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STUDENT'S KNOWLEDGE ABOUT LAND SUBSIDENCE IN SEMARANG CITY, INDONESIA

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ABSTRACT

The city of Semarang is one of the cities on Java Island's north coast that experiences land subsidence. The rate of land subsidence varies across different areas. This research aims to analyse the relationship between students' knowledge about land subsidence phenomena and the location of schools experiencing (SMAN 14 Semarang) and not experiencing (SMAN 4 Semarang) land subsidence in Semarang City. The population for this study comprises all high school students at SMA Negeri 4 Semarang (1,179 students) and SMA Negeri 14 Semarang (958 students). Sampling was conducted using the Slovin formula with a 5% margin of error, yielding 306 respondents from SMA Negeri 4 Semarang and 300 from SMA Negeri 14 Semarang. The sampling technique employed was cluster random sampling. Data collection techniques included multiple-choice tests, followed by point-biserial correlation analysis. The results of this study indicate that students at both SMA Negeri 14 Semarang and SMA Negeri 4 Semarang demonstrate a high level of knowledge about land subsidence, and the analysis indicates no significant relationship between students' knowledge and school location in areas with different subsidence conditions in Semarang. This highlights the effectiveness of geography instruction in conveying local environmental phenomena and underscores the importance of integrating contextual, place-based examples, such as land subsidence, into geography curricula.

Keywords: *student's knowledge; land subsidence; school location*

INTRODUCTION

The Earth's surface is a dynamic entity, and the forces acting around the Earth create shapes that influence its form. In daily life, we encounter issues stemming from various phenomena that, in turn, impact the surrounding environment and people. One such phenomenon is land subsidence. Land subsidence occurs in coastal areas due to their susceptibility to pressures from both land and sea environments. This process, or the downward movement of Earth's surface, is a geological natural disaster that has occurred widely across various regions

around the world, especially in coastal or alluvial plain areas (Sophian, 2010). Understanding land subsidence is essential not only from a physical geography perspective but also as a contextual phenomenon that can strengthen students' geographic literacy.

Land subsidence is a process in which the ground surface lowers relative to a specific datum (geodetic reference framework), with various factors contributing to it (Marfai & King, 2008). Land subsidence is a slow, long-term vertical movement of the Earth's crust. Generally, surface lowering happens in rapidly developing large cities and in areas with relatively young soil structures. Meanwhile, Wirawan et al. (2019) explain that land subsidence is a phenomenon of changes in ground elevation over an extended period. If it continues, areas experiencing subsidence will see further land lowering, and this subsidence is not uniform across regions. The consequences of land subsidence become more apparent in coastal urban areas. In recent years, several northern coastal regions of Central Java—such as Semarang, Brebes, Pekalongan, Demak, and Kendal—have experienced frequent tidal flooding (rob), which is closely linked to land subsidence (Handayani et al., 2020; Nashrrullah et al., 2014). One cause of this tidal flooding is land subsidence. This means that the sea level is higher than the surrounding land surface due to land subsidence. If an area experiences land subsidence that lowers it below its surroundings, it becomes a central region potentially affected by flooding during the rainy season. These impacts demonstrate how physical geography processes interact with human settlements, infrastructure, and livelihoods.

Semarang, the capital city of Central Java Province, represents a clear example of a coastal urban area experiencing land subsidence. Rapid urban development, high population density, and increasing infrastructure demand have intensified groundwater extraction, which is a major contributor to land subsidence (Akbar & Setiawan, 2022; Wakode et al., 2018). The northern part of Semarang is dominated by young alluvial deposits that are still undergoing compaction, making the area particularly susceptible to subsidence (Marfai & King, 2007; Gemilang et al., 2020). Recent global studies have identified Semarang as one of the cities with the fastest rates of land subsidence worldwide (Wu et al., 2022). These

conditions provide a strong local context for integrating land subsidence into geography education.

In the context of geography learning, environmental phenomena such as land subsidence are closely aligned with the objectives of geography education, which emphasise spatial thinking, human–environment interaction, and regional problem analysis (Kahraman, 2016; Metoyer et al., 2015; Piotrowska et al., 2019). According to the geography curriculum at the senior high school level (SMA), students are expected to understand physical processes occurring on the Earth's surface and analyse their impacts on human life (Kurniawati et al., 2023; Widodo et al., 2025). Learning that is contextual and based on local environmental issues has been shown to improve students' conceptual understanding and environmental awareness (Iswandari & Retnaningrum, 2021).

Student knowledge plays a crucial role in achieving meaningful learning outcomes (Sewagegn, 2020). Knowledge is not only the result of information acquisition but also reflects students' ability to interpret, explain, and apply concepts to real-world situations (Chang et al., 2024). In geography education, students' understanding of local environmental phenomena indicates how well they connect abstract concepts learned in the classroom with observable conditions in their surroundings (Hamid et al., 2021; Wijayanto et al., 2023). However, students living in different physical environments may develop different levels of understanding, depending on their exposure to and experience with specific phenomena.

Despite extensive scientific research on land subsidence in Semarang, studies examining students' knowledge of this phenomenon from an educational perspective remain limited. In particular, there has been no prior research comparing students' knowledge levels between schools in areas affected by land subsidence and those in relatively stable areas. This gap is important to address, as differences in environmental context may influence students' understanding of geographic phenomena.

Therefore, this study aims to analyse the level of students' knowledge of land subsidence in Semarang, using SMA Negeri 4 Semarang, located in a relatively stable area, and SMA Negeri 14 Semarang, located in a land-subsidence-prone area, as case studies.

By examining students' knowledge within different environmental contexts, this research is expected to contribute to geography education by providing insights into how local environmental phenomena can be effectively integrated into geography learning.

MATERIALS AND METHODS

This research is a quantitative study with a correlational design. It aims to analyse the relationship between knowledge of land subsidence and the location of schools in Semarang. The research was designed to determine whether differences in environmental exposure to land subsidence are associated with variations in students' knowledge levels. The classification of school locations into areas experiencing and not experiencing land subsidence was based on scientific and geospatial evidence from previous studies (Kuehn et al., 2010). These studies consistently identify North Semarang as a subsidence-prone zone, whereas southern areas, such as Banyumanik, are relatively stable and exhibit minimal subsidence rates. Considering this and the criteria for public schools, the researcher selected two high schools: SMA Negeri 4 Semarang, located in Banyumanik, and SMA Negeri 14 Semarang, located in North Semarang. The selection of these two schools allowed for a clear spatial contrast within the same urban system, minimising differences in curriculum, educational policy, and socio-administrative conditions while emphasising environmental variation.

The population for this study includes all students at SMA Negeri 4 Semarang (1.179 students) and SMA Negeri 14 Semarang (958 students). The sample size was calculated using Slovin's formula with a 95% confidence level. As a result, 306 students from SMA Negeri 4 Semarang participated in the study, including 88 Grade X, 123 Grade XI, and 95 Grade XII students. Meanwhile, 300 students from SMA Negeri 14 Semarang were selected, comprising 102 Grade X, 104 Grade XI, and 94 Grade XII students. Sampling was conducted using cluster random sampling to ensure representation across grade levels.

Data on students' knowledge of land subsidence were collected via a multiple-choice test comprising 20 items. The instrument was structured around five indicators: (1) understanding of land subsidence phenomena, (2) types of ground movement, (3) causes of land

subsidence, (4) impacts of land subsidence, and (5) mitigation efforts related to land subsidence. The question items were developed through the refinement of an instrument grounded in theoretical constructs and previous studies (Gumilar et al., 2014; Ikuemonisan & Ozebo, 2020; Islam et al., 2017; Marfai & King, 2006). The validity and reliability tests of the instrument were conducted with 31 students from SMA Negeri 4 Semarang. The results indicated that the instrument met the criteria for validity and reliability, confirming its suitability for measuring students' knowledge.

Data analysis used descriptive statistics to identify the overall level of students' knowledge of land subsidence at each school. To address the research objective "examining the relationship between students' knowledge and school location," the point-biserial correlation test was applied. In this analysis, students' knowledge scores were treated as continuous variables, while school location was treated as a dichotomous variable representing subsidence-affected and non-affected areas.

RESULTS AND DISCUSSION

1. The Level of Student Knowledge About the Phenomenon of Land Subsidence at SMA Negeri 14 Semarang (high land subsidence rate)

In this study, students' knowledge was tested using 5 indicators from parameters related to their understanding of the land subsidence phenomenon. These indicators include the definition of land subsidence, types of land subsidence, causes of land subsidence, impacts of land subsidence, and land subsidence mitigation. Based on the research conducted at SMA Negeri 14 Semarang, which represents a region experiencing land subsidence, the level of students' knowledge about the phenomenon of land subsidence falls into the "good" category.

The average knowledge score for all students at SMA Negeri 14 Semarang is 91.50. The average knowledge score at SMA Negeri 14 Semarang is 90.21 for males and 93.06 for females. According to **Figure 1**, for males, 4 students scored between 59 and 69, representing 2%. 20 students, or 12%, achieved scores between 70 and 79. Scores between 80-89 were obtained by 37 students, accounting for 23%, and 103 students, representing 63% achieved scores

between 90-100. For females, 1 student scored between 59 and 69, which is 1%. 10 students, or 7%, achieved scores between 70 and 79. 33 students, representing 24% obtained scores between 80-89, and scores between 90-100 were achieved by 92 students, accounting for 68%.

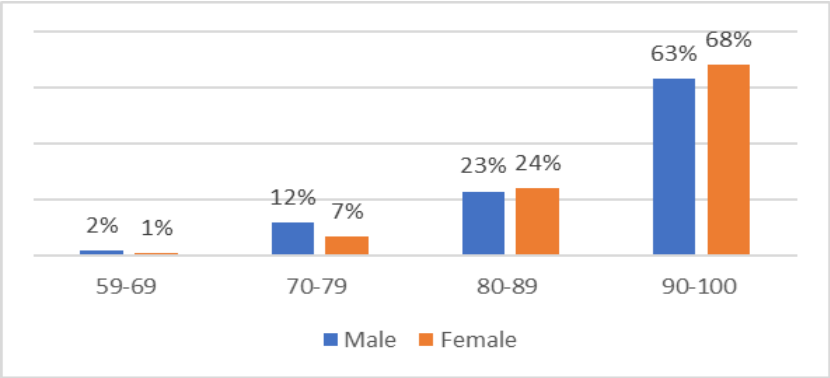

Figure 1. The Level of Knowledge of Male and Female Students About Land Subsidence at SMAN 14 Semarang

Source: Data Analysis, 2023

Table 1. The Level of Knowledge of Male and Female Students About Land Subsidence for Each Indicator at SMAN 14 Semarang

Category	Male (F)	Female (F)	Male (%)	Female (%)
Indicator 1 (Definition of land subsidence)				
Poor	5	8	3%	6%
Moderate	36	27	22%	20%
Good	123	101	75%	74%
Indicator 2 (Types of land subsidence)				
Poor	0	0	0%	0%
Moderate	18	8	11%	6%
Good	146	128	89%	94%
Indicator 3 (Causes of land subsidence)				
Poor	0	0	0%	0%
Moderate	8	6	5%	4%
Good	156	130	95%	96%
Indicator 4 (Impact of land subsidence)				
Poor	11	0	7%	0%
Moderate	5	5	3%	4%
Good	148	131	90%	96%
Indicator 5 (Land subsidence mitigation)				
Poor	11	14	7%	10%
Moderate	0	0	0%	0%
Good	153	122	93%	90%

Source: Data Analysis, 2023

In the first indicator, students' understanding of the phenomenon of land subsidence shows good results, as shown in Table 1. For males, in the poor category, there were 5 students (3%); in the sufficient category, 36 (22%); and in the good category, 123 (75%). Among females, in the poor category, there were 8 students (6%); in the sufficient category, 27 (20%); and in the good category, 101 (74%). These results are due to students at SMA Negeri 4 Semarang receiving instruction on lithosphere topics, which has enabled them to gain geological knowledge.

In the second indicator, which is types of ground movement, the students' knowledge at SMA Negeri 14 Semarang shows good results, as illustrated in **Table 1**. For males, there were no students in the poor category, 18 in the sufficient category (11%), and 146 in the good category (89%). For females, there were no students in the poor category, 8 in the sufficient category (6%), and 128 in the good category (94%).

In the third indicator, the factors causing land subsidence, the research results show promising outcomes, as illustrated in **Table 1.** For males, there were no students in the poor category, 8 in the sufficient category (5%), and 156 in the good category (95%). For females, there were no students in the poor category, 6 in the sufficient category (4%), and 130 in the good category (96%).

For the fourth indicator, the impact of land subsidence, the results are as follows: for males, 18 students were in the sufficient category (11%) and 146 in the good category (89%). Among females, 8 students were in the sufficient category (6%) and 128 in the good category (94%). The indicator of land subsidence aligns with Bott et al. (2021), who state that coastal plains in lower Semarang are prone to land subsidence and flooding. SMA Negeri 14 Semarang, being located in the lower part of Semarang on the coastal plain, is also potentially affected by land subsidence.

In the fifth indicator, efforts to mitigate land subsidence, the results at SMA Negeri 14 Semarang show good outcomes, as shown in **Table 1**. For males, there were 11 students in the poor category (7%), none in the sufficient category, and 153 students in the good category (93%). For females, there were 14 students in the poor category (10%), none in the sufficient category, and 122 students in the good category (90%).

2. The Level of Student Knowledge About the Phenomenon of Land Subsidence at SMA Negeri 4 Semarang (Not Experiencing Land Subsidence)

In this study, the level of student knowledge at a school in an area with low subsidence rates was also assessed using 5 indicators: the definition of land subsidence, types of land subsidence, factors causing land subsidence, impacts of land subsidence, and mitigation efforts for land subsidence. Based on research conducted at SMA Negeri 4 Semarang, students' knowledge of land subsidence falls into the "good" category. The average knowledge score for all students at SMA Negeri 4 Semarang is 88.79. The average scores obtained are 88.17 for males and 89.56 for females.

In **Figure 2,** which details the results of the knowledge test on land subsidence at SMA Negeri 4 Semarang, the findings are as follows: among males, no students scored between 59 and 69. 8 students scored between 70 and 79, representing 6%. For scores between 80-89, 55 students (44%) were enrolled, and for scores between 90-100, 61 students (49%) were enrolled. Among females, no students scored between 59 and 69. 17 students scored between 70 and 79, representing 9%. For scores between 80-89, 65 students (36%) were enrolled, and for scores between 90-100, 100 students (55%) were enrolled.

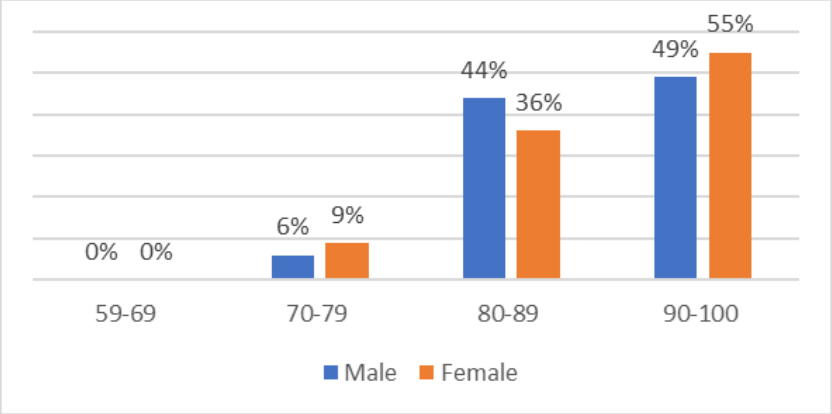

Figure 2. The Level of Knowledge of Male and Female Students About Land Subsidence at SMAN 4 Semarang

Source: Data Analysis, 2023

In the first indicator, students' understanding of the phenomenon of land subsidence shows good results, as illustrated in **Table 2**. It demonstrates the levels of knowledge among both male and female students regarding land

subsidence. For males, there were 3 students in the poor category (2%), 20 in the sufficient category (16%), and 101 in the good category (81%). For females, there were 3 students in the poor category (2%), 34 in the sufficient category (19%), and 145 in the good category (80%).

Table 2. The Level of Knowledge of Male and Female Students About Land Subsidence for Each Indicator at SMAN 4 Semarang

Category	Male (F)	Female (F)	Male (%)	Female (%)
Indicator 1 (Definition of land subsidence)				
Poor	3	3	2%	2%
Moderate	20	34	16%	19%
Good	101	145	81%	80%
Indicator 2 (Types of land subsidence)				
Poor	0	0	0%	0%
Moderate	3	4	2%	2%
Good	121	178	98%	98%
Indicator 3 (Causes of land subsidence)				
Poor	0	0	0%	0%
Moderate	11	17	9%	9%
Good	113	165	91%	91%
Indicator 4 (Impact of land subsidence)				
Poor	9	5	7%	3%
Moderate	4	9	3%	5%
Good	111	168	90%	92%
Indicator 5 (Land subsidence mitigation)				
Poor	21	33	17%	18%
Moderate	0	0	0%	0%
Good	103	149	83%	82%

Source: Data Analysis, 2023

In the second indicator, types of ground movement, the students' knowledge at SMA Negeri 4 Semarang shows good results, as shown in **Table 2**. It illustrates the levels of knowledge for both male and female students regarding types of ground movement. For males, there were 0 students in the poor category (0%), 3 in the sufficient category (2%), and 121 in the good category (98%). For females, there were 0 students in the poor category (0%; 0), 4 in the sufficient category (2%; 4), and 178 in the good category (98%; 178). This indicator regarding the factors causing land subsidence aligns with Bott et al. (2021), who indicate that urban development in Semarang, given its hilly and sloping topography, can lead to various disasters, such as landslides. SMA Negeri 4

Semarang, located in the upper part of Semarang, allows students to learn about the different types of ground movement.

In the third indicator, the factors causing land subsidence, the research results show good outcomes, as depicted in **Table 2**. It illustrates the levels of knowledge for both male and female students regarding the factors causing land subsidence. For males, there were 0 students in the poor category (0%), 11 in the sufficient category (9%), and 113 in the good category (91%). For females, there were 0 students in the poor category (0%; 0), 17 in the sufficient category (9%), and 165 in the good category (91%).

The fourth indicator, the impact of land subsidence, shows the levels of knowledge among male and female students regarding its effects. For males, there were 10 students in the poor category (8%), 6 in the sufficient category (5%), and 147 in the good category (87%). For females, there were 5 students in the poor category (3%), 9 in the sufficient category (5%), and 168 in the good category (92%).

In the fifth indicator, efforts to mitigate land subsidence, the results of the test at SMA Negeri 4 Semarang show good outcomes, as illustrated in **Figure 2**. It reflects the levels of knowledge for both male and female students regarding mitigation efforts for land subsidence. For males, there were 21 students in the poor category (17%), 0 in the sufficient category (0%), and 103 in the good category (83%). For females, there were 33 students in the poor category (18%), 0 in the sufficient category (0%), and 149 in the good category (82%).

Education about land subsidence is urgent to implement so that the impacts of land subsidence can be mitigated (Sarah et al., 2022). Knowledge about land subsidence among students at SMAN 14 Semarang and SMAN 4 Semarang is categorised as good; however, this result contrasts with findings by Takagi et al. (2016), which state that communities in northern Jakarta are not yet aware of the negative impacts of land subsidence. Similarly, Saputra et al. (2017) note that the government and local communities remain indifferent to land subsidence, which can adversely affect their lives.

3. The Relationship Between Students' Knowledge About the Phenomenon of Land Subsidence and The Location of Schools in Semarang.

Based on the research results, there is no relationship between students' knowledge levels and the location of their schools regarding land subsidence. The point-biserial correlation test yielded a correlation coefficient of 0.473, which is greater than 0.05. The correlation result is shown in **Table 3**.

Table 3. Results of the Correlation Test Using Biserial Point Analysis

		SMAN 4 Semarang	SMAN 14 Semarang
SMAN 4 Semarang	Pearson Correlation	1	0.042
	Sig. (2-tailed)		0.473
	N	306	300
SMAN 14 Semarang	Pearson Correlation	0.042	1
	Sig. (2-tailed)	0.473	
	N	306	300

Source: Data Analysis, 2023

Based on the point-biserial correlation test results, there is no relationship between students' knowledge of land subsidence and whether their school is located in an area with land subsidence or without it in Semarang City. Students' knowledge of a natural phenomenon is acquired in school through learning, and other factors that affect their knowledge include their personal experiences.

Students' knowledge in schools located in areas with high land subsidence rates and those without land subsidence shows no significant difference. Students in areas with high land subsidence rates should be more familiar with the phenomenon since they experience it directly in their daily lives. This aligns with findings from Esteban et al. (2020) and Saputra et al. (2017), which indicate that coastal communities experiencing land subsidence need to adapt to environmental changes caused by it.

Several factors beyond school location may influence students' knowledge of land subsidence. Although both schools follow the same national geography curriculum, differences in curriculum implementation, teaching strategies, and the use of learning media may affect students' understanding. Media exposure and students' socioeconomic backgrounds may also shape access to information and learning resources. In addition, students' life experiences and direct exposure to land subsidence impacts may strengthen understanding through experiential learning. This study also recognises potential biases related to differences in school quality, teacher characteristics, and geography learning practices, which were not directly

measured. Therefore, while the results indicate a relationship between student knowledge and school location, the findings should be interpreted cautiously, as they may reflect the combined influence of geographic context, instructional practices, and students' environmental experiences rather than school location alone.

CONCLUSIONS

This study concludes that students at both SMA Negeri 14 Semarang and SMA Negeri 4 Semarang demonstrate a high level of knowledge about land subsidence, with average scores of 91.50 and 88.79, respectively. The point-biserial correlation analysis indicates that there is no significant relationship between students' knowledge of land subsidence and school location in areas with different subsidence conditions in Semarang. These findings suggest that students' understanding of land subsidence is primarily influenced by formal geography learning at school, supported by additional factors such as media exposure and personal experiences, rather than by direct environmental exposure alone. This highlights the effectiveness of geography instruction in conveying local environmental phenomena and underscores the importance of integrating contextual, place-based examples, such as land subsidence, into geography curricula. Future research is recommended to incorporate additional variables, such as instructional practices, learning media, and students' socioeconomic backgrounds, and to involve more schools and regions, using mixed-methods or spatial approaches, further to explore the relationship between geography education and environmental understanding.

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