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MORALITY BEFORE KNOWLEDGE

School participation in environmental awareness and flood disaster mitigation: A literature review

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ABSTRACT

Background: Jakarta's sinking has become a major environmental issue over the past two decades, since the year 2000. Various perspectives on the causes of Jakarta's sinking risk have emerged, including land subsidence, sea level rise, and reduced public environmental awareness. This issue has particularly affected the capital city in recent years, especially North Jakarta, an area bordering the northern coast of the Java Sea. This situation affects communities, especially children as the inheritors of the environment. Therefore, it is important to understand the forms and roles of school participation in increasing environmental awareness and supporting flood disaster mitigation, as well as the factors that support and hinder school involvement in addressing flood disasters. **Methods:** Literature was collected using keywords such as "Jakarta sinking", "North Jakarta floods", "school participation", and "sustainable environment" in various combinations through online academic sources. Three main thematic areas were identified and reviewed: (1) forms of school participation in environmental issues; (2) supporting and inhibiting factors for school participation; and (3) the implementation of schools' roles in sustainable environmental management. **Findings:** The analysis was conducted using four indicators of school participation in environmental issues based on Cohen and Uphoff's community participation theory: participation in decision-making, program implementation, monitoring and evaluation, and utilization of results. The review indicates that school participation can contribute to environmental awareness and community responses to flood-related risks. **Conclusion:** This literature review demonstrates the relationship between community understanding of environmental issues and flood-related risks, highlighting the role of schools in supporting environmental awareness and disaster mitigation. **Novelty/Originality of this article:** This study integrates school participation, environmental education programs, and their practices to identify appropriate environmental and flood mitigation efforts at the community level.

KEYWORDS: Jakarta sinking; participant planning; school.

1. Introduction

The phenomenon of Jakarta's sinking has become a serious issue in the last decade, following the recurring major flooding events that have severely impacted the city in recent years. The geographic location of Jakarta and its surrounding areas is primarily situated on the northern coast of the Java Sea (Raeihan, 2022). Special Capital Region of Jakarta/*Daerah Khusus Ibukota Jakarta* (DKI Jakarta) faces a high potential for flood disasters and other hydrometeorological hazards (Taryana et al., 2022). One of the primary factors contributing to the possibility of Jakarta's sinking is climate change, which has led to a continuous rise in sea levels (Nur et al., 2024). Several studies indicate that land subsidence, rising sea levels,

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and the lack of environmental awareness among the public are the main drivers accelerating the city's sinking risk. A modeling study conducted by Bennett et al. (2023) predicts that the combined effects of land subsidence and rising sea levels due to climate change will lead to widespread inundation of Jakarta's territory by the end of this century.

According to the 2024 Indonesian disaster data and information/*data informasi bencana Indonesia* (DIBI), the most frequent disasters in DKI Jakarta Province are flooding and extreme weather events. These disasters are primarily triggered by climate change and rapid urban development. Flooding occurs when the discharge of river water exceeds normal levels due to continuous rainfall upstream or in a specific location, overwhelming the river's capacity to contain the water, leading to overflow and inundation of surrounding areas (Ningrum & Ginting, 2020). Based on the 2024 Indonesian disaster risk index/*indeks risiko bencana Indonesia* (IRBI), DKI Jakarta has a moderate risk index with a value of 59.29, with the highest percentages observed in East Jakarta and North Jakarta. An analysis of land subsidence in DKI Jakarta published in the Journal of Science and Physics Innovation Vol. 2, No. 2, using the differential interferometric synthetic aperture radar (DInSAR) method, shows that between 2016 and 2017, North Jakarta experienced the highest land subsidence rate, averaging 8.2 cm per year. Another study further indicates that North Jakarta ranks as the highest-risk area for flooding in Southeast Asia.

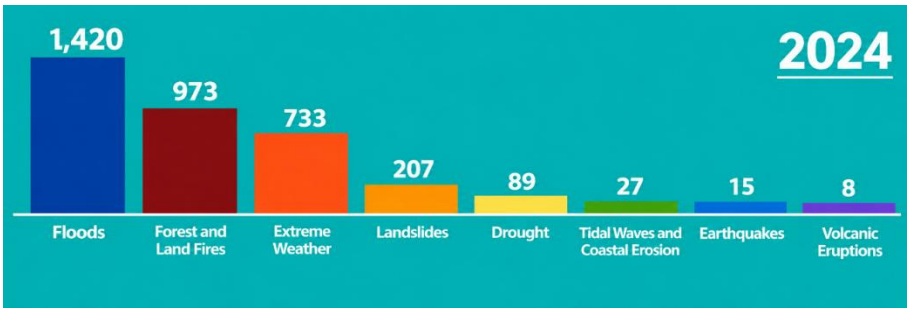


Fig. 1. Data on the number of disasters that occurred in Indonesia in 2024

According to data from the National Disaster Management Agency/*Badan Nasional Penanggulangan Bencana* (BNPB) in 2024, floods remain the most frequent type of disaster in Indonesia, with the highest ratio of disaster-related casualties. Flood disasters encompass three key aspects; first, the occurrence of an event or disturbance that poses a threat and causes damage; second, the event or disturbance endangers the lives, livelihoods, and functions of communities; and third, the threat results in casualties and exceeds the community's capacity to cope using their own resources (Isa, 2016; Fahreza et al., 2024). Flooding in the capital region not only causes economic and infrastructural losses but also leads to significant social impacts. Among these is the deterioration of public health due to an increased risk of skin diseases caused by prolonged exposure to floodwaters (Lekatompessy et al., 2023). In addition, displacement and disruption of community life have long-term implications for future generations. Therefore, one of the government's key priorities in flood prevention, disaster mitigation, and sustainability efforts is the integration of climate change adaptation measures into policy frameworks, alongside the enhancement of environmental education (EE) and public awareness, both of which are embedded within Indonesia's sustainable development goals (SDGs).

Data released by the United Nations International Strategy for Disaster Reduction (UNISDR) indicates that approximately 60% of children worldwide are victims of natural disasters. This issue is particularly concerning, as in the next 10–20 years, the long-term impacts of disasters are expected to affect children's physical and psychological well-being. The long-term success of disaster prevention and mitigation efforts does not rely solely on physical infrastructure but also on community awareness and participation, including that of schools, which play a vital role as trusted institutions in promoting environmental education among communities, particularly the younger generation. Disaster data from several regions reveal that a significant number of victims are school-aged children,

whether at school or in surrounding areas, highlighting the urgent need to introduce disaster awareness and risk reduction education from an early age (Humsona et al., 2019; Fauzi & Handayani, 2021). The government, therefore, must consider disaster mitigation strategies that ensure the continuity of education for students. Schools, as formal institutions, are believed to be spaces where learners develop character and maturity as social beings capable of interacting responsibly with their environment (Risdo & Dorlan, 2023). The urgency of disaster preparedness is also the responsibility of schools as educational institutions that emerge from and serve the community. Disaster preparedness education should begin at a very young age (Al-Nashr, 2018). Schools have implemented various programs to support this, such as Project-Based Learning models, the *Adiwiyata* environmental education program, and the disaster-prepared school (*Sekolah Siaga Bencana*) initiative. Environmental awareness learning programs are also among the eighteen character values formulated by the research and development agency of the Indonesian Ministry of National Education. Environmental care (*peduli lingkungan*) refers to attitudes and actions that aim to prevent environmental damage and to develop initiatives that restore and preserve nature (Hayati & Wildah, 2021).

Although previous studies have extensively examined Jakarta's land subsidence, flooding, climate-related risks, and disaster mitigation, most of the existing literature has focused on physical, environmental, infrastructural, and policy aspects. Meanwhile, studies concerning schools have primarily emphasized environmental education, disaster preparedness, and the development of environmental awareness among students. However, the existing literature has not sufficiently synthesized the forms and roles of school participation in planning and implementing responses to sinking issues in North Jakarta. Furthermore, limited attention has been given to the factors that support or constrain school participation in addressing these environmental and disaster-related challenges. Therefore, a literature review is needed to synthesize the existing evidence on school participation, its roles, and the supporting and inhibiting factors in addressing Jakarta's sinking and flood-related issues in North Jakarta.

To address this gap, this study is guided by two main research questions; (1) what are the forms and roles of school participation in efforts to raise environmental awareness and prevent Jakarta from sinking? and (2) what factors support and hinder school involvement in addressing the flood disaster issues in North Jakarta? In addition, this study explores how schools implement their roles in contributing to sustainable environmental participation. Aligned with these research questions, the objectives of this study are twofold: first, to identify the forms and roles of school participation in efforts to prevent Jakarta from sinking; and second, to identify the supporting and inhibiting factors that influence school involvement in flood-related issues in North Jakarta.

To analyze these questions, this literature review is grounded in the theory of participation, which encompasses involvement in decision-making, implementation, and utilization of outcomes. It is also anchored in the concept of environmental education, which aims to foster awareness, knowledge, attitudes, and skills for environmental preservation. According to Cohen and Uphoff's participation theory, community participation consists of four key indicators; participation in decision-making, participation in program implementation, participation in monitoring and evaluation, and participation in the utilization of results. These indicators serve as the analytical framework for examining the role of schools in promoting sustainable environmental engagement and disaster preparedness within the context of Jakarta's environmental challenges.

2. Methods

This study employs a qualitative approach. Qualitative research is conducted to describe and analyze social phenomena, attitudes, and perceptions, both at the individual and group levels (Ansori, 2020). The method used in this study is a library research method. Library research involves the systematic collection of research data from written documents such as books, scientific journals, magazines, newspapers, and official

institutional reports (Sari, 2020). Through this method, the study seeks to describe and analyze existing phenomena related to environmental awareness, school participation, and disaster prevention efforts, whether these phenomena are occurring in the present or have occurred in the past.

The research data were obtained through a literature study without the need for fieldwork. A literature review is considered capable of providing answers to social issues, as it synthesizes findings from previous research conducted by other scholars (Robby et al., 2022). Based on the study conducted by Kalantari et al. (2020), which employed a systematic literature review (SLR) method, the following steps were adopted as part of the SLR approach; formulating research question based on review topic; searching and selecting appropriate articles that linked to the research questions; analysing and synthesizing the literature; and identifying categories and conducting coding based on the theoretical framework.

The first stage involved identifying the data sources. In this study, the researcher utilized online databases, including the Institute of Electrical and Electronics Engineers (IEEE), Springer, ScienceDirect, and Google Scholar. The next stage was determining appropriate search keywords, including Jakarta sinking, North Jakarta flooding, school participation, and sustainable environment. This article highlights the issue of land subsidence and flooding in North Jakarta and explores the role of community participation through schools, particularly through environmental awareness learning programs, as a preventive and mitigation measure against recurring flood disasters in the region. The researcher initially limited the search to 50 publications published between 2018 and 2025. Inclusion and exclusion criteria were subsequently applied during the screening process. The articles were screened systematically and individually based on their titles, abstracts, introductions, and full-text content. Articles were excluded if they did not meet the predetermined criteria, including those that did not employ a qualitative approach, did not focus on Jakarta, were not research articles, were inaccessible, or were published before 2018. After the initial screening, the remaining articles were subjected to a more detailed eligibility assessment. A duplication check was also conducted to ensure that each selected article represented a unique source. Following the screening, eligibility assessment, and duplication-checking processes, a total of 25 articles met all predetermined inclusion criteria and were included in the final analysis. These articles were subsequently analyzed comprehensively based on the theoretical framework employed in this study.

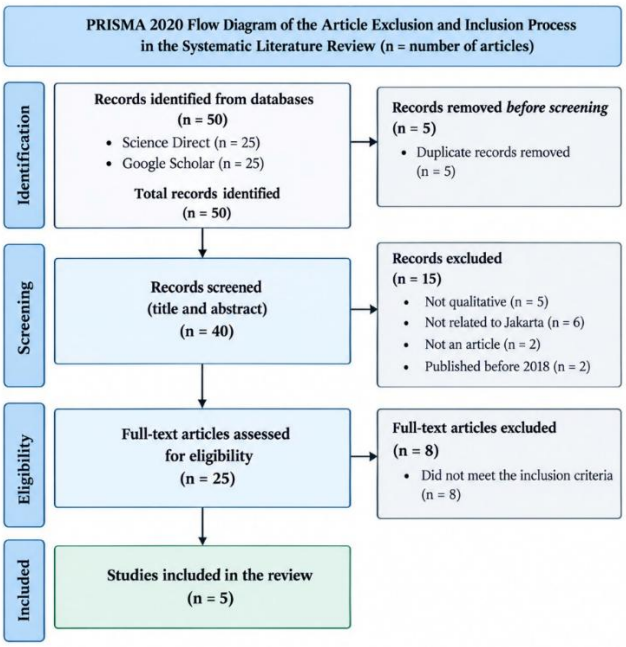


Fig. 2. PRISMA 2020 flow diagram of the article screening, exclusion, and inclusion process in the systematic literature review (n = number of articles) by researcher

3. Results and Discussion

The overall data were obtained from three sources using the following keywords: Jakarta sinking, school participation, and environment. Based on these keywords, the number of data sources retrieved from each platform was as follows: 25 from Google Scholar and 25 from the ScienceDirect database, resulting in a total of 50 sources. The collected data were then categorized into three undergraduate theses and dissertations, 18 journal articles, and two articles. In cases where duplication was identified across the three databases, particularly between theses and journal articles, the duplicate data were excluded from the final count. All data presented in Table 1 consist of undergraduate theses/dissertations and scientific articles published in various academic journals. The total number of scholarly articles identified through the applied criteria was 18. No relevant articles were found for the year 2017 or 2025; therefore, the research data used in this study cover publications from 2018 to 2024 only.

Table 1. School participant planning of Jakarta sinking issues

No.	Researcher and year published	Result
1.	Dahlia & Fadiarman (2020)	The result shows, based on the school vulnerability assessment of flooding shows that there are 8 non-vulnerable schools, 22 with low vulnerability schools, 16 medium vulnerability schools, and 4 high vulnerability schools. Based on an analysis of school risks to flooding, there are 10 low risk schools, 27 moderate risk schools, and 13 high risk schools. The analysis results were identified as being consistent between the highest areas of vulnerability and risk, namely the North and West Jakarta areas.
2.	Fauzi & Handayani (2021)	The findings of this study indicate that disaster mitigation socialization was conducted by the North Jakarta Municipal Regional Disaster Management Agency/*Badan Penanggulangan Bencana Daerah* (BPBD) by providing information on the following topics: (1) types of disasters, (2) disaster mitigation, and (3) evacuation procedures for each type of disaster. The activity was attended by teachers, educational staff, members of the community surrounding the school, and students. Given the importance of disaster preparedness, many participants showed considerable interest and actively paid attention to the information provided. In addition, the implementation of evacuation route planning by participants involved in the community-based disaster preparedness school program was carried out very well. This initiative was further strengthened by the establishment of a school disaster response team.
3.	Al-Nashr (2018)	The findings of this study present the Disaster-Prepared Madrasah/*Madrasah Siaga Bencana (*MSB) as an initiative to strengthen disaster preparedness within madrasahs by raising awareness among all members of the educational institution, both individually and collectively, before, during, and after a disaster occurs. Furthermore, the study identifies an integrated disaster preparedness learning model that incorporates disaster preparedness concepts into all subject areas. This approach aims to develop students' disaster preparedness awareness and character effectively. Thus, each subject taught in the

		classroom also incorporates lessons and values related to disaster preparedness.
4.	Suntari (2018)	The results of this study state that all elementary school teachers in the North Jakarta area who are affected by rob water state that they have never provided a simulation to their students regarding the way to deal with flood water. However, 35% of respondents stated that they had received a flood prevention simulation. Simulations that have been given are only intended for adults, not for elementary school-age children. Most teachers have also taught material about disasters, but only a few have specifically discussed rob floods.
5.	Efendi, Nasruddin, & Karani (2022)	The results of this study are illustrated in terms of school participation and infrastructure which are classified as less resilient, while in terms of the knowledge of the learning community at *Madrasah Aliyah Darul Ilmi* it is classified as tough. The data shows that what needs to be done so that school participation in the learning community is resilient to land fire disasters is to improve facilities and infrastructure, as well as provide understanding and education regarding environmentally sound schools and disaster mitigation
Total		Five articles

3.1 The issue of Jakarta sinking city

A senior researcher from the National Research and Innovation Agency/*Badan Riset dan Inovasi Nasional* (BRIN) presented, in a seminar, the results of a simulation on sea level rise and its impact on Jakarta, which showed that approximately 160.4 km^2 (24.3%) of the city would be affected (Assifa, 2021). Each year, the land surface in Jakarta subsides by approximately 10 to 12 centimeters, with the most severe subsidence occurring in the Pluit area of North Jakarta. As stated by the Minister of Public Works and Public Housing/*Pekerjaan Umum dan Perumahan Rakyat* (PUPR), Basuki Hadimuljono, on Tuesday (October 5, 2021).

> "*This happens because Pluit is located near the coastline, and excessive groundwater extraction takes place in the area*." (B.H., Minister of Public Works and Public Housing)

As reported by The New York Times on Thursday (December 21, 2017), the newspaper predicted that Jakarta could sink within the next ten years due to climate change. According to the publication, changing weather patterns have led to rising sea levels in the Java Sea and increasingly extreme weather conditions in Jakarta. In 2017, an abnormal storm event transformed city streets into rivers within a short period of time.

Several researchers have agreed that there is a significant potential for Jakarta, particularly its northern region, to become submerged. Elfitri (2023) predicted that in the coming years, up to 90% of Jakarta could be inundated, especially in the northern areas. In addition, other researchers concurred that the urgency of Jakarta's submergence stems from multiple contributing factors. These include excessive groundwater extraction, large-scale urban development, Jakarta's geographical location near the coast and along 13 rivers, inadequate water catchment areas, and climate change leading to land subsidence. Land subsidence also has serious social implications, such as the deterioration of living standards and environmental quality, including sanitation and public health, in the affected regions (Assifa, 2021). Moreover, the issue of Jakarta's potential submergence cannot be separated from the recurring flood disasters in the capital city. Numerous studies have identified both natural and anthropogenic causes of flooding. Natural factors include rainfall intensity,

erosion and sedimentation, river topography and geophysics, inadequate river and drainage capacity, land subsidence, and damage to flood control infrastructure. Human-induced factors encompass land-use changes, improper waste disposal, the proliferation of informal settlements along riverbanks, and ineffective flood management planning.

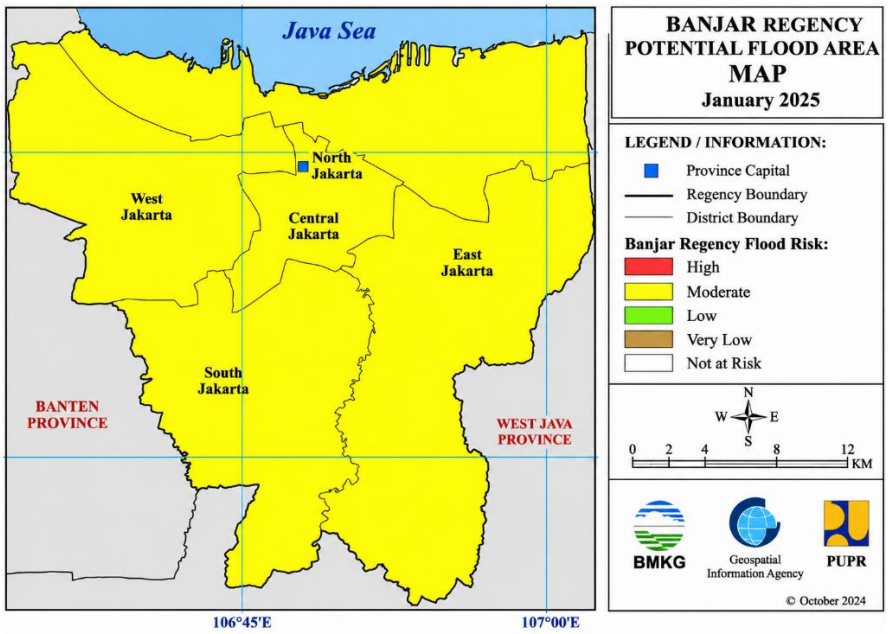


Fig. 3. Forecast of potential flood-prone areas in DKI Jakarta for January 2025

Several researchers have also emphasized that this issue represents not only a local environmental concern but has evolved into a matter of global significance. As noted by the President of the United States, Joe Biden, in his speech at the Office of the Director of National Intelligence on July 27, 2021, it was projected that Jakarta could sink within the next ten years, based on research related to climate change and global warming (Assifa, 2021). In several parts of North Jakarta that are highly susceptible to flooding, the land has subsided by as much as 2.5 meters over the past decade (Lin & Hidayat, 2018). One of the most critically affected areas predicted to experience submergence is Muara Baru. Studies project that Muara Baru could become part of the open sea by 2050, reaching a depth of approximately 4.6 meters if no governmental intervention is undertaken. Moreover, not only Muara Baru but also seven other coastal areas of Jakarta are predicted to be at risk of submergence by 2050. These areas include Kamal Muara, Tanjungan, Pluit, Gunung Sahari, Ancol, Marunda, and Cilincing (Wiryono, 2021).

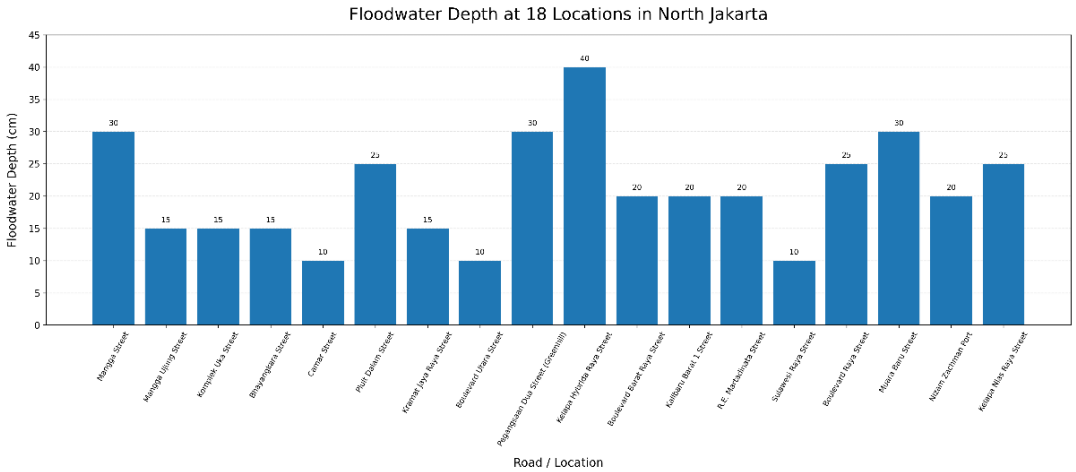


Fig. 4. Flood points in North Jakarta

From Figure 4, it can be observed that there are 18 flood points identified in North Jakarta, with an average inundation depth of 20.8 cm, which falls into the light inundation category. However, several locations, such as Kelapa Hybrida Raya street, experienced water levels reaching 40 cm, classifying them as moderate inundation areas that require serious attention from the government. 18 flood points recorded within a single administrative city, North Jakarta can be categorized as a region with a relatively high concentration of flood occurrences, thus necessitating stronger flood management efforts from local authorities. Among the six districts in North Jakarta, Penjaringan, Pademangan, Tanjung Priok, Koja, Kelapa Gading, and Cilincing, five districts were reported to be affected by flooding. The issue of land subsidence has, in fact, been recognized since the enactment of Regional Regulation of the Special Capital Region of Jakarta Number 10 of 1998, which governs the taxation on groundwater utilization in Jakarta. This regulation was reported to have successfully reduced the rate of groundwater decline from 20 cm per year to approximately 5 cm per year (Wiryono, 2021). In addition, the government has issued specific regulations addressing flood disaster management, namely Governor Regulation of the Special Capital Region of Jakarta Number 13 of 2021 on the Contingency Plan for Flood Disaster Management in the Province of DKI Jakarta (2021).

The urgency of flood disasters cannot be separated from their negative consequences, particularly for communities residing in affected areas. Taryana et al. (2022) highlighted based on the Aqueduct Global Flood Analyzer, that Indonesia ranks as the sixth most flood-affected country in the world. According to Bagus (2024), research shows the impacts of flood disasters encompass significant physical, social, and economic losses. The social impacts include the increasing frequency of coastal flooding (tidal floods or *rob*), disruptions to daily activities, and the deterioration of critical infrastructure that supports community life. These impacts vary depending on local geographical conditions, some regions experience localized flooding due to extreme rainfall, while others suffer from riverine floods originating from upstream areas that inundate low-lying regions. On the other hand, tidal flooding occurs when high sea tides inundate coastal zones, producing similar adverse impacts but with different causal mechanisms (Kurniawan et al., 2024).

Based on the analysis above, Jakarta is not the only city in the world projected to face sinking in the near future due to natural factors that cannot be avoided. However, other contributing factors can be prevented or mitigated through community participation, including active participation within the school community. Such preventive efforts are also necessary through various forms of participation and the involvement of all school stakeholders in different roles to address this important issue.

3.2 The forms of school participation in environmental issues

Hayati (2021) describes participation as a process of voluntary contribution by a community group in decision-making, in which members of the community are emotionally and mentally engaged in achieving goals that aim to improve their overall well-being. Another study by Adisasmita in Sesilia Kristina Kusen (2021), explains that community participation in development includes involvement in both the planning and implementation stages of local development programs or projects. Community participation is therefore regarded as a crucial element in achieving the success and sustainability of development initiatives. Further asserts that participation refers to the conscious involvement of an individual or a community group in an activity. Moreover, several studies indicate that community participation in development can reduce costs, increase efficiency, and enhance the long-term effectiveness of national development. Similarly, Sari (2021) emphasizes that the core principles of participation in community-based activities lie in group effectiveness and efficiency, while Sari also notes that broader benefits can be gained by the government through the implementation of participatory approaches.

In relation to the forms of community participation, refers to the theory of community participation by Cohen and Uphoff, which identifies four key indicators of participation; (1)

participation in decision-making, (2) participation in the implementation of programs, (3) participation in monitoring and evaluation, and (4) participation in the utilization of results. According to Djoeffan (2002), based on various historical insights and experiences in implementing participatory approaches, the role of participation can be formulated into seven essential elements, as follows; (1) community participation forums have the potential to influence planners in creating development policies and plans that align with the needs and capacities of the community. The formulation of development decisions thus becomes more accurate (trustworthy), legally valid, and reliable in practice; (2) community participation ultimately functions as an agent of structural change in political and economic development by prioritizing the interests of grassroots communities. In other words, participation can significantly influence development planners to stimulate social transformation within society and vice versa; (3) participation can enhance the quality of community resources through positive behavioral changes, such as improving work ethic and moral integrity in accordance with legal, social, and religious norms; (4) participation plays a role in fostering comprehensive development planning. The greater the diversity of interests represented through participatory forums, the more innovation will emerge. Furthermore, as decentralization progresses, new ideas can be better integrated, leading to more inclusive and comprehensive development planning; (5) participation contributes to the establishment of objective decision-making bodies. Local development plans will more accurately reflect and align with community aspirations when widely discussed through participatory groups; (6) participation also helps increase public awareness regarding the role of development planning as both a democratic force and a community empowerment mechanism; (7) community participation serves as a means to articulate critical perspectives toward established models of development.

Tri et al. (2024) stated that a community-based approach serves as the key to successful flood mitigation, as the solutions developed are more closely aligned with local needs and can be implemented sustainably. In the context of disasters, local communities are the primary actors and most directly affected populations. Therefore, it is crucial that local residents possess sufficient knowledge to recognize disaster risks in order to reduce potential damage and minimize losses. Several studies emphasize that education remains one of the most effective media for raising public awareness, especially among younger generations, regarding environmental preservation and disaster mitigation. Through learning materials, education plays a central role in reducing disaster risk. According to data from the Central Bureau of Statistics/*Badan Pusat Statistik* (BPS, 2023), the number of one-year-old children in Jakarta reached 457,866 (24.44%), reflecting the significant proportion of the school-age population that can be targeted through environmental education programs. The role of schools as active participants in environmental sustainability is therefore essential and also highlights that schools serve as effective institutions for imparting knowledge on prevention, mitigation, and environmental sustainability to students—knowledge that is expected to be internalized and applied in their daily lives. Furthermore, there is an urgent need for school-based programs designed to strengthen preparedness in preventing environmental degradation and mitigating natural disasters. As emphasized by Ansori et al. (2019), one of the key strategies to enhance disaster preparedness is through capacity building within the school community, which involves students, teachers, and other school components as integral participants in disaster risk reduction efforts.

The forms of school participation in preventing environmental degradation, mitigating flood disasters, and contributing to sustainable development include: The implementation of environment-based curricula, the Adiwiyata school award program, the disaster-prepared school program, and project-based learning models that foster environmental conservation knowledge and awareness. Several key aspects must be considered in the implementation of these programs. The establishment of an environment-based curriculum is carried out by the central government through collaboration between the Ministry of Environment, the Ministry of National Education, the Ministry of Religious Affairs, and the Ministry of Home Affairs. On February 19, 2004, the Environmental Education Policy was

officially adopted as a directive for the implementation and development of environmental education in Indonesia. The environment-based curriculum consists of four main development indicators; 1) development of cross-disciplinary learning models; 2) exploration and integration of local environmental issues and materials from surrounding communities; 3) development of learning methods rooted in environmental and cultural contexts; and 4) development of curricular activities to enhance students' environmental awareness and responsibility. The project-based learning model essentially provides students with opportunities to acquire process-oriented skills and apply them in real-life contexts, creating meaningful learning experiences (Yanti, 2018). However, this model often requires longer durations to complete assigned projects and involves higher costs as well as additional learning resources and equipment. Meanwhile, the disaster-prepared school program/*Sekolah Siaga Bencana* (SSB) requires the fulfillment of four key components; 1) attitudes and actions of all school members; 2) school policies and regulations; 3) school disaster preparedness plans; and 4) availability of disaster-related resources within the school (Dewi, 2019). Each of these programs has distinct objectives and methods of implementation. Schools are encouraged to exercise discretion and contextual judgment in determining which programs best align with their specific needs and characteristics to promote sustainable environmental education. Under the framework of school-based management, each school possesses the autonomy to manage and execute its roles as an essential community institution in fostering environmental stewardship and resilience.

3.3 Supporting and inhibiting factors of school participation

In a brief study, Marhum (2021) stated that several factors influence public participation. First, education, including literacy, needs, social position, and the lack of courage to express opinions, plays a significant role. Second, limited understanding of the state and governance affects citizens' capacity to participate meaningfully. Third, there is often a tendency to misinterpret the inspiration, goals, and interests of community associations, which can lead to misconceptions regarding the intentions and motivations of both the public and government institutions. This misunderstanding, coupled with a lack of open access for citizens to participate in various development programs, limits effective participation. Several studies have also indicated that the increasing number of flood-affected areas in 2020 highlighted the limited capacity of existing drainage infrastructure to cope with extreme weather conditions. Additionally, development planning experiences in Indonesia show that public aspirations have not yet manifested in optimal participation during decision-making processes related to regulations, policies, and government programs. Al-Nashr (2018) similarly argued that, in implementing government programs through education, there are several inhibiting factors affecting school participation in sustainable environmental development and disaster mitigation efforts. These include inadequate school buildings, damaged facilities and infrastructure, and limited school resources, all of which pose potential hazards to the safety of students, teachers, and school staff. Furthermore, other researchers noted that the lack of participatory platforms hinders active community engagement. Without adequate mechanisms for communication, collaboration, and coordination among educational institutions, government agencies, and local communities, the implementation of environmental and disaster mitigation programs tends to be fragmented and less effective.

To foster environmental awareness among students, effective and continuous efforts are required, particularly those related to factors that influence students' environmental knowledge, attitudes, and behaviors. The enhancement of these three aspects can be achieved through the school's role as an institution responsible for providing understanding, raising awareness, and guiding students to develop environmentally conscious attitudes and behaviors. Schools play a crucial role in improving students' environmental literacy through the active involvement of all school components. This includes strengthening teachers' capacity in conducting environmental education and disaster mitigation awareness programs, as well as implementing continuous monitoring

and evaluation of school activities to assess the extent of change occurring across the three domains, particularly in terms of environmental attitudes.

Overall, the reviewed literature indicates that school participation in environmental sustainability and disaster mitigation is shaped by an interplay of individual, institutional, and structural factors. Although schools have considerable potential to strengthen environmental literacy, awareness, and preparedness, limited educational capacity, inadequate infrastructure and resources, restricted access to participatory platforms, and weak communication and coordination among stakeholders continue to constrain meaningful participation. These findings suggest that school participation should not be understood merely as the involvement of students or teachers in program activities, but as a collaborative process that enables all school stakeholders and surrounding communities to contribute to decision-making, implementation, monitoring and evaluation, and the utilization of program outcomes. From a critical perspective, strengthening school participation therefore requires community service initiatives that move beyond short-term awareness-raising toward sustained capacity building, inclusive collaboration, and locally responsive empowerment. Such an approach can position schools as strategic spaces for developing community resilience, strengthening environmental and disaster-related knowledge, and translating participation into sustainable collective action. Thus, the synthesis of the reviewed studies contributes to the development of a more participatory and sustainable model of community service and empowerment, particularly in addressing environmental and disaster risks affecting vulnerable urban communities such as North Jakarta.

3.4 Implementation of the school's role in participation toward environmental sustainability

Based on the primary data from the Ministry of Primary and Secondary Education in the Administrative City of North Jakarta, there are 409 elementary schools and 231 junior high schools. These are distributed across the six districts within North Jakarta. The detailed distribution is as follows.

Table 2. Number of basic education units (primary and secondary) in the administrative city of North Jakarta

Number	District name	Elementary schools	Junior high schools	Total
1	Penjaringan	69	48	117
2	Pademangan	25	15	40
3	Tanjung Priok	95	52	147
4	Koja	71	38	109
5	Kelapa Gading	40	28	68
6	Clincing	109	50	159
	Total	409	231	640

The distribution of these schools provides an important institutional context for strengthening school-based participation in environmental sustainability and disaster mitigation. The results of the 2024 IRBI calculations indicate a declining trend in the risk index, from 156.43 in 2015 to 128.52 in 2024, with an annual reduction rate ranging between 1.17% and 2.82%. This table signifies an increased awareness of disaster risk reduction efforts across regions. One of the most effective ways to raise this awareness is through schools' active participation in disaster mitigation education. In 2024, there has been a noticeable increase in the number of schools implementing disaster mitigation education. This trend aligns with the growing number of schools in the Administrative City of North Jakarta that have adopted environmental education programs. According to data from formal educational institutions committed to environmental awareness and forestry culture, there has been a year-to-year increase in schools in North Jakarta participating in environmentally conscious programs. Specifically, in 2020, there was an addition of one elementary school/*Sekolah Dasar* (SD) and one senior high school/*Sekolah Menengah Atas* (SMA); in 2021, one more elementary school joined the program; in 2022, there was no

increase; while in 2023, one elementary school was added. In 2024, there was a significant rise compared to previous years, with the addition of five elementary schools, one junior high school/*Sekolah Menengah Pertama* (SMP), and three senior high schools. These developments indicate an increasing institutional commitment to integrating environmental awareness and disaster mitigation into school activities. Therefore, it is crucial for the government to strengthen educational initiatives focused on flood prevention and disaster mitigation, particularly for children in disaster-prone areas. These efforts can be effectively carried out through both intracurricular and extracurricular learning programs in schools, enabling schools to serve as strategic spaces for developing environmental awareness and disaster preparedness from an early age.

One form of school implementation as a means of participation in environmental development and disaster mitigation is the SSB. According to Al-Nashr (2018), there are three main aspects that must be present in such schools: safe school facilities, disaster management systems, and education on disaster risk reduction and prevention. The SSB functions as a school-based disaster prevention system by strengthening awareness among all school stakeholders, including through school culture, infrastructure, and the active involvement of the school community before, during, and after a disaster (Utama et al., 2018). Thus, the implementation of SSB demonstrates that school participation extends beyond the provision of information and involves institutional preparedness, collective responsibility, and the development of capacities among school stakeholders. Fauzi et al. (2021) further explained that during the implementation of disaster awareness socialization, participants showed very high enthusiasm. This was influenced by several factors; (1) limited knowledge and understanding of disasters among participants; (2) disaster mitigation socialization being a new experience for them; and (3) the participants' recognition of its crucial importance in disaster situations. Moreover, the role of disaster mitigation socialization provides several benefits, including: (1) enhancing understanding of disaster mitigation; (2) introducing participants to disaster mitigation procedures; and (3) providing knowledge about different types of disasters. Meanwhile, the implementation of the project-based learning model was conducted over six sessions, with each session allocated 2 × 45 minutes (equivalent to two class periods). These findings indicate that participatory and experiential learning approaches can provide opportunities for students and other school stakeholders to develop practical knowledge and preparedness rather than merely receiving theoretical information.

In another study, Tri et al. (2024) emphasized that sustainable development has become a crucial issue that inevitably serves as a cornerstone for both current and future solutions. This concept is closely related to environmental carrying capacity, ecological resilience, spatial planning, land use, public health, as well as economic and social challenges. All of these aspects must function in continuous harmony to ensure long-term sustainability. When synthesized with the findings on school-based disaster mitigation, these dimensions demonstrate that the role of schools extends beyond the delivery of environmental and disaster-related knowledge. Schools can function as community-based institutions that connect education, environmental awareness, disaster preparedness, and collective action. The implementation of SSB, therefore, represents not merely an educational intervention but also a form of participatory community service that strengthens the capacity of students, teachers, parents, and surrounding communities to recognize risks, participate in preparedness activities, and apply mitigation knowledge in their daily environments.

The reviewed literature further indicates that sustainable school participation requires continuous collaboration among school stakeholders, government institutions, and local communities, supported by adequate infrastructure, institutional systems, and capacity-building programs. Such collaboration can transform schools into strategic spaces for community empowerment by fostering environmental literacy, strengthening local resilience, and encouraging collective responsibility for disaster risk reduction. Thus, the contribution of school participation to environmental sustainability lies not only in

increasing awareness but also in building sustainable community capacity and translating knowledge into collective action, particularly in vulnerable areas such as North Jakarta.

3.4.1 Implementation and effectiveness of environmental programs conducted in schools in North Jakarta

Based on several indicators of community participation proposed by Cohen and Uphoff, one key indicator applied in schools is participation in the implementation of established programs. The government, particularly the Ministry of Education, has introduced environmental programs as part of the learning curriculum, aimed at promoting environmental awareness education to reduce environmental degradation and mitigate natural disasters caused by human activities. Efendi et al. (2022) explained that school participation in fostering a disaster-resilient learning community is illustrated through three main pillars of activity; school physical facilities, school management, and the dissemination of disaster-related knowledge. Within the framework of school participation indicators, these include; anticipation and socialization, early warning systems, evacuation routes, training and workshops, and information dissemination. Among these, the highest implementation rate in schools is found in early warning systems and information dissemination. Conversely, the indicators with the lowest implementation rates, each at only 8%, are anticipation and socialization, evacuation route establishment, and training or workshops. On the other hand, Suntari (2018) reported that 94% of teachers had taught disaster-related materials to their students, and 88% of them had specifically taught about tidal flooding (*banjir rob*) and how to anticipate it in their local environments. These findings demonstrate a relatively high level of teacher involvement in disaster-related education. However, most of this educational effort occurred at the elementary school level, with the majority of materials focusing on disasters such as earthquakes, volcanic eruptions, and tsunamis, while flood-related education remained comparatively limited. This finding is particularly relevant to North Jakarta, where coastal and flood-related risks require learning content that is responsive to local environmental conditions.

It can be observed that the implementation of school participation in environmental development and disaster mitigation aligns with the indicators of community participation, particularly in the aspect of participation in decision-making. This is reflected through the application of school-based management, which allows schools to determine the types of environmental programs to be implemented by considering several factors, such as geographical conditions, disaster risks, teacher readiness, learning materials, and the characteristics of school components, particularly the students. Furthermore, participation in the implementation of agreed-upon programs involves executing various environmental initiatives while taking into account both supporting and inhibiting factors that influence school participation. In addition, participation in monitoring and evaluation is essential for assessing the effectiveness of the implemented programs. Continuous monitoring can assess changes in students' environmental knowledge, attitudes, preparedness, and behavior, while evaluation can provide evidence for improving subsequent programs. In this regard, monitoring and evaluation should involve relevant school stakeholders rather than being conducted solely as an administrative requirement. The findings can subsequently inform future planning, resource allocation, and program adaptation. Lastly, participation in the utilization of results refers to the extent to which the knowledge, skills, and outcomes generated through school-based environmental and disaster mitigation programs can be applied by students and other school stakeholders within their families and surrounding communities. The practical application of disaster preparedness knowledge, particularly regarding locally relevant risks such as tidal flooding, represents an important pathway through which school-based participation can extend beyond the school environment. Thus, the effectiveness of environmental programs should not be assessed solely based on the number of programs implemented, but also on their ability to generate meaningful behavioral change, strengthen preparedness, and produce benefits that can be transferred to the wider community.

Overall, the reviewed literature indicates that environmental and disaster mitigation programs in North Jakarta schools have provided an important foundation for strengthening school participation, particularly through teacher-led education, early warning systems, and information dissemination. Nevertheless, implementation remains uneven, especially in areas requiring active participation, practical training, anticipation, evacuation preparedness, and continuous capacity building. These findings suggest that strengthening the effectiveness of school-based environmental programs requires an integrated participatory approach in which decision-making, implementation, monitoring and evaluation, and utilization of results are interconnected. Such an approach can transform environmental education from a primarily instructional activity into a sustainable community empowerment mechanism, enabling schools to contribute more effectively to disaster resilience and environmental sustainability in North Jakarta.

Table 3. The role of each participant

Participant	Role	Form	Decision-making	Implementation	Monitoring & evaluation	Utilization of results
School principal	Decision maker/coordinator	Direct & collaborative	Coordinates and ensures implementation of environmental and disaster mitigation programs	Reviews program implementation and school preparedness	Uses evaluation results to improve school programs and preparedness policies	School-based management enables schools to determine programs according to local risks and school conditions.
Teachers	Implementer/educator	Direct	Deliver environmental and disaster mitigation education; conduct socialization and learning activities	Monitor students' knowledge, attitudes, preparedness, and participation	Apply evaluation findings to improve teaching and environmental education	94% of teachers taught disaster-related materials; 88% specifically taught tidal flooding and its anticipation.
Students	Learner/beneficiary/active participant	Direct	Participate in environmental learning, disaster preparedness activities, socialization, and project-based learning	Provide feedback and demonstrate changes in knowledge, attitudes, and preparedness	Apply disaster mitigation knowledge and practices in school, family, and community environments	Students are the primary recipients and users of environmental and disaster mitigation knowledge.
School management/staff	Program implementer/supporting actor	Direct & collaborative	Support facilities, information dissemination, early warning systems, and disaster preparednes	Monitor infrastructure, preparedness systems, and program implementation	Use monitoring results to improve school safety and preparedness	Early warning systems and information dissemination showed relatively high

			s mechanisms			implementation.
Parents	Supporter/community partner	Direct & indirect	Support environmental and disaster preparedness activities beyond school	Provide feedback regarding students' application of knowledge at home	Apply preparedness and environmental practices within households	Represents an important link between school-based learning and community-level application.
School community	Collaborative actor	Collaborative	Participates collectively in environmental programs, disaster preparedness, and school-based activities	Participates in reviewing program effectiveness	Translates program outcomes into collective environmental and preparedness practices	Participation is strongest when environmental education is connected with school culture, facilities, and management.

4. Conclusions

This study demonstrates that community participation through schools plays a crucial role in promoting sustainable environmental development and disaster mitigation in North Jakarta. Schools function not only as educational institutions but also as agents of change in fostering environmental awareness, preparedness, and resilience among future generations. The findings highlight the close relationship between public understanding of environmental risks, human activities contributing to flooding, and the broader challenge of Jakarta's potential submergence. Therefore, strengthening school participation is essential not only for transferring environmental knowledge but also for developing community capacity to address environmental risks through sustained collective action.

The study identifies a gap between the existing implementation of school-based environmental programs and the expected level of meaningful participation and sustainable practices. Although environmental education, SSB, early warning systems, disaster information dissemination, and project-based learning have been implemented, their application remains uneven due to limited infrastructure readiness, inadequate evacuation facilities, insufficient training and workshops, and differences across educational levels. Furthermore, students are often positioned as recipients of environmental knowledge rather than active participants in identifying problems, developing solutions, implementing actions, and evaluating outcomes. Accordingly, school-based initiatives should adopt a more integrated and participatory approach, supported by improved infrastructure, teacher capacity, participatory mechanisms, and continuous monitoring and evaluation, while adapting programs to local environmental risks, particularly flooding and tidal flooding in North Jakarta.

Project-based learning should be strengthened as an action-oriented approach that connects classroom knowledge with real environmental challenges. Students should be encouraged to identify environmental problems, investigate their causes and impacts, formulate context-specific solutions, implement collaborative projects, and evaluate their outcomes. In accordance with Cohen and Uphoff's participation framework, sustainable school participation requires the integration of four dimensions: participation in decision-making, program implementation, monitoring and evaluation, and utilization of results. These processes should actively involve school principals, teachers, students, parents, school committees, government institutions, and surrounding communities according to their respective roles and capacities. Furthermore, project outcomes should extend beyond

the classroom through application within families and local communities, strengthening the relationship between education, collective action, community service, and empowerment.

Ultimately, the sustainability of school-based environmental and disaster mitigation programs depends on continuous government support and the collective commitment of all school stakeholders. Government institutions play an important role in providing policy direction, resources, infrastructure, capacity building, and program evaluation, while schools translate these supports into locally relevant and participatory practices. By integrating environmental education, project-based learning, disaster preparedness, community service, and community empowerment, schools can extend their impact beyond the classroom and contribute to environmentally responsible, disaster-resilient, and empowered communities. In North Jakarta, this participatory school-based approach represents an important pathway toward long-term urban resilience and environmental sustainability.

Author Contribution

Conceptualization, Z.F.P.; Methodology, Z.F.P.; Data Curation, Z.F.P.; Formal Analysis, Z.F.P.; Writing – Original Draft Preparation, Z.F.P.; and Writing – Review & Editing, Z.F.P. The author has read and agreed to the published version of the manuscript.

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During the preparation of this work, the authors used Grammarly to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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