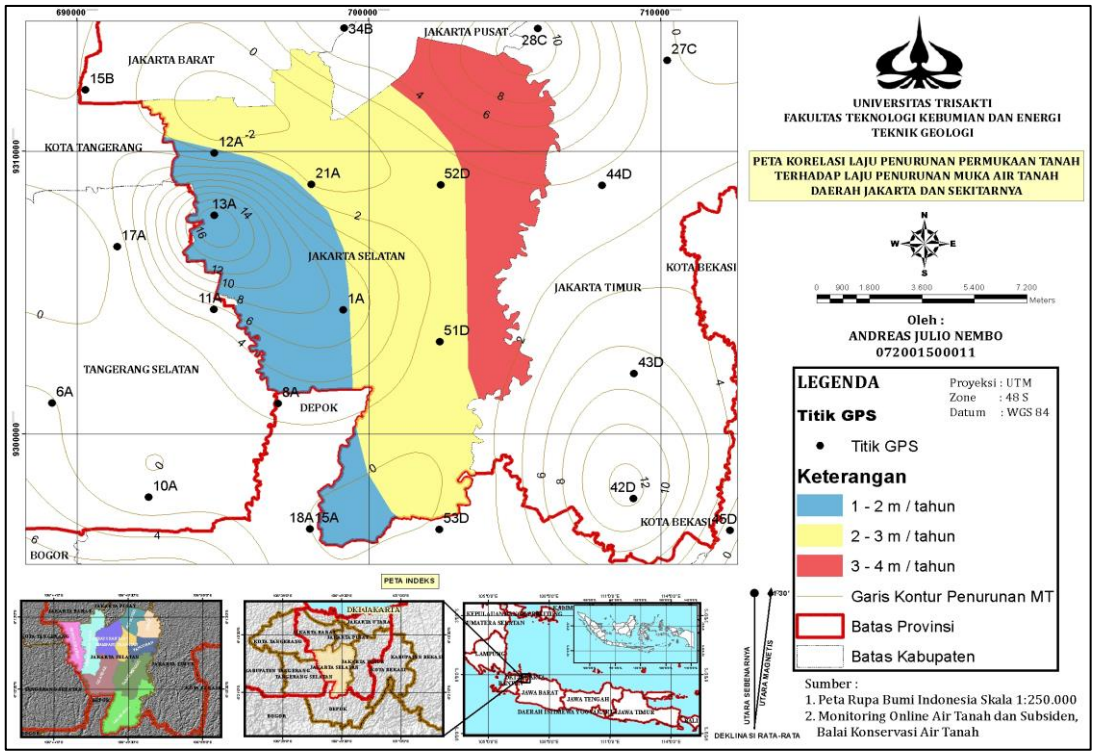

Figure 9
Correlation map of soil subsidence rate with groundwater subsidence rate

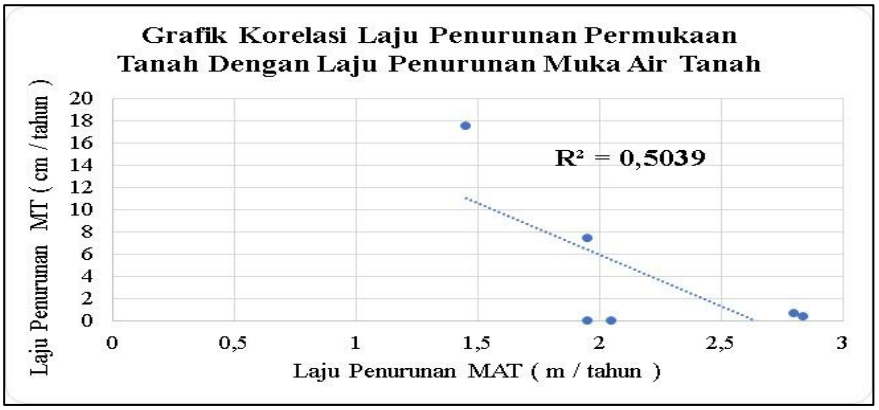

Figure 10
Relationship between soil subsidence rate and groundwater subsidence

CONCLUSION

Based on the results of studies that have been carried out in this study, it can be concluded that surface sedimentary deposits are dominated by clay layers that are still in an unconsolidated condition relatively thickened to the north with a thickness of more than 300 m. This condition shows that the sedimentary layer in Jakarta is still undergoing a compaction process so that naturally there is a decrease in the soil surface. Soil subsidence in the study area has a fairly strong correlation to groundwater subsidence, which means it has a strong correlation relationship of 50.4%.

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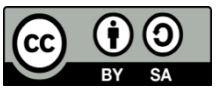

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