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Student Resilience in Responding to Climate Change in Coastal Areas of Demak Regency: Implications for SDGs

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Abstract: This study aims to describe the level of student resilience in facing climate change. The research subjects were senior high school students in Sayung and Bonang Subdistricts, Demak Regency. The study employed a mixed-methods approach with a sequential explanatory strategy, in which quantitative analysis is followed by qualitative exploration. Quantitative data were obtained through the analysis of student resilience questionnaires. Meanwhile qualitative data were gathered through in-depth interviews with teachers and students from the schools that served as research sites. The results of the study show that most students' resilience also falls into the moderate category 49%, low 28%, and high 23%. Qualitative findings revealed that the school environment and family support were the main factors influencing this moderate level of resilience. In conclusion, resilience serves as an important factor that mediates students' responses to environmental stress. This study recommends strengthening school support, improving adaptive facilities to climate change, and integrating disaster education into the coastal school curriculum to enhance student resilience.

Keywords: Climate change; Demak coastal area; Student resilience

Introduction

Indonesia has approximately 75% of its territory composed of oceans and islands, which is why it is known as a maritime nation. Data on Indonesia's coastline length published by the maritime sector indicates that Indonesia has 81,000 km of coastline, or about 14% of the world's total coastline (Rizaldi et al.,2023; Arisanto et al., 2023; Suwarno & Verne, 2019; Pusat Riset Kelautan, 2017; Prasetyo et al., 2019).

Considering this unique and diverse geographical location, Indonesia's coastline is categorized into three components: the coastal hinterland, the coastal area, and the offshore zone (Kusuma-Atmadja & Purwaka, 1996). The coastline itself is a geomorphological feature that is highly dynamic and susceptible to change, whether caused by natural processes or human activities. These changes directly impact the management of coastal areas and the sustainability of existing resources, with factors such as coastal infrastructure development, estuarine river flows, and sea depth influencing patterns of coastal erosion and accretion (Purwanti & Koestoer, 2024; Prasita et al., 2023; Suryanti et al., 2025).

The analysis of coastline changes in the Semarang coastal area during the period 2001–2021 indicates that erosion occurred at an average rate of approximately 10.31 m/year, while accretion proceeded more intensively, reaching around 20.95 m/year. Projections for changes up to 2041 suggest that the rate of erosion will slightly decrease to 10.15 m/year, whereas accretion is expected to remain around 19.69 m/year, implying that although the rate of change tends to be stable compared to the previous two decades, coastal dynamics remain significant (Amalia et al., 2023; Parman, 2010; Aniendra et al., 2019).

The diverse interactions and activities occurring in coastal areas often lead to environmental degradation and ecological damage. This degradation is worsen by

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climate change, which makes coastal regions increasingly vulnerable to environmental disasters (Handiani et al., 2022; Husnayaen et al., 2018; Paputungan et al., 2024; Roukounis & Tsihrintzis, 2022; Bukvic et al., 2020; Azuga, 2021; Wood, 2023).

Demak Regency, the practice of open waste burning releases substantial amounts of greenhouse gases, such as CO_2, CH_4, and N_2O, contributing to climate change (Zaman et al., 2024). Advanced environmental monitoring technologies, like Al- and F-doped tin oxide thin films, have the potential to track these emissions in real time (Susilawati et al., 2015).

Combining local waste management initiatives with such sensor technology could provide accurate air quality data, enhancing efforts for climate change mitigation and adaptation. As climate vulnerability in coastal regions is expected to increase in the coming years, the need for information on adaptation strategies (Ferrol et al., 2015), and resilience against coastal disaster risks continues to grow (Bukvic et al., 2020; Handayani et al., 2020; Purnaweni et al., 2018), This situation is also occurring in one of the northern coastal regions of Java Island, namely Demak Regency (Sarasadi & Rudiarto, 2021).

Demak Regency is one of the districts in Central Java that has experienced severe coastal abrasion over the past 20 years (Yuliani & Rejeki, 2020), the coastal soil structure in Demak, which largely consists of mud deposits and swamps, likely accelerates the rate of land subsidence. Recent studies show that abrasion in the coastal areas of Sayung District has increased to 262.74 hectares (Irsadi et al., 2022; Ramadhani et al., 2021).

The projected tidal sea level for 2025, previously estimated to reach 1.63 meters, has now become a reality faced by students in Demak. This condition has resulted in areas at risk of flooding and tidal inundation (rob) reaching 57% of the total area of Demak Regency (Suryanti & Marfai, 2016).

Coastal morphology is strongly affected by long-term sea level rise and hydrodynamic variations driven by climate change. Rising sea levels accelerate erosion and alter sediment distribution along the coast, while changes in rainfall patterns and currents can modify sediment input into estuarine systems, ultimately reflected in measurable shifts in the shoreline (Surbakti et al., 2025). These significant changes have affected social life, health, the economy, and education.

Recent studies in the coastal areas of Demak, particularly in Sayung, indicate that physical environmental changes caused by coastal abrasion, tidal flooding (rob), and land subsidence have resulted in significant infrastructure damage—including roads, public facilities, and educational institutions—disrupting the learning environment, reducing accessibility, and affecting the socio-economic activities of local communities (Ayyam et al., 2019; Beecham, 2020; Wicaksono et al., 2022; Kusuma et al., 2017; Susanto, et al., 2024).

Indirectly, climate disasters may cause trauma that affects students' mental health. Post-Traumatic Stress Disorder (PTSD), anxiety, depression (Clayton et al., 2023) and insomnia (Rifkin et al., 2018) are among the mental health issues associated with climate disaster events. Physical disasters such as tidal flooding not only damage school buildings and learning infrastructure but also hinder students' mobility to school, prolong travel time, and increase safety risks, ultimately creating unstable and uncertain learning conditions. Repeated exposure to such disrupted environmental conditions has the potential to become a source of chronic stress for students, particularly in coastal areas experiencing continuous disasters.

This situation has a significant impact on students' psychological well-being. Several studies have found that climate change can cause feelings of pressure or stress among adolescents. These studies also indicate that the phenomenon triggers symptoms of anxiety and affects the mental health of young individuals, as evidenced by the use of the climate anxiety scale in the Indonesian context, highlighting the emotional and psychological consequences of climate change for the youth population (Cavalcante et al., 2023; Lutsko, 2021; Rachmayani et al., 2025; Jaro & Saffana 2023; Ernyasih et al., 2023) are more susceptible to a decline in learning motivation & resilience (Wood, 2023).

This impact not only affects academic achievement but can also disrupt students' social and emotional development, which is crucial for shaping their future character. This condition requires psychological resilience among the younger generation, especially in the education sector. Students must be able to manage stress through resilience. Resilience is the ability of students to adapt, recover from adversity, pressure, and difficulties in academic, social, emotional, and environmental contexts. In learning activities, resilience and learning motivation are closely associated with mental health impacts resulting from climate-related disasters (Gawrych, 2022; Gu et al., 2022; Maaruf et al., 2023; Wu et al., 2020). In context, Indonesia has cultural diversity, unique geographical conditions, and natural vulnerability due to natural disasters and social dynamics; therefore, resilience becomes a key aspect that must be instilled from an early age. Students who possess resilience tend to develop a never-give-up attitude, are able to manage stress and emotions, and remain motivated to learn even in difficult situations.

Although numerous studies have examined the impacts of climate change and coastal disasters on environmental degradation, physical vulnerability, and socio-economic conditions, empirical research that

explicitly focuses on students' psychological resilience in disaster-prone coastal areas remains limited, particularly within the context of primary and secondary education in Demak Regency. Existing studies tend to emphasize physical mitigation measures, community-level vulnerability, or general social impacts, while the psychological capacity of students to cope with, adapt to, and recover from continuous disaster-related stressors has received insufficient scholarly attention. This gap is especially critical in regions exposed to chronic and recurrent climate hazards, where students are required to sustain emotional stability and learning engagement amid persistent uncertainty.

In the context of Demak Regency, previous research has predominantly addressed coastal abrasion, land subsidence, and tidal flooding, with very limited exploration of how prolonged environmental instability shapes students' mental well-being, stress regulation, and adaptive functioning. Psychological resilience in this setting is not merely related to academic performance, but rather to students' ability to manage fear, anxiety, and disruption so that learning processes can continue effectively both at school and in non-school settings such as home or temporary learning environments.

Moreover, there is a lack of integrated and context-specific studies that comprehensively identify individual, familial, school-related, and social environmental factors influencing students' psychological resilience in disaster-affected coastal areas. Addressing these gaps, the present study offers novelty by providing empirical evidence on students' psychological resilience in a highly vulnerable coastal region through an integrative framework that bridges climate disaster studies, educational psychology, and resilience theory. This research contributes to the literature by advancing a contextualized understanding of how students maintain psychological stability and learning continuity under sustained climate-related stress, and by informing the development of disaster-adaptive educational policies and targeted psychosocial interventions for coastal communities.

Method

Research Design

This study employs a mixed-methods research design with a sequential explanatory strategy, in which quantitative analysis is followed by qualitative exploration. Quantitative data were obtained from measuring the valuation of resilience. Qualitative data were collected through interviews and observations.

This research selected 2 sub-districts out of 4 coastal sub-districts in Demak Regency. The selection of these two sub-districts was done purposively, considering differences in coastal characteristics (levels of tidal flood vulnerability, ecosystem degradation, and school condition variations). The two selected sub-districts are Sayung and Bonang.

The ecological differences between the two areas are as follows the first Sayung Sub-district has a high level of abrasion and tidal flooding (rob) and is the most severely affected area in Demak, the second Bonang Sub-district is dominated by fishponds and mangrove forests, but it has a high potential to experience future tidal flooding due to the construction of seawalls. Although conditions in Bonang are relatively more stable, it still faces pressures from climate change. Therefore, these two sub-districts represent a relevant variation of coastal conditions aligned with the objectives of this research.

Population and Samples

The population of this study consists of students at the Senior High School (SMA) and Islamic Senior High School (MA) levels located in the coastal areas of Demak Regency that are affected by climate change. The sampling technique used in this research is proportional stratified random sampling. The determination of samples was based on geographic location variations and different levels of coastal disaster vulnerability among schools.

Although it is possible that not all types of schools are proportionally represented, the selection was carried out by ensuring the representation of diverse ecosystem contexts and relevance to the research objectives. Therefore, the findings of this study possess high transferability, although generalization to other schools with similar characteristics remains limited. Based on the population data and the formula above, Table 1 shows the calculation of the sample distribution of schools per stratum.

Table 1. Research Location and Sample

Distric	Senior High School (SMA)	Islamic Senior High School (MA)	Total
Sayung	2	8	10
Bonang	3	6	9
Total	5	14	19

Table 2. School Sample Distribution per Stratum

District	Type of School	Population	Percentage	Sample Schools
Sayung	SMA	2	10.50%	1
Sayung	MA	8	42.10%	3
Bonang	SMA	3	15.80%	1
Bonang	MA	6	31.60%	3

The details of the sample schools are presented in table 3.

Table 3. Names and Addresses of Sample Schools

No	School Name	Address
Sayung Distric		
1	MA An Nidham	JL. Genuk Pamongan, Km. 05, Sayung, Kalisari, Krajan Utara, Kalisari, Sayung District, Demak Regency, Central Java
2	MA Fathul Huda	Jl. Raya Tambak Bulusan KM 4, Sidorejo Village, Sayung, Demak Regency, Central Java
3	MA Hidayatul Mubtadi'in	Penjor, Bulusari, Sayung District, Demak Regency, Central Java
4	SMA 1 Sayung	Belah, Gemulak, Sayung District, Demak Regency, Central Java
Bonang Distric		
5	MA Miftahul Ulum Weding	Jl. Weding-Demak KM 5, Weding Village, Bonang District, Demak Regency, Central Java
6	MA NU 2 Serangan	Jl. Melayu No. 1, Serangan, Bonang District, Demak Regency, Central Java
7	MAS Matholiul Falah Jali	Jl. Pintu Air No. 1, Jali Bonang, Bonang District, Demak Regency, Central Java
8	SMAS Takhassus Al Qur'an Bonang	Jl. KH Ahmad Nawawi Ali, Suwati, Serangan, Bonang District, Demak Regency, Central Java

The respondents selected for this study were 12th-grade students. The justification for selecting 12th graders is based on the following considerations: 1) They possess more mature cognitive and reflective abilities. 2) Their academic development stage is relevant, as they are preparing to enter higher education or the workforce, making learning motivation and resilience highly relevant to investigate. 3) They have experienced longer exposure to climate conditions throughout their schooling period compared to 10th- and 11th-grade students.

The determination of the minimum number of respondents refers to Green's (1991). Based on Green's formula above, the respondent distribution is assumed to be a minimum of 30 respondents in each school, resulting in a total of approximately 488 students.

Instrument

The instrument used is a Student Resilience Questionnaire. This questionnaire adapts resilience scale instruments from three journal articles, namely the Resilience Scale (RS), the Resilience Scale for Adolescents (READ), and the Connor-Davidson Resilience Scale (CD-RISC). Based on the adaptation from the above articles, three indicators were obtained: psychological (personal strength), social support, and coping and adaptation. These indicators then produced a total of 11 statement items.

Three indicators were identified, namely psychological factors (personal strength), social support, and coping and adaptation. These indicators were operationalized into a total of 11 questionnaire items. Each item represents one of the three indicators, with four items measuring psychological factors (personal strength), three items measuring social support, and four items measuring coping and adaptation.

This measurement prioritizes the representation of core constructs rather than the number of items alone. Although established resilience scales, such as the Connor–Davidson Resilience Scale (CD-RISC), were originally developed with 25 items, this study adopts a concise measurement approach based on key indicators that are relevant to the research context and objectives. The instrument was also validated in several stages. Content validity was assessed through expert judgment, in which the instrument was reviewed to ensure indicator relevance, clarity of wording, and adequate representation of the resilience construct. Subsequently, empirical validity was examined by testing item–total correlations using SPSS to confirm that each item contributed significantly to the measured construct.

In addition, the instrument was deliberately designed to be concise and efficient to avoid excessive length, which in the context of student respondents may reduce concentration, increase response fatigue, and negatively affect the quality and accuracy of responses. Therefore, the use of 11 items in this study is considered sufficient and reliable for measuring student resilience in accordance with the research objectives.

Procedure

The research procedure began with sampling from the population, followed by data collection using the student resilience questionnaire instrument. Before the instrument was used, a content validity test was carried out. The instrument was reviewed by experts (expert judgment). Next, an empirical validity test was conducted, in which the instrument was tested for item-total correlation using SPSS. An item is considered valid if it has a correlation of $r > 0.3$ and $p < 0.05$. A reliability test was also conducted. The instrument was tested using Cronbach's Alpha, and a value greater than 0.7 was considered reliable. This was also carried out in other instrument research regarding validity and reliabilityquitionare testing (Sa'adah & Ikhsan, 2023;

Rokhim et al., 2023; Anggraeni, 2017; Anggis & Wulandari, 2020).

In addition to questionnaire-based data collection, interviews and observations were conducted to deepen and contextualize the quantitative findings. Specifically, the interviews were designed to further explore the categories of student resilience (high, moderate, and low) identified through the questionnaire results. Teachers and students were purposively selected based on these resilience groupings to capture variations in experiences, coping strategies, and psychological responses to disaster-prone environmental conditions. Observations were employed to strengthen the interview data by examining students' behavioral responses, learning engagement, and adaptive practices within classroom and school settings. Through this sequential explanatory approach, qualitative data serve to enrich the interpretation of quantitative patterns and provide a more nuanced understanding of how student resilience manifests in everyday educational contexts.

Data Analysis Techniques

The categorization of student resilience levels was carried out using an empirical distribution technique. The resilience scores obtained from 488 respondents were sorted from the highest to the lowest, then divided into three categories—high, medium, and low—based on the actual distribution of data in the field. This technique was used to objectively describe student resilience conditions according to the score distribution found in the research population.

The categorization of resilience levels was determined by dividing the respondent scores into three groups: low, medium, and high. This approach refers to Azwar (2019) and Sugiyono (2017), who state that category formation can be conducted based on the empirical distribution of actual data. According to Azwar, score categorization functions to group or place test or measurement scores into certain categories, thereby facilitating the interpretation and understanding of the data.

Table 4. Score Categorization Formula

Categorization	Score Criteria
Low	$X < (\mu - 1\sigma)$
Medium	$(\mu - 1\sigma) \leq X \leq (\mu + 1\sigma)$
High	$X > (\mu + 1\sigma)$

X = individual/respondent score; μ = mean score of all respondents; σ = standard deviation of the scores

Result and Discussion

The research results present the percentage of student resilience in each category.

Table 5. Percentage of Student Resilience in Each Category

Resilience	Respondent	Score
Low	136	28%
Medium	241	49%
High	111	23%
Total	488	100%

Based on the calculation results above, the average resilience score for each school and village was then calculated, as shown in Table 6.

Table 6. Average Resilience

School Name	District	Average resilience
MA An-Nidham	Sayung	36.20
MA Fathul Huda	Sayung	36.30
MA Hidayatul Mubtadi'in	Sayung	33.60
SMA N 1 Sayung	Sayung	33.10
MA Miftahul Ulum	Bonang	34.30
MA NU 2 Serangan	Bonang	34.50
MA Matholiul Falah Jali	Bonang	37.20
SMA Takhassus Al Qur'an	Bonang	33.80

Based on the results of the student resilience questionnaire data processing, it was found that most students, namely 241 students (49%), fall into the moderate category, so students are in the "Survival" phase (surviving out of necessity) but have not yet reached the "Thriving" phase (thriving amidst disaster). Meanwhile, 136 students (28%) are in the low category, and 111 students (23%) are in the high category.

Therefore, it can be concluded that the resilience of students in the coastal areas of Demak Regency is classified as moderate. This indicates that most students have been able to adjust to environmental conditions affected by climate-related phenomena such as tidal flooding, coastal abrasion, and extreme weather. However, their ability to fully adapt and recover from pressure is not yet strong.

A moderate level of resilience means that students already possess several positive aspects, such as the ability to persist and continue schooling despite unfavorable environmental conditions, the presence of social support from family and school, and an optimistic outlook toward the future. However, this still needs to be strengthened in other aspects, such as self-confidence, stress management skills, and problem-solving abilities in facing unpredictable environmental challenges.

These results are consistent with ecological and psychological resilience theories (Masten, 2024; Ungar, 2024), which state that resilience is the outcome of interactions between individual, social, and environmental factors. Students living in coastal areas prone to climate disruptions tend to develop adaptive resilience gradually, depending on the support they

receive from the education system and surrounding community.

In the context of Demak Regency, ecological challenges such as coastal abrasion, seawater intrusion, and declining family economic productivity can potentially affect students' psychological stability. Therefore, the "moderate" category can be interpreted as a form of partial adaptive resilience, in which students have begun to adjust but still require reinforcement from their social environment and educational institutions.

Based on the calculation of the average resilience scores of students in the eight schools studied, the highest mean resilience score was found at MA Matholiul Falah Jali (37.2), while the lowest was recorded at SMA N 1 Sayung (33.1). Overall, all average scores fall within the moderate category, with a score range of 33.1 to 37.2. This indicates that the level of student resilience is relatively stable across schools, with only minor variations.

Differences in average resilience scores between schools can be interpreted as the influence of socio-ecological conditions and educational support in each area. For example, schools such as MA Matholiul Falah Jali (Jali) and MA Fathul Huda (Jetaksari) have higher resilience scores. This may be linked to social stability and strong community support in coping with the impacts of climate change. Meanwhile, schools located in areas with high risk of tidal flooding (rob) and abrasion, such as SMA N 1 Sayung (Gemulak), tend to have lower resilience scores. Fluctuating environmental conditions can create ecological stress, potentially affecting students' psychological well-being and adaptive capacity. This finding is reinforced by interviews with teachers at SMA N 1 Sayung. One teacher explained:

"Tidal flooding often blocks road access and causes severe traffic congestion. As a result, many students arrive late, feel physically exhausted, and show decreased motivation and concentration during lessons" (T1, interview, July 2025).

Figure 1. Interview teacher

According to the theory of environmental resilience and psychological resilience Masten (2024), Ungar (2024), Ginting et al. (2023), an individual's ability to adapt to environmental changes is influenced by ecological, social, and institutional factors. In this context, research findings indicate that schools with more stable ecological conditions tend to have students with higher levels of resilience, whereas schools located in areas with greater exposure to climate-related risks (e.g., tidal floods and land subsidence) show slightly lower resilience, although still within the moderate category. This suggests an indirect relationship between ecological conditions and students' psychological resilience, which can be strengthened through educational interventions and social support from schools. Previous studies have emphasized that environmental literacy, school ecological conditions, and students' readiness to face ecological issues are important factors in determining how students respond to environmental changes, particularly when school ecological conditions support learning focused on environmental issues (Amin & Maritasari, 2023; Ginting et al., 2023). Furthermore, differences in students' environmental awareness are observed between schools that implement environmental programs and those that do not, indicating that the social context and school policies also play a role in shaping students' pro-environmental behavior (Larashati, 2022; Putri et al., 2025).

Conclusion

The descriptive analysis results show that student resilience is in the moderate category, with a distribution of 49% in the moderate category, 28% in the low category, and 23% in the high category. This indicates that most students have fairly good adaptive abilities in facing climate change but still require support to strengthen their psychological and social capacity. Differences in resilience levels between schools are also influenced by environmental conditions and the socio-ecological stability of each area. Schools with more stable environmental conditions show higher resilience scores compared to schools that are frequently affected by tidal flooding (rob) or coastal abrasion.

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Author Contributions

The authors are divided into advisors and executors. Conceptualization, I.K.N. and IWS; methodology, I.K.N.,

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Conflicts of Interest
The authors declare no conflict of interest in this research.

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