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Analysis of correlaton land subsidence in south semarang with geological conditions using overlay method

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Abstract—Land subsidence in the city of Semarang based on the measurement results of the Global Positioning System (GPS) is quite significant. Land subsidence is a phenomenon that can cause losses and provide losses to the environment, therefore research is needed to examine the characteristics of land subsidence. One of the factors causing land subsidence is due to these geological conditions, Semarang is a coastal city that contains alluvial deposits. Especially in northern Semarang. The phenomenon of land subsidence occurs in this region. Naturally, these materials are alluvial deposits. Therefore the relationship of land subsidence to the geological method can be used by the overlay method. The results of this study were obtained from geology and land subsidence in North Semarang.

Keywords: Land subsidence, Geological conditions, Overlay, North Semarang

I. INTRODUCTION

One of the phenomena that has occurred in recent years is land subsidence. This subsidence is felt strongly by several cities located in coastal areas. This is because subsidence has a negative impact and causes losses. Land subsidence is defined as the sinking of land relative to a given reference plane (geodetic reference frame), where there are various variables that cause it. Subsidence can be slow or sudden. In most cases, subsidence is within a few centimetres per year.

The northern part of the city of Semarang consists of lowlands and coastal areas composed of alluvial deposits that have not been fully compacted. This is a natural factor that causes land subsidence in the Semarang area. The land subsidence that occurs in Semarang causes physical damage to buildings and infrastructure, as well as tidal flooding (Lubis, 2011). A picture of the effects of land subsidence is shown in Figure 1.

Semarang land subsidence according to H. Z. Abidin, et al, (2010) land subsidence in Semarang in 2008-2011 ranged from an average of 6-7 cm per year with the largest land subsidence value of 14-19 cm per year. In addition, research by Roy Kasfari, et al in 2017, the lowest land subsidence ranged from 2.18 cm per year with the largest land subsidence of 21.33 cm per year (Marfai and King, 2007). Considering its impact, land subsidence in Semarang needs to be monitored in order to reduce and prevent further impacts. In this study, the geodetic method used to measure the amount of land subsidence in Semarang is the Global Positioning System (GPS) survey (Beutler, et al, 2007).

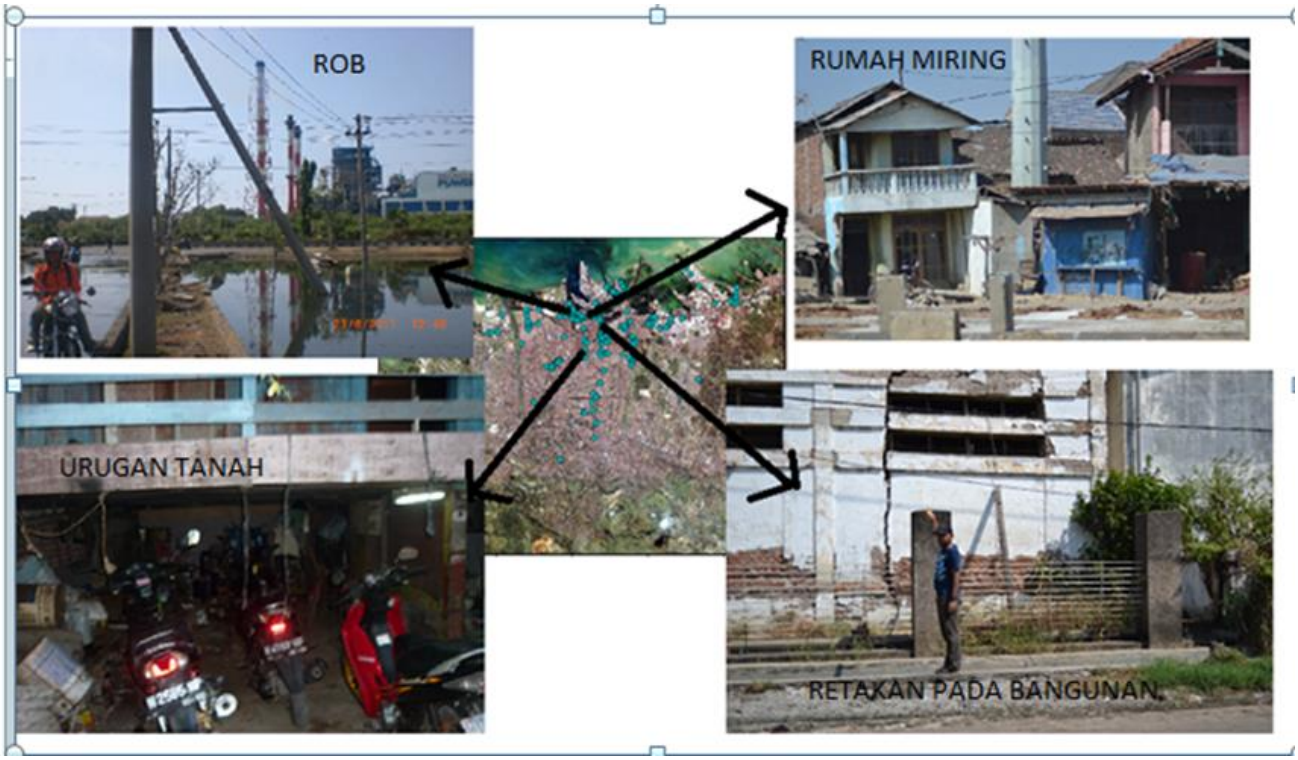

Figure 1: Impact of subsidence damage in North Semarang

II. METHODS

Several subsidence studies have been conducted in Semarang city using various geodetic methods such as levelling (Marfai and King, 2007), Global Positioning System (GPS) survey and interferometric survey. and King, 2007), Global Positioning System (GPS) survey and interferometric synthetic aperture radar (InSAR) (Lubis, et al., 2011).

In this study, direct data collection was carried out using the GPS data campaign survey method (Hofmann, et al, 2007). For land subsidence in Semarang in 2008-2011, measurements were made using a geodetic type GPS device. The results of observation data were processed using Bernese 5.0 software. The results of data processing obtained coordinate values of observation points in 2008, 2009, 2010 and 2011. From these results, 3 periods of land subsidence were obtained, namely 2008-2009, 2009-2010 and 2010-2011. The results of the Semarang land subsidence map are overlaid with the geological map of Semarang city. The result of the overlay can be done the relationship between land subsidence in North Semarang with geological conditions (GRDC, 1996) of the region. See Figure 2 for more details.

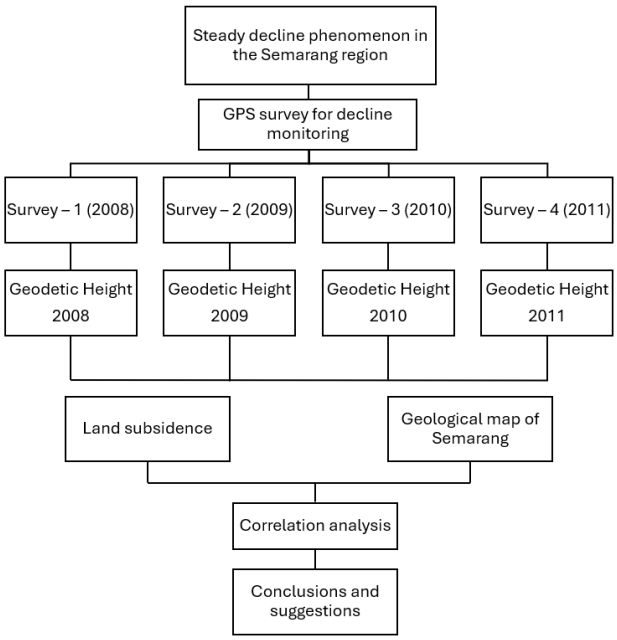

Figure 2. Research methodology

III. RESULTS AND DISCUSSION

The results of the processing of land subsidence with geodetic type GPS obtained the amount of land subsidence can be seen in the following table. The data shown start from 2008 - 2011.

Table 1. Semarang land subsidence results 3 periods from 2008-2011

POINT	2008-2009		2009-2010		2010-2011		POINT	2008-2009		2009-2010		2010-2011	
	(cm/year)	Std	(cm/year	Std	(cm/year)	Std		(cm/year)	Std	(cm/year	Std	(cm/year)	Std
259	-1.1	0.1	-1.5	0.1	-2.9	0.1	CTRM	-6.7	0.1	-18.7	0.1	-7	0.1
1106	-6.8	0.2	-2	0.2	-2.7	0.1	ISLA	-12.3	0.1	-9.7	0.1	-5.8	0.1
1114	-5.3	0.2	-0.4	0.2	-0.6	0.1	JOHR	-4.9	0.1	-17.7	0.1	-8.7	0.1
1124	-3.7	0.2	-4.8	0.2	-8.5	0.1	K371	-3.3	0.3	0	0.3	0	0.2
1125	-4.5	0.1	-5.1	0.1	-4	0.1	KO16	-2	0.2	-0.8	0.2	0	0.1
1303	-0.8	0.1	0	0.1	-1.1	0.1	MP69	-5.1	0.2	-1.7	0.2	-0.5	0.1
AY15	-2.2	0.1	-0.9	0.1	-1.1	0.1	MSJD	-8.7	0.1	-7.4	0.1	-5.8	0.1
BM01	-13.5	0.2	-9.6	0.2	-10.5	0.1	MTIM	-9.4	0.1	-9.7	0.1	-5.9	0.1
BM05	-4.9	0.6	-7	0.1	-5.4	0.1	PMAS	-5.3	0.1	-11.4	0.1	-7.7	0.1
BM11	-3.8	0.1	-9.8	0.1	-3.3	0.1	PRPP	-9.1	0.1	-13.8	0.1	-10.3	0
BM16	-10.3	0.2	-3.2	0.2	-3.5	0.1	SD01	-8	0.2	-5.3	0.1	-7.8	0.1
BM30	-1.6	0.2	0	0.2			SD02	-4.2	0.1	0.7	0.1	0	0.1
BTBR	-8.8	0.1	-8.1	0.1	-8.6	0.1							

From Table 1, the amount of land subsidence in Semarang was the highest in 2008-2009 at 13.5 cm/year, while it was 18.7 cm/year in 2009-2010 and 10.5 cm/year in 2010-2011. Zonal map of land subsidence in Semarang.

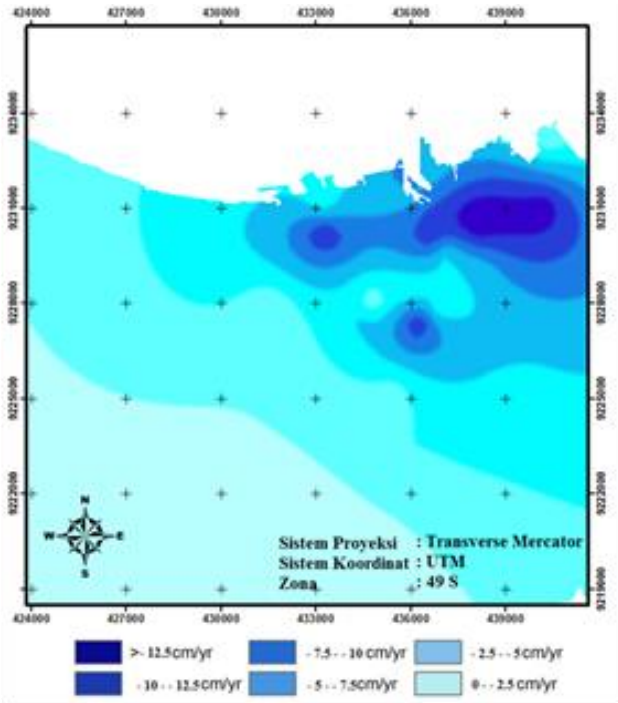

Figure 3. Subsidence zone map 2008 – 2009

Figure 3 shows that the largest land subsidence of 13.5 cm occurred in North Semarang, shown in dark blue.

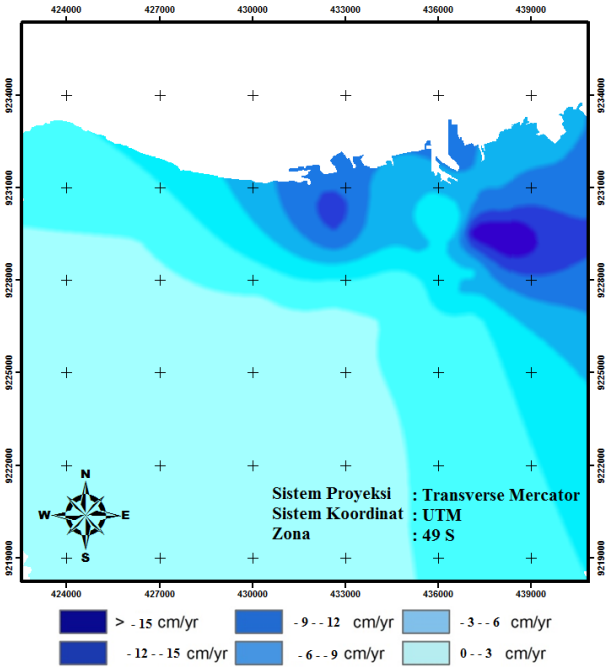

Figure 4. Subsidence zone map 2009 – 2010

Figure 4 shows that the largest land subsidence of 18.7 cm occurred in North Semarang, which is marked in a dark blue colour.

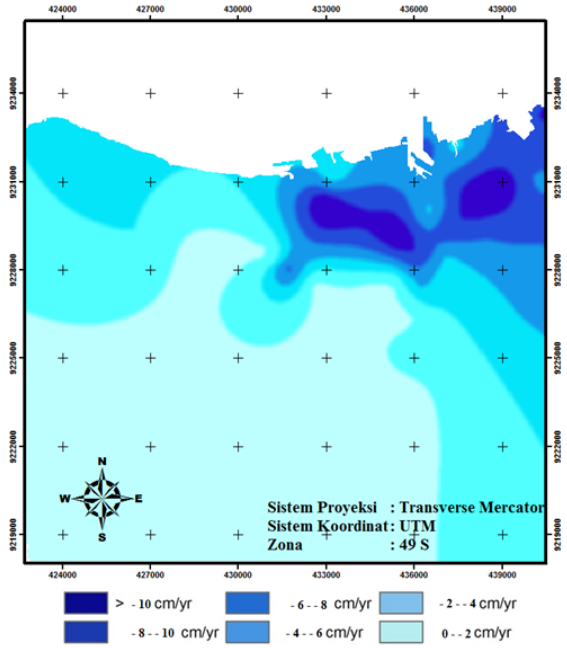

Figure 5. Subsidence zone map 2010 – 2011

It can be seen from Figure 5 that the largest land subsidence is 10.5 cm. It can also be seen that the largest decrease in land subsidence occurred in the northern part of Semarang. From 3 periods of land subsidence in Semarang, when combined for 4 years of observation into 1 land subsidence zoning map, the largest average subsidence is obtained. The average rate of land subsidence in Semarang from 2008-2011 ranges from 0.3 cm per year to 10.7 cm per year. The land subsidence zoning for the period 2008-2011 is divided into 6 zones. The interval between the zones is 2 cm. From the data processing, the largest land subsidence zoning is dominant in the eastern and northern parts of North Semarang. While for the smallest decline occurred in the southern part of Semarang region, which is 0-2 cm / year.

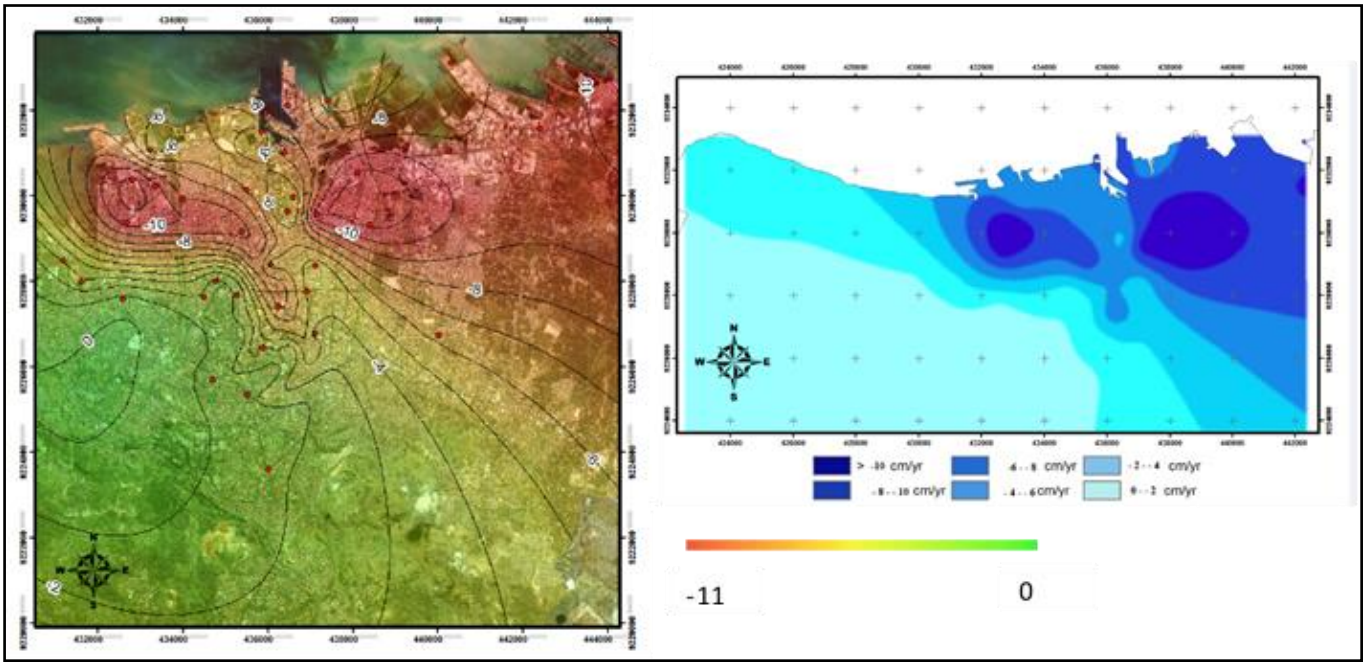

Figure 6. Semarang subsidence map 2008-2011

To determine the correlation between the geological map and land subsidence in Semarang, an overlay of the average land subsidence zone from GPS observations and the geological map of Semarang was created, as shown in Figure 7.

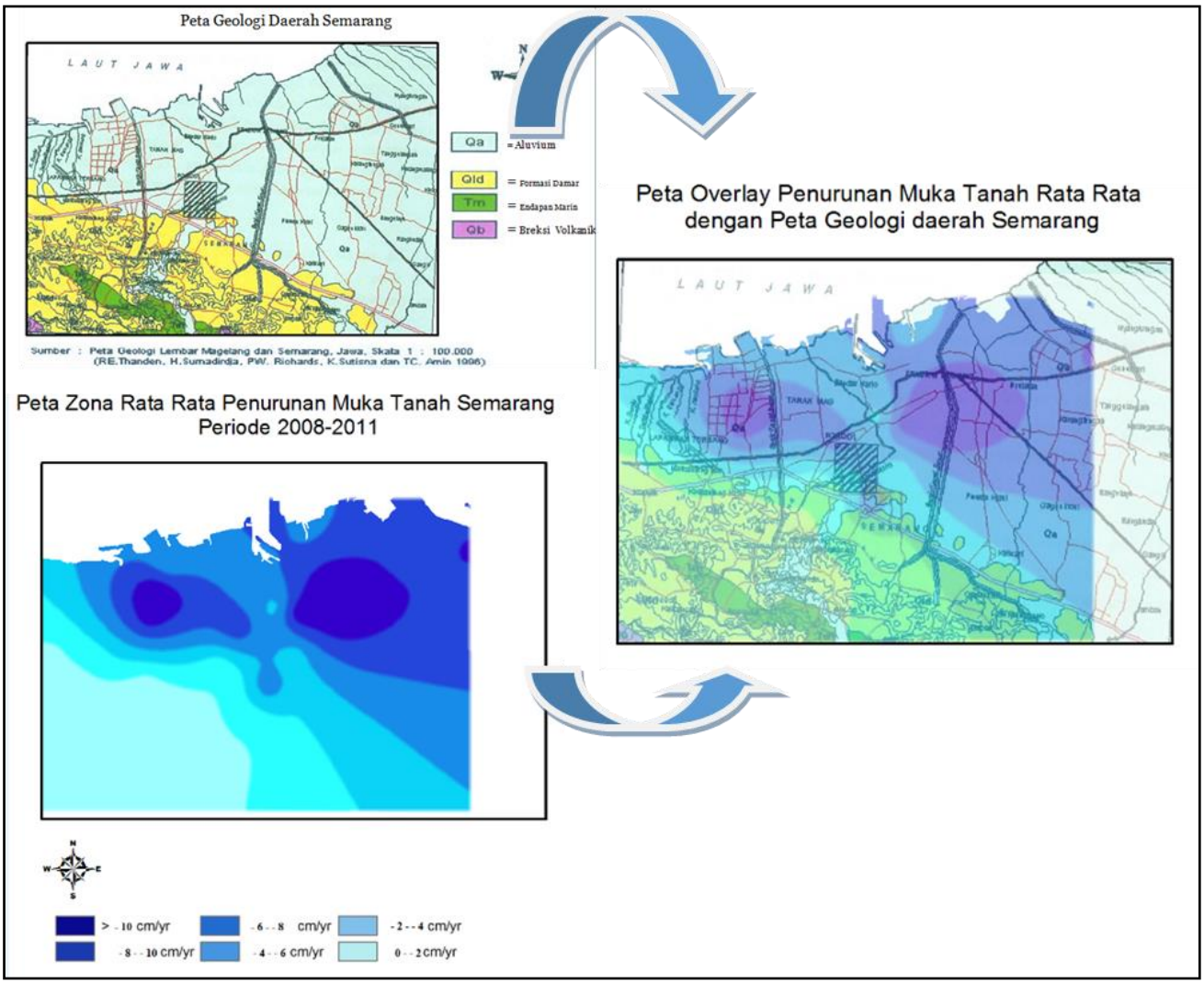

Figure 7. Results of overlay of geological map and Semarang Land Subsidence Zone Map 2008-2011

From Figure 7, the results of overlaying the geological map and the 2008-2011 Semarang land subsidence zone map, it can be seen that there is a correlation from the geological conditions of Semarang area, which in the northern part is alluvial / clay, where the nature of alluvial is easy for land subsidence due to the process of consolidation / compression of soil. Therefore, the geological conditions of Semarang and land subsidence have a significant correlation because the greatest land subsidence occurs in areas with alluvial geology.

IV. CONCLUSION

From the analysis of this study, it can be concluded that land subsidence in the Semarang area is quite significant. From the data processing, it can be seen that there is a correlation of land subsidence in Semarang with the geological conditions of Semarang. The correlation is where the area / zone of large land subsidence there are lithological conditions in the form of layers of alluvial deposits still occur consolidation / compaction of the soil so that the soil naturally decreased. With the overlay method, the correlation between land subsidence and geological conditions can be seen visually where land subsidence occurs in the alluvial sediment layer.

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