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MORALITY BEFORE KNOWLEDGE

Community adaptation in order to face climate change risk in coastal cities : A review

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ABSTRACT

Background: Coastal cities in Indonesia have various problems dealing with urbanization, population growth, and climate change risk at the same time have pushed many vulnerable residents into the low elevation zone in coastal cities, leave alone with a high exposure to potential hazards and environmental degradation. This condition leads to many interconnected problems between socioeconomic, health, and safety of the people. In order to face those challenges, community adaptation is required. This paper tries to explore community adaptation in several coastal cities in Indonesia so that any challenges and adaptation options can be recognized. **Methods**: This paper uses a literature review approach by Torraco in order to explore community adaptation with considering that this theme is categorized as an emerging theme. Cities selected include small and large coastal cities or regencies, including Jakarta, Cirebon, Demak, Semarang, Bandar Lampung, Padang, Ternate, and Gorontalo. **Findings:** Each coastal cities have its own climate change risk. The community adaptation can be categorized into five types of adaptation: physical infrastructure adaptation, practice and behaviour adaptation, social and cultural adaptation, economic adaptation, and green infrastructure adaptation that is impacted by climate change risk and human factors. Aside from community adaptation, there should be a systematic resolution from the government to address coastal cities' climate-related issues. **Conclusion**: In order to tackle climate change risk issues in coastal cities, a lot of dimensions need to be combined both at the community level and the policy level to have a better community adaptation and resilience. **Novelty/Originality of this article:** The novelty of this paper lies in explicitly exploring community adaptation in both small and large coastal cities or regencies in Indonesia in order to face climate change risk.

KEYWORDS: adaptation strategies; climate change risk; coastal cities; community adaptation; urban resilience.

1. Introduction

Indonesia is a geographically disaster prone area, including earthquakes, tsunamis, floods, landslides, volcanic eruptions, and extreme weather are the occurrences which occur every time, and it put many people's lives at stake and cause many losses (Partini & Hidayaht, 2024). Based on the geoportal disaster database by National Agency for Disaster Countermeasure, BNPB Indonesia, there are 1,287 occurrences of floods, 20 occurrences of earthquakes, 4 occurrences of volcanic eruptions, 1 occurrence of tsunami, 30 occurrences of droughts, 506 occurrences of wildfires, 15 occurrences of tidal floods and abrasion, 539 occurrences of extreme weather, and 188 occurrences of landslides from 1st January 2025 until 15th October 2025 (BNPB, 2025b). This indicates that Indonesia has various types of disasters within a relatively short period of time. Based on the data, there is a strong

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indication that the disaster in Indonesia can mainly be categorized as a hydro-meteorological disaster, by look at disaster occurrences were dominated by floods, landslides, droughts, tidal floods, and extreme weather, despite Indonesia also having a high risk of tectonic and volcanic disasters caused by its geographical position in the ring of fire.

In 2025, floods became the most common disaster that occurred. Chatastopics floods, as one of the hydrometeorological disasters, have become undeniable since they happen because of climate change, that led to high precipitation severity and frequency (Kim et al., 2023). In December 2024, BNPB Indonesia noted that there were 226 occurrences of disasters and 99.12% of it came from hydrometeorological disasters, with 47 deaths, 10,413 injuries, and 842,552 people suffering (BNPB, 2024). The latest record only in September 2025, also noted that there are 176 occurrences of disasters and dominated by hydrometeorological disasters taking place about 96.59% with 34 deaths, 49 injuries, and 8,716 people suffering throughout Indonesia (BNPB, 2025a). Therefore, hydrometeorological disasters cause a great impact on casualties and losses (Ramadhan et al., 2022).

These hydrometeorological disasters are suspected to occur because of human activity factors and global climate change taken place (Tejakusuma et al., 2023), since there has been an increase in the frequency of climate and weather disaster-related events in the last 10 years in Indonesia (Putra et al., 2021b; Tejakusuma et al., 2023). It also confirms by another study, that climate change is also significantly increasing hydrometeorological disaster events (Suratman et al., 2024). In addition, environmental mismanagement and human factors create environmental degradation, which also cause hydrometeorological disasters (Putra et al., 2021b). Hydrometeorological disasters can have a great impact on individual life, such as creating loss of human life, displacements, and economic losses in both agricultural and industrial sectors, along with the destruction of infrastructure, even affect the tourism sector (Aeni & Khoirul Anwar, 2024). This calls attention so that together we should address how climate change and human factors can impact a lot of people's lives, especially in Indonesia.

In general, climate change creates new risks and exacerbates existing risks, leading to ecosystem shift and putting pressure on food production, and increasing catastrophic changes (OECD, 2015). Based on the IPCC (Intergovernmental Panel on Climate Change) sixth Assessment Report, risk in the context of climate change has two definitions: risk can arise from potential impacts of climate changes and it can also arise from human responses to climate change that both can impact livelihoods, economic, social, cultural assets, infrastructure, ecosystems, health, and species (Reisinger et al., 2020). In this study, the use of climate change risk is under the IPCC definition of risk that arises from climate change impact by examining interactions between climate-related disasters with the exposure and vulnerability of the affected community or ecological systems. Within the Indonesia's context, climate change risk impacted in various sectors, including natural sectors such as decreasing forest and biodiversity; economic sectors within urban and agricultural sectors; and community sectors that lead to poverty problems, gender, and health problems (World Bank Group, 2021).

Indonesia is an archipelagic country, the largest at most, that has over 17,000 islands and its coastlines extend for approximately 81,000 kilometers, making it the second place after Canada (Hakimi et al., 2025). The presence of climate change, which heavily exacerbates hydrometeorological disasters, also affects the lives of people in coastal areas, especially coastal cities. Coastal cities hold an important place in global trade networks through the presence of ports and diverse cultural and recreational opportunities (Islam et al., 2025), especially when nearly 40% of the global population lives within 100 kilometers of the coastline area (Monckeberg & Gómez, 2025). Climate change poses a remarkable challenge to all coastline communities around the world through various problems such as rising sea level, storms, and coastal erosion, that threaten many livelihoods, especially in Indonesia, which also faces intensified extreme weather, tropical cyclones, storms, and drought in some areas in Indonesia (Hakimi et al., 2025). Another study also suggests that coastal cities in Indonesia face challenges such as urbanization, population growth, and the

rise of sea level at the same time (Gisevius et al., 2025). In addition, fisherman communities in coastal cities are also impacted by these occurrences and affect their economic resources (Diatmika & Sartika, 2025). Indonesia and its large population that reside in coastal cities are at risk, and it is inevitable to make them vulnerable to climate change impacts (Kamakaula, 2024), and the country's urban poor community is the most vulnerable (World Bank Group, 2021). Coastal cities in the Global South are notable for socio-economic inequality problems along with environmental degradation and climate hazards (Islam et al., 2025), a combination of both climatic and non-climatic factors (Le, 2020), including Indonesia is also faces with multifaceted and interconnected problems in the socio-economic context that add complexity layers in order to survive and adapt (Hakimi et al., 2025).

Based on the World Bank data, there are around 4.7 billion of people who reside in cities by 2024 (World Bank, 2024). Indonesia also projects that by 2035, the percentage of the population that will reside in urban areas based on its own province is estimated to be about 66.6% of the total population (BPS, 2020). Therefore, the coastal city is likely to face the greatest risk of climate impact, especially for vulnerable populations that live in informal settlements (Islam et al., 2025). The growing population in coastal cities is inevitably increasing the use of the land around coastal areas or the Low Elevation Coastal Zone as their human settlement, and will face sea-level rise threats (Lehmkoster, 2017). Sea-level rise is the most prevalent impact of climate change, and the combination of rapid land subsidence attributable to excessive groundwater extraction is the main problem for coastal cities and their communities (Hakimi et al., 2025). Another study in the Global South also mentions that sea level rise is the most urgent problem to consider, since it can lead to massive displacement, permanent flooding, considerable loss of coastal area, and accelerate coastal erosion that can lead to the damage of infrastructure and change the ecosystem (Islam et al., 2025). Indonesia is one of the leading nations in the Global South that has unique problems regarding climate change risk in its coastal areas. Therefore, it's crucial to identify vulnerabilities for each coastal city in Indonesia in order to map the problems and offer solutions to local and national governments, and international institutions.

In this research, the researcher would like to focus on how the community adapts as a solution to face climate change risks. The community in the coastal area is in disadvantage due to climate change risks, and how communities try to adapt to these problems is also essential to reducing vulnerability and improving resilience (Kamakaula, 2024). It is important to note that in order to face climate change risks in coastal areas, all stakeholders, from the government institution to the community level, should be involved, and it is important to recognize that every areas have difference characteristics due to the geographical nature and the community's nature itself that might affect community adaptation style. Many studies in Indonesia's coastal cities and their relation with climate change risks revolve around just big cities such as Jakarta and Semarang that face a concerning sea-level rise. Therefore, it's important to look at various cities. To fill the research gap, this study will focus on combining the community adaptation practice both within small and large coastal cities or regencies in Indonesia, as it has received limited attention in other scholarly work that solely focuses on one big city, in order to discover more adaptation options.

2. Methods

This research uses an integrative literature review approach. The topic related to coastal cities, community adaptation, and climate change risk is an emerging topic. This approach might be suitable, since an integrative literature approach is intended to cover both mature and new or emerging topics in order to diversify knowledge based on the topic selected, as it also continues to develop (Torraco, 2005). Much research has been done on community adaptation in coastal cities, but it does not delve into a details explanation of each city's progress and initiatives throughout Indonesia, especially regarding its community adaptation initiatives. This study will describe the progress of each city, both

small coastal cities or regency and large coastal cities or regency. Therefore, the explanation of the finding will be divided based on the city's progress and initiatives.

2.1 Data collection process and management

Supported by Torraco's guidelines for organizing an integrative literature review, several key criteria must be addressed, including how the literature was selected, what keywords were used in the search process, what criteria were applied to retain or discard the literature, and how the selected studies were reviewed and synthesized (Torraco, 2005). This paper is conducted from early October 2025 until 27th October 2025. The first literature search for this paper is from 11th October to 12th October 2025. This research starts from the BAPPENAS or Ministry of National Development Planning report on The List of Priority Locations & Climate Resilience Actions and searching for the availability practice based research based on each city. All of the literature for this paper was obtained through online library platforms such as Science Direct. In addition, Google Scholar is used with consideration that there are more diverse studies since the study searches for real-world practices of the coastal cities community adaptation throughout Indonesia, so it needs some national articles to be discovered. All articles used are come from reputable journals such as Ocean & Coastal Management, International Journal of Disaster Risk Reduction, and some International Conferences with English language journal articles. Even so, Bahasa Indonesia language journal articles still need to be included due to their high relevance to the topics.

This paper uses some keywords to collect the relevant data, such as "adaptation strategies, climate change risk, coastal cities, community adaptation, and urban resilience" are used in various combinations that are also paired with certain areas of coastal cities. During the literature search process, there are some criteria to be met as part of discarding the literature, such as using papers that were published between 2020-2025. In addition, the researcher also activated the open access button so that the articles can be found and downloaded more easily, while actively curated based on year published and prioritizing English language journal articles. The literature was reviewed first by looking at the title, and then the researcher continued to read the abstract provided. When the abstract is not relevant to the topics, the literature is not going to be used. When the abstract was relevant to the topics, the reading continued to the urgency of the study and its findings. Meanwhile, when the literature was not relevant to the topic and there were some findings that could enrich the discussion, they were included in the discussion, but not for the main articles to be reviewed. After searching at online library databases, the researcher found approximately 105 articles based on the keywords and title. After selecting the suitable research by reading the abstract and finding, there are a total of 12 articles to be reviewed.

After reviewing all the literature based on each city, the community adaptation will be categorized using Biagini's adaptation typology, and allowing the emergent themes to be mentioned where they did not exist in the existing typology. Reviewed 92 adaptation projects on climate change in 70 developing countries using the Global Environment Facility adaptation-funding portfolio, and based on an empirical study developed using the grounded theory (Biagini et al., 2014), making the adaptation typology introduced by Biagini relevant to this study, as Indonesia is also a part of a developing nation, and this research reviews an empirical study of community adaptation in the local context. Offering 10 types of adaptation, Biagini also mentioned that the flexibility of adaptation activities could evolve as a reflection of the situation in each area, which might be different (Biagini et al., 2014), and so the new emergence theme is also stated in this research.

2.2 Location selection process

The location of the study is crucial to decide. This paper combines both small coastal cities or regencies and large coastal cities or regencies as both second-level administrative areas below provinces. All of that considering that both types of coastal cities or regencies

need to be addressed properly, and to examine how communities are trying to adapt. Since every area has its own characteristics. In this paper, we will examine Jakarta, Cirebon, Demak, Semarang, Bandar Lampung, Padang, Ternate, and Gorontalo community adaptation. This choices are based on the availability of data and the BAPPENAS or Ministry of National Development Planning report on The List of Priority Locations & Climate Resilience Actions. All cities mentioned above are a part of the priorities to enhance climate resilience actions in the marine sectors, coastal sectors, water sectors, and agricultural sectors (Ministry of National Development Planning, 2021). Furthermore, disaster events, urban population, and population density that take place in the areas mentioned are also a part of the researcher's consideration. The table below will present the selected cities with diverse information sources based on the BPS database and reports by the CRIC projects.

Table 1. City and Regency main data

City or Regency	Population 2022-2025	Area Km^2	Density/Km^2 2022-2025
Jakarta	10,677,975 *(2025)*	661	15,978 *(2025)*
Cirebon Regency	2,413,810 *(2025)*	1,071.9	2,112 *(2025)*
Demak Regency	1,080,700 *(2023)*	977.7	1,269 *(2023)*
Semarang	1,694,700 *(2023)*	370	4,580 *(2023)*
Bandar Lampung	1,077,664 *(2024)*	183.77	6,609 *(2024)*
Padang	919,145 (2022)	695	4,041 *(2022)*
Ternate	197,010 *(2023)*	159	1,274 *(2023)*
Gorontalo	210,200 *(2025)*	79.59	2,963 *(2025)*

BPS (2022a, 2022b, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2024, 2025a, 2025b); CRIC (2025).

Based on the data above, looking at the population, area, and its density, the researcher uses this as the grounding argument to take a look at each city's progress and initiatives when facing climate change risks. These demographic and spatial characteristics are considered crucial indicators for assessing urban vulnerability, adaptive capacity, and the extent to which local governments prioritize climate resilience in their development planning. Furthermore, variations in population concentration and land availability may influence the scale, urgency, and type of adaptation strategies implemented across cities.

3. Results and Discussion

3.1 Results

Coastal cities have their own problems when it comes to climate change. Climate change creates a vulnerable situation in coastal cities, leading to many disasters, including flooding. With urbanization that requires many land use changes and exacerbates climate change problems, storm surge flooding might increase in coastal cities (Sun et al., 2025). This can cause significant damage to all residents, especially in vulnerable communities. By 2060, around 1,4 billion people are expected to live in the Low Elevation Coastal Zone, with one if the most drastic population increases occurring in Indonesia (Lehmkoster, 2017). Furthermore, Indonesia is ranked at the top third of countries with climate risk that have a high exposure to flooding and extreme heat (World Bank Group, 2021). This climate risk might not only impact in environment, but to many sectors in social, economic, health, and safety. To face those challenges, community adaptation is required. The table below summarizes how communities are trying to adapt both in small coastal cities or regency and large coastal cities or regency in Indonesia.

Table 2. Summary of research studies identified by its location

Name & year	Location	Methods	Risks	Community	Adaptation strategies
Wannewitz, M. & Garschagen, M. (2024)	Jakarta	Qualitative	River flooding, coastal flooding, and resettlement	Local highly vulnerable resident (fisherman, seasonal worker, daily wage laborers)	Relied on their social capital resource, such as family and kin, traditional neighborhood institutions (RT), and CSO-supported groups. In order to do collective action, such as infrastructure adjustment, flood mitigation, and river cleaning.
Adibroto, T. A., Wijayanti, P., Pratama, R. A., Adhi, R. P., Ihsan, I. M., Handika, R., & Musirin, S. D. R. H. (2024).	Jakarta (Cengkareng and Penjaringan districts)	Mix methods	River flooding, sea level rise, and land subsidence	Every household affected	Constructing concrete in front of the door, elevating the first floor, constructing the second floor, safeguarding valuable possessions on the second floor, moving to another house, evacuating stuff outside, floating precious stuff into a plastic basket, wrapping administrative documents, and climbing to the house roof.
Mulyadi, A. (2024)	Cirebon Regency	Qualitative	Rising temperature, coastal flooding, declining primary productivity, which led to debt, and water quality	Fisherman	Livelihood changes to another job, the catching range becomes longer and takes more time, diversification of fishing gear and catches that are worth selling, and building a small dam and increasing the elevation of the house
Suhendra, M. L., & Benardi, A. I. (2025)	Demak Regency (Pantura Road, Sayung District)	Qualitative	Tidal flooding	Local communities	Elevate their house foundation, construct multi-story buildings, rely on government support, and elevate the land around cemeteries each year
Ghani, M. W., & Hidayati, I. (2024)	Demak Regency	Qualitative	Sea-level rise, tidal flooding, land degradation, and displacement	Small-scale fishing community	Create embankments, seek government support, house elevation by abandoning the ground floor, relocate belongings to a higher place, mangrove

					restoration, and permanent migration
Rahman, B., Wicaksono, N. A. B., Kannila, M., & Ridlo, M. A. (2022)	Demak Regency (Sayung district)	Qualitative	Tidal flooding and abrasion	Local communities	Elevate floors and walls, house on stilt, connecting settlement, build taluds at every entrance to residential area, road elevation, build house stage model, elevate house from scratch, build new house in the same location, and permanent migration
Setiyono, H., Handoyo, G., Suryoputro, A. A. D., Rifai, A., Ario, R., & Pratikto, I. (2023)	Semarang City (Genuk District)	Qualitative	Flooding, tidal flooding, and soft ground make buildings to sink.	Local communities (fishermen and small-scale trading)	Elevate the building, raise the floor, and rebuild the building
Ilmi, W. Z., Sunarharum, T. M., Santoso, H., & Prihanto, Y. (2025)	Bandar Lampung City	Qualitative	Risk of diseases and tidal flooding	Local communities	Rely on the government support, strengthen community bonds, and elevate their floors
Maya Riantini, M., Mardiharini, M., Saptana, Sudjarmoko, B., Kasymir, E., Nur'aini, L. G., Anindita, S. H., Syukur, M., Zulham, A., Wardono, B., Ketut Ardana, I., Indrawanto, C., & Wahyudi, A. (2024)	Bandar Lampung and other area	Quantitative	Loss of income due to climate change	Fishermen	Fishing on the coast, expanding fishing areas, doing a side job, making loans, utilizing savings and family members' savings, and relying on government support
Putra, A., Barlian, E., Fatimah, S., Heldi, & Umar, I. (2021a)	Padang City	Qualitative	Ecosystem changes due human or natural factors lead to loss of income	Fishermen	Choose another sector aside from fishing, modify the boat fleet, change it into tourist transportation, rely on ancestral knowledge, rehabilitate and restore the ecosystem by mangrove plantation
Abbas, S., Sahjad, S., Syawal, J., Amin, A. M., & Nurbaya, N. (2023).	Ternate City	Qualitative	Declining water resource, loss of plant vegetation and marine	Local communities	Developing environmentally sensitive mindset, household waste management, and

			habitats, flood and landslides due to volcanic activities, abrasion both in land and coastal area, and high sea waves		organic farming systems.
Putalan, R., Azzahra Sudirman, A., Nusi, F., & Ariany, S. palma. (2025)	Gorontalo	Qualitative	Sea level rise, extreme weather, environmental degradation, and loss of productivity among fishermen	Fishermen	Encourage collective movement, economic diversification by women, and the young generation's roles to help.

Based on the table above, many of the reviewed studies are dominated by qualitative methods in order to discover empirical practice of community adaptation in coastal cities. However, mix methods research and quantitative research also contributed on explaining adaptation strategy even though not dominant as qualitative research, which offer a lot of variety about risks and adaptations strategy to be discovered. We can conclude that each city has its own characteristics about the risks they have to faces and how they are trying to adapt to those risks. Ranging from flood risks, rising temperatures, tidal floods, environmental degradation, and many more. The most dominant risk throughout every city is mainly in sea-level rise, tidal flooding, abrasion, and the loss of productivity or income. Some also show experiencing displacement and resettlement, that add variety of risks that the community has been through. This emphasized that every city has its own problems that need to be solved and it offer a lot of adaptation strategies. The word cloud generated by NVivo12 based on the articles above also shows various significant words.

Fig. 1. Word clouds about significant words based on the articles above

The word clouds show that climate, change, social, adaptation, community, coastal, fishermen, flood, and vulnerability are the repeated words in the articles above. This shows how significant community adaptation and climate change are intertwined, based on the study, especially in the fishermen's communities. Vulnerability is also mentioned, showing

how great the risk is that communities face. Some city names mentioned indicate that Jakarta and Semarang, as coastal cities, were mentioned in many studies, and might have a very serious or significant circumstance that needs to be explored. Therefore, the further explanation for each city will be explored in the next section.

3.2. Each city's progress and initiatives

3.2.1 Jakarta

North Jakarta, as a coastal area, is particularly vulnerable to many disasters, including climate change, coastal erosion, coastal and/or river floods, groundwater salinization, and intensified rainfall (Purnomo et al., 2024). At the same time, Jakarta also has underlying issues such as climate change that are increasing sea-level rise and high precipitation, uncontrolled urbanization development that leads to changes in land use into settlement and subsidence of land, and socio-economic issues contribute to increasing vulnerability of the people (Rahayu et al., 2020). The combination of sea-level rise, land subsidence, and high precipitation is both increasing the risk of river flooding and is a major threat of the coastal area (Adibroto et al., 2024; Nurhidayah & McIlgorm, 2019). Challenges that coastal communities in Jakarta face are already at a disadvantage because of its geographical environment and persistent climate change, those occurrences disrupting their property, income, and result in losses in life (Purnomo et al., 2024). Especially, when coastal flooding and inland flooding occur at the same time, resulting in backwater phenomena that make floodwater unable to flow down, long-term planning is definitely needed to face these occurrences (Rahayu et al., 2020).

North Jakarta as the most vulnerable area that is threatened by sea-level rise, land subsidence, and coastal flooding caused by climate change, which is undergoing rapid change needs to understand the situation of its vulnerable communities in order to adapt (Adibroto et al., 2024). The study in Cengkareng and Penjaringan district explains that 342 households sampled that reside in the area are at risk of river flooding, land subsidence, and sea-level rise, which previous floodings have caused tremendous damage, such as damage to home-based businesses, injuries, evacuation, clean-up costs, and even disturbing daily activities for people unable to go to work or school (Adibroto et al., 2024). Still in the North Jakarta and different districts, the Cilincing district has relatively lower vulnerability to flood, but is more likely to experience higher flood risk in the future caused by slum area settlement that leads to physical and economic vulnerability, and temporary buildings that have a poor resistance to floods (Rahayu et al., 2020). Aside from flooding, there are people who face the risk of resettlement because of the coastal flooding (Wannewitz & Garschagen, 2024). Mia Wannewitz & Matthias Garschagen (2024) study highly vulnerable communities in coastal areas, mentioning that social capital and social identity tied to their surrounding are a crucial aspect in order to adapt. The highly vulnerable people, such as fishermen, seasonal workers, and daily wage workers was relied heavily on their family and kinship connections, followed by traditional neighborhood institutions like RT, and CSO-supported programs as a part of their adaptation strategies in order to face climate change risk (Wannewitz & Garschagen, 2024). As simple as infrastructure adjustment, access to work, and lending some money is performed by family, followed by a traditional neighborhood group that offers mutual support, informal loans, and even collective mitigation activity such as river cleaning (Wannewitz & Garschagen, 2024). Another study also mention that all respondents have many different adaptation strategies, such as constructing concrete in front of the door, elevating the first floor, constructing the second floor, safeguarding valuable possessions on the second floor, moving to another house, evacuating stuff outside, floating precious stuff into a plastic basket, wrapping administrative documents, and climbing to the house roof in order to face flooding (Adibroto et al., 2024). Most of the mitigation action is safeguarding their belonging rather than relocating. This is due to the fear that there is a lack of privacy, overcrowded, and even afraid that there is another individual will take the opportunities to steal their precious belonging that are left

unattended (Adibroto et al., 2024). There are other considerations of not relocating permanently, including the fact that they were afraid it would impact their work and school, since the distance would contribute to that aspect, such as longer commute from home to that place (Adibroto et al., 2024).

Current community initiatives in another study mention that aside from cleaning in waterways to avoid clogging, people also build boat mooring piers to reduce waves that destroy their boats, affecting their work (Purnomo et al., 2024). Despite individual mitigation action, there are a lot of people who still want public mitigation by improving drainage systems, pump capacities, dredging, and widening the river (Adibroto et al., 2024). The government also gives programs and policies, such as the construction of giant sea wall embankments, mangrove planting, adding more Municipal Drinking Water Company services to supply fresh water, river dredging, road elevation, construction of canals, construction of moorings, constructing potable water from rainwater, and direct subsidy in coastal areas in Jakarta (Purnomo et al., 2024). The government program itself is inadequate to fully address these climate change issues that lead to many environmental and socio-economic problems because of a lack of coverage and continuity, even though there are coastal embankment elevation projects that have succeeded in making it into national strategic level projects and acquired funding (Purnomo et al., 2024). With climate change, many respondents in another study also experience layoffs since the company is drowned by tidal flooding, in addition to production loss and fishing income loss (Purnomo et al., 2024). Meanwhile, the government mainly offers policy implementation with hazard-based approaches as an adaptation option rather than a resilience and adaptation approach that attempts to enhance the community resilience and adaptation strategies (Nurhidayah & McIlgorm, 2019). This shows that even though there is support from the government, the gap is still too big to save people from the socio-economic problems caused by climate change. Especially, with limited annual income, they did not have an opportunity to mitigate better, exacerbating their vulnerability to disaster (Purnomo et al., 2024). Based on the legal framework in Indonesia, climate change impacts and adaptations do not have a legal framework, and the issues are controlled under several sectoral legislation, decrees, and sub-legislation (Nurhidayah & McIlgorm, 2019) despite it's a part of human rights that every individual has a right to feel safe from many threats, including environmental threats that affect their daily life. Law No. 24/2007, which talks about disaster management in Indonesia, does not explicitly mention climate change impact and adaptation measurement, so sea level rise and coastal flooding are not categorized as disasters under this legal framework (Nurhidayah & McIlgorm, 2019). For instance, the legal framework regarding climate change impact and adaptation should be addressed in order to enhance the resilience of the vulnerable communities in the coastal areas.

Policies and programs should be based on the understanding of how humans as a community have complex relationships with their environmental systems' vulnerabilities in order to face climate variability and changes that appear to affect their social-economic conditions too (Purnomo et al., 2024). Another study suggests that to face climate change and economic vulnerability, programs that can be offered include an accessible early warning system, embankments, fuel subsidies for fishermen, socialisation about climate change impacts, community capacity building to make local businesses to support their economy, and regulation of fishing gear operations(Purnomo et al., 2024).

3.2.2 Cirebon

The Cirebon coastal areas are in a different situation from Jakarta. While Jakarta's environmental problems revolve around sea-level rise, coastal flooding, and inland flooding, Cirebon coastal areas have two main problems, that is drought caused by rising temperatures in the dry season and high precipitation of rainfall during the rainy season, which lead to floods (CRIC, 2025). Based on the literature reviewed at Gebang, Cirebon Regency, it confirms that fishermen in the coastal areas are at risk of rising temperatures and land subsidence, which leads to a decline in their daily income (Mulyadi, 2024). It is

also supported by another study, that rising sea temperatures and worsening pollution in the sea destroy marine ecosystems as the place which support various fish species (Mahardeka et al., 2025). The rising temperature also affected another area of Cirebon regency, Pegagan Lor Village, which is disturbing the agricultural sector and farmers' life (Pratiwi et al., 2017). Another location in Cirebon city, Kasepuhan Village, is threatened by flood disasters because of its geomorphological area near the downstream, and when there are high-intensity rainfall can lead to flood disasters despite its location near with coastal area (Pratiwi et al., 2017).

Weather change caused by climate change heavily impacted economic sectors in the coastal area in Cirebon (Mahardeka et al., 2025). In addition, human factors such as industrial, household waste, and excess sediment loading from the river pollute the sea waters, making fishermen spend a large amount of money in the fishing capital (Mulyadi, 2024). This also leads to a competition among fishermen that lead to many problems, such as using prohibited fishing gear, overfishing, and even catching protected species (Mulyadi, 2024). Furthermore, prolonged exposure to extreme weather also give a different risk for fishermen for both their safety and potential damage to their fishing gear (Mahardeka et al., 2025). In order to survive, many fishermen also come up with a solution to be in debt to a non-banking institution with high rates of interest (Mulyadi, 2024).

In order to overcome this indirect challenge from climate change and human factors, fishermen in Gebang, Cirebon regency, have a few forms of adaptation, such as changing jobs, increasing the fishing range, diversifying both of fishing gear and catches that are worth selling, building a small dam, and increasing the elevation of the house in order to face tidal flooding (Mulyadi, 2024). Another methods in Kesepuhan village that face floods, the people affected try to elevate their valuable belongings into the second floor or the top of the wardrobe (Pratiwi et al., 2017). In addition, they also put sandbags in front of the door so that water is unable to come in, and have a habit of not throwing garbage into the river (Pratiwi et al., 2017). The areas that face drought, Pegagan Lor Village, Cirebon Regency, have adapted to drought that affects their farms by discussing it with other farmers and women agricultural groups, and try to sell snacks when drought at its peak to increase their incomes (Pratiwi et al., 2017). Meanwhile, at the policy level, the local government institution also has projects, including rainwater harvesting and greywater management, to build resilience in order to face climate change (Pratiwi et al., 2017). Furthermore, in order to face flood disasters, the government just spread awareness about not disposing of household waste out of its place without any relocation policy (Pratiwi et al., 2017). Even though there are many policies and interventions, the risk is still felt by a lot of people. Another study suggests that these occurrences are caused by the lack of coordination between the government institutions, both central and regional, resulting in an overlapping legal framework to save the environment and budget restrictions (Mahardeka et al., 2025). So, it's important to address how community adaptation and needs align with the government programs and policies. Aside from making improvements in infrastructure, improving the community's resilience capacities is also a part of the priority. The budget allocation also needs to be evaluated.

3.2.3 Demak

In the Demak regency, the community in the coastal area is highly impacted by climate change. In Demak, the small-scale fishermen's communities confront sea-level rise as a main threat that causes increasing risk in coastal flooding and erosion (Ghani & Hidayati, 2024). Increased population density might reinforce economic growth and pressure that also comes with a cost, as people who are vulnerable economically will be pushed into the outskirt area of the city and leading to many problems. In Sriwulan Village, Sayung District, Demak regency has experienced tidal flooding resulting from increased development, which is a change of land use function of a large rice field area before, making it into a pond area mixed with ocean (Rahman et al., 2022). In the Sayung district, Pantura Road, as the main transportation corridor to connect major urban areas also impacted by tidal flooding and

disrupts many people's lives (Suhendra & Benardi, 2025). As a continuous and recurring event, tidal flooding disrupts people's commute to the workplace, make people unable to attend on time, and they are trapped in a long traffic jam (Suhendra & Benardi, 2025). There are a lot of people who think that this is common occurrence and not random (Ghani & Hidayati, 2024; Suhendra & Benardi, 2025).

In small-scale fishing communities, people are trying to adapt to the situation in various ways in order to face sea-level rise and tidal flooding. A lot of residents are constructing embankments around their property, elevating their house, abandoning their ground floor, and relocating to a higher place (Ghani & Hidayati, 2024). Some people who face land subsidence and continue sea level rise, they are also seek financial support from the government (Ghani & Hidayati, 2024). Mangrove restoration is also a part of the adaptation process in the Demak Regency coastal area (Ghani & Hidayati, 2024). Another study in the Sayung district also found that the adaptation option is chosen with financial considerations based on their resource (Rahman et al., 2022; Suhendra & Benardi, 2025). There are residents who have a good financial resource, try to elevate their house foundation or build a multi-story building, meanwhile residents who have limited financial resources tend to make a stilt house, and even wait for government support (Suhendra & Benardi, 2025). Another study in Sriwulan village, Sayung District, also mentions that building a house on stilts is due to economic problems, which are cheaper rather than building a house again (Rahman et al., 2022). That study also mentions, people who do not know where to go also decide to stay by elevating their building floors, building walls, and connecting settlements by living close to their relatives (Rahman et al., 2022). The resident whose house is a part of the parents' inheritance tends to build taluds at every entrance to residential alleys to protect the house (Rahman et al., 2022). Meanwhile, as Sriwulan village has an industrial or factory area that is still considered to have potential, make the resident rent out or build rooms or a boarding house to increase their income (Rahman et al., 2022). Another study also mentions that in Sriwulan village, raising valuable items to a higher place as a part of adaptation strategies to face tidal flooding is ineffective, and the effective strategies are to build village embankments, floor elevation, and do back road filling (Rudiarto et al., 2020). Another problem also occurs in the cemeteries. Cemeteries are covered with tidal flooding that damages their physical condition, and people try to elevate the land around the cemeteries collectively each year as a part of the adaptations (Suhendra & Benardi, 2025). In addition, an insightful study obtained in Sayung and Bonang districts also shows that religious leaders, local leaders, and ritual traditions are crucial in order to communicate the risk of the flood through warung or local small restaurants and mosques as a place to discuss (Febriana et al., 2025). Parents also have a crucial role in teaching their children to learn the nature sign and self-evacuate, since this is something they should face in daily life (Febriana et al., 2025). All of this shows that adaptation strategies are focusing on the residents who decided to stay, and they have already built the capacity to cope with this occurrence.

Even so, migration is viewed as a more adaptive approach in order to face sea-level rise, including tidal or coastal floods (Ghani & Hidayati, 2024). Many residents slowly understand the situation they are in, while looking at their surroundings start to sink. They are forced to adapt to the situation; some decide to move to save themselves, some can not move outside their village (Rahman et al., 2022). A lot of small-scale fishing families use adaptive strategies in the village first and temporarily move before they decide to permanently move (Ghani & Hidayati, 2024). There are many factors that should be taken into account when deciding to move. This includes socioeconomic status, accessibility to resources, livelihood opportunities, education, healthcare, potential improvement in quality of life, and when there is a big push factor to move, such as the frequency and severity of flood events and threats (Ghani & Hidayati, 2024). In Sriwulan Village, people decide to move for various kinds of reasons, including they are feeling bored of tidal waves, there are people who are tired of home appliances and electronic damage, and they are looking for economic income elsewhere (Rahman et al., 2022). There are a lot of dilemmas when choosing to permanently migrate, and people who consider this option as a part of an adaptation strategy is vary based on their consideration of the specific destination to settle

and individual circumstances in order for migration to succeed (Rahman et al., 2022). For the government intervention, in the Demak Regency, mostly in infrastructure adjustments, such as pumping systems, installed water barriers, and dredging of sedimentation (Suhendra & Benardi, 2025). This is shows that government institutions should have an integrative approach to make a solution for this complex problem related to the environment and socioeconomic problems by combing both infrastructure adjustment and community resilience using community development approaches in order to tackle this problem.

3.2.4 Semarang

Same with what happened in Demak Regency, Semarang City also faces tidal flooding that is exacerbated by rapid development, such as port constructions, industrial growth, and reclamation, which exacerbates tidal flooding severity (Harini et al., 2016). Industrial growth definitely needs land to place its factories despite its limited sources, resulting in many people being pushed down to live in an uninhabitable area to settle, in this case is coastal area (Setiyono et al., 2023). Impacting negatively on physical, social, and economic aspects, the resident is already familiar with this tidal flooding (Harini et al., 2016). In Genuk District, Semarang City, the residents are experiencing tidal flooding and soft ground that makes the building sink, which leads them in a vulnerable position (Setiyono et al., 2023). As a part of their adaptation, they are already trying to elevate their buildings, rebuild buildings that have come down, and raise the floor (Setiyono et al., 2023). Another study also suggest that in some part of the Semarang coastal city, people build levees in front of the house and made warning system for people to not throw their waste in channel stream and encourage mangrove restoration (Harini et al., 2016). In a different place, Tambak Lorok, also has a different kind of risk other than coastal flooding, which is polluted water that leads to socio-economic problems, since many residents have a high reliance on natural resources like fish to be sold in order to live (Alidrus & Wiyono, 2024). The socioeconomic dimension impacts them in losing income, house damage, and increased vulnerability (Alidrus & Wiyono, 2024).

Another story, in Mangunharjo Village, is the village in Semarang that has successfully overcome tidal flood with the government support in mangrove restoration (Harini et al., 2016). Hence, the resident in Mangunharjo Village are still impacted in social-economic aspects, where the tidal flood caused by sea-level rise affected their fishpond as a source of their livelihoods (Wijayanti & Pratomo, 2016). There are two options that the resident would take in order to survive. There are residents who is still being fishpond farmers catching fish and prawns by restoring their environmental condition, while the other majority choose to change their job by selling their fishpond and shift into industrial laborers, motorcycle taxi drivers, traders, construction workers, and many more (Wijayanti & Pratomo, 2016). Another insight also provides that many communities in the Semarang coastal area tend to have a habit of living in harmony with disasters by thinking that disaster is something that come and go, tidal flood is perceived as something given by God, and thinking that economic loss is still tolerable for them (Harini et al., 2016). This absolutely, also confirms that the religious aspect plays a significant role in how people perceive risks or disasters same goes for the Demak Regency case, where the religious leader also has a significant role in order to communicating and spreading awareness about risks or disasters. In addition, the same goes with the Demak Regency, in Semarang City, the government intervention related to infrastructure adjustment, such as make water barrier walls, pump houses, retention ponds, constructing dikes, and cleaning drainage channels (Setiyono et al., 2023).

3.2.5 Bandar Lampung

Bandar Lampung city has its own condition regarding its coastal areas. In Bandar Lampung, the residents should live with the climate change impacts such as sea-level rise

and tidal flooding. In Kota Karang and Kangkung subdistrict, people also live in waste reclamation, filled with construction debris and waste, with their understanding of the situation(Ilmi et al., 2025). Besides, the resident also hold their life in line, since the environment has poor waste management, decreasing fish catches inevitably leads to loss of income (Ilmi et al., 2025). In another area in Bandar Lampung, many fishermen are also decreasing in income due to climate change (Riantini et al., 2024). This shows that people in coastal areas frequently confront various interconnected problems that come from climate change to disasters to their socioeconomic situation, and human factors that also exacerbate the environmental degradation put their position in a vulnerable situation.

In that situation, the resident along the coast also increase the risk of diseases such as malaria, diarrhea, and dengue fever caused by their polluted environment (Ilmi et al., 2025). In Kota Karang and Kangkung subdistricts, people also relied on government support to stabilize their economy, resulting in there are people who are dependent too much and there are also people also realize that they should become independent because it's much more sustainable (Lubis et al., 2024). The dependency is caused by unsustainable lifestyles, and there are people who try to allocate their money in their children's education or buy a motorcycle in order to increase their income as an online taxi driver, with women also looking for work as a housemaid or selling goods in the market (Ilmi et al., 2025). They do all of that in order to fulfill their needs. Another coastal area shows a different type of adaptation in order to face the indirect impact of climate change on their economic situation. In Bandar Lampung, some fishermen choose to fish on the coast when the weather is not good (Riantini et al., 2024). Decline in fish catches, some fishermen have another stream of income by being Quranic teachers with their wives and children working as laborers, Quran teachers, housemaids, tailors, Posyandu cadres, or selling goods in order to survive and adapt to climate change (Riantini et al., 2024). They also borrow some loans from third parties, or local collector traders called "langan" to cover the cost of declining catches and operating their boat (Riantini et al., 2024). Another insight in order to build resilience in the community is the role of a good leader to make the environment better, and the number of good leaders has decreased in Kota Karang and Kangkung subdistricts, leading to environmental degradation (Ilmi et al., 2025). The same goes with the study in North Jakarta, where some RT might not offer help to some residents (Wannewitz & Garschagen, 2024). In Pesisir Barat, Lampung province, there are also traditional houses called "Lamban Langgakh" which means "stilt house" reflecting an elevated structure of the house using wooden pillars that hold a specific meaning of both cultural identity and ecological adaptation in order to face humid and flood disasters in the area (Herlina et al., 2025). This local wisdom can also be a big help in facing disaster or climate change risk. Besides, this type of house structure or called Rumah Panggung, is also been proven to be effective in facing flood disasters (Herlina et al., 2025). So, in the Bandar Lampung case, we can learn that many adaptations were adopted by the resident in order to face the complex situation from climate change and their environment.

3.2.6 Padang

Padang city is a part of the coastal cities in Indonesia. West Sumatra has a coastline area of approximately 375 km, with Padang city is one of its area (Riviwanto & Basuki, 2019). In West Sumatra, coastal abrasion is the main problem along the coastal fishing settlement, including at Padang city (Bagindo et al., 2023). These occurrences resulting in damage transportation access for the community (Bagindo et al., 2023). Ecosystem changes also occurred in coastal regions caused by coastal abrasion, tidal flooding, and sedimentation, leading to damage to mangrove and coral reef ecosystems that affect fishermen's productivity (Putra et al., 2021a). Another study also mention that West Sumatra experienced a severe abrasion lead to a decline in income for the fishermen community (Bagindo et al., 2023). Another study also mentions that climate change impacts in fishermen's activities include disrupting the time of fishing and capture area, affecting

species availability or fishing gear, loss of productivity, and disturbing aquaculture activities (Riviwanto & Basuki, 2019).

Meanwhile, the fishermen along the coastal areas in Padang City are traditional fishermen who heavily rely on natural resources and the sea conditions (Putraa et al., 2021a). In order to adapt, the fishermen try to diversify their job in another sector. In order to met their needs, many fishermen try to (1) sell foods and beverages on the beach, such as boiled noodles, snacks, and young coconut, that much more profitable with low capital at first since many people own coconut trees (2) providing services such as being a security officer or offering cleaning servies (3) For fishermen who owns boat, they are renting out their boat to take tourist around, offering transportation services when dry season arrive (Putra et al., 2021a). The fisherman's wives also take part to help increase their income in another part of West Sumatra by opening small businesses selling food, selling fish, and helping the fishermen to dry fish (Bagindo et al., 2023). Another study in Padang City also revealed more varied adaptation strategies beyond those previously mentioned to increase income and preserve the environment, such as changing the time of fishing, changing the fish species to be caught, forming women's groups, avoiding burning garbage and disposing of waste into the sea, refraining from cutting trees carelessly, cultivating drought-resistant crops, maintaining clean water resources, and eliminating mosquito breeding sites (Riviwanto & Basuki, 2019). The fishermen also have their own local ecological knowledge passed down through the generations in order to notice nature signs about the best time for fishing, which is still used today (Riviwanto & Basuki, 2019). Based on this local wisdom, the fishermen are also trying to adjust the situation based on natural signs and the moon, but still need to have other skills in order to succeed, since sometimes this local knowledge is not 100% correct all the time with many weather anomalies occurring (Riviwanto & Basuki, 2019). This also highlights that local knowledge has a crucial role in order to adapt in certain areas in coastal cities in Indonesia. This case is the same as in Bandar Lampung, where the people already have prior knowledge about how to navigate themselves in order to survive. But, something that is also important is to combine our local wisdom with a suitable technology so that resilience can be built.

3.2.7 Ternate

Ternate city has it more complex condition regarding disaster. Based on the Indonesia disaster risk index, Ternate City is classified as a moderate risk when it comes to multi-risk disasters (BNPB, 2022) and as climate impact disasters, such as abrasion and extreme waves, are classified as a high risk (BNPB, 2022). Surrounded by the sea and has Gamalama mountain, Ternate is also at high risk of volcanic eruption, earthquake, and tsunami (Putri, 2025). Since climate change progresses slowly rather than natural disasters such as volcanic eruptions, earthquakes, and tsunamis, how the local communities perceive of climate risk also varies and differs. At the moment, information regarding Gamalama Mountain has the highest demand in Ternate City (Purnomo et al., 2021). Therefore, climate change still needs to be addressed. Especially, with the condition of increasing development, give pressure on the urban coastal area (Abbas et al., 2023). This might lead to another problem if it is not addressed properly. In another study, abrasion and landslide are significant problems in the coastal area of Ternate Island (Abbas et al., 2023). Posit as another problem, floods and landslides also frequently occur in Ternate as an aftereffect of cold lava due to Mount Gamalama's eruption (Purnomo et al., 2021). This gives a very complex situation about what is happening in Ternate. The communities might have different perceptions about disasters and climate risk at the same time.

Ternate landslides are exacerbated with beach reclamation, resulting in sea level rise, soil erosion, and abrasion on the beach (Abbas et al., 2023). Beach abrasion also results in damage to homes (Abbas et al., 2023). In Rua Village, Ternate, the resident believes that climate change has occurred with dreadful consequences in their region (Abbas et al., 2023). But another study suggests that high tides and abrasion along the coastline of Ternate are not considered as disasters by the resident due to their unfamiliarity with the climate-

related disaster, and emphasize more on volcanic eruptions as dangerous, followed by floods and landslides (Purnomo et al., 2021). This is related to how climate change progresses slowly, rather than other natural disasters, leading to how people related to climate events differently. However, the resident in Rua Village mentioned that, climate change is perceived by the resident is through weather change events, reduced water resources, contamination of groundwater and seawater, last is sea level rise, that lead to abrasion (Abbas et al., 2023). In line with another study, Ternate faces a great challenge regarding water resources due to decreasing groundwater quantity, increasing population density that needs clean water, and saltwater intrusion (Nagu et al., 2018). Another study suggests that decreasing of water resources is due to the loss of mangrove, nipa, and seagrass vegetation in several areas at Gambesi and Sasa subdistrict (Abbas et al., 2023). Vegetation loss is also happening in some areas due to changes in land function into development areas such as build residental areas, offices, tourist attractions, schools, and steam power plants (Abbas et al., 2023). It can also be noted that environmental damage in Ternate is not only because comes from natural factors, but also because of human factors, whereas the spatial planning in Ternate is not based on its natural reserves (Abbas et al., 2023).

In order to face these challenges, the residents in Rua Village suggested that developing an environmentally sensitive mindset, building awareness through education, maintaining mangrove vegetation, doing household waste management, and organic farming systems are ways to adapt to climate change (Abbas et al., 2023). Another way to adapt can also be by integrating local wisdom in our daily lives. Based on the Ternate case, there are the Fere Kiea and Kololi Kie traditions. Fere Kie and Kololi Kie traditions are traditions that ritualized by the Ternate Ethnic that have a big purpose of preserving how human relationships with nature (Fatah et al., 2024). Fere Kie and Kololi Kie one of the values that need to be held is about the importance of protecting nature, both mountain and sea, and see it as something a part of our life (Fatah et al., 2024). This tradition holds special significance in order to integrate local wisdom and a way to protect nature that also considered an important tradition for people in Ternate. This can occur since the Ternate society holds religious beliefs and local culture very dearly even reflecting on how they are perceive disaster through this lens (Putri, 2025). Aside from this tradition, they have 'barangka' concept in their cosmological interpretation that define there is certain area should be avoid since it can give dangerous situation or give unbalance spiritual energies that lead them to not choose their settlement around this areas, while geographically, areas that considered as barangka are lava flow path from Mountain Gamalama (Putri, 2025). All this also shows that in Ternate, local wisdom holds a very crucial aspect in order to adapt to disasters. Furthermore, when it comes to climate change related disaster, permanent migration to certain areas is possible as a way to adapt and mitigate. But, with the Ternate case, natural disasters such as volcanic eruptions still hold more importance than climate change impact. While eventually there will be a refugee of climate change impact in Ternate, there is no place available to temporarily migrate as a refugee in their surrounding island, except for a disaster such as a volcanic eruption or tsunami (Purnomo et al., 2021).

In conclusion, Ternate still needs a lot of work regarding how to build community resilience and adaptation. The development of the population and various risks of climate impact and natural disasters are increasing the community's vulnerability, so it's mandatory to do things to make an adaptation plan both in community level and policy level. Immature decentralized politics in Ternate make every decision-making process still necessary to improve, since it always seek on external assistance due to fragmented problems present regarding disaster, and there is no reliable authority on climate disaster (Purnomo et al., 2021). It can also be proven from another study that state Ternate establishment is still not consider environmental friendly development policies (Abbas et al., 2023). So, it's important to first have the same definition and the differences between climate change impact disasters and natural disasters, then we can also have different types of planning in adaptation and mitigation. Furthermore, it's important to involves communities perspective and local wisdom into consideration creating the synergy

between the tradition of the people and modernity in order to live alongside with environment.

3.2.8 Gorontalo

In Gorontalo city, people face climate impact. Such as sea level rise, extreme weather, and ecosystem degradation that affect the resident income since it is highly dependent on natural resources such as the fisheries sectors (Putalan et al., 2025). Another study in Bilato District, Gorontalo Regency, also felt the same way that many fishermen are unable to go fishing due to unpredictable weather, changes in fishing season, along with the wind season that disrupts the journey as a part of climate change (Pambudi et al., 2023). In order to face these challenges, the fishermen in Gorontalo City make some adaptation efforts. The adaptation efforts include making a collective movement to help in fixing fishing gear and making a fish catch profit-sharing system (Putalan et al., 2025). Women or fishermen's wives also take a part in economic diversification by processing marine products, trading, and being a daily wage worker (Putalan et al., 2025). In addition, the young generation also takes part by having marketing role on social media in order to promote the marine products (Putalan et al., 2025). Aside from helping economic diversification, women also take part in environmental conservation through mangrove plantation (Putalan et al., 2025). This shows that women also have a significant role in adaptation action and should be considered in every decision, since women have experiences that are most relevant in daily life and can offer solutions through those experiences. Another study in North Gorontalo, Ilodulunga Village, found that people also have an adaptation action plan in order to face climate change impact by making an early warning sign at several points that support mangrove ecosystems (Lahay et al., 2020). Another article also suggests that fishermen can expand their fishing area, using technology-enabled fishing tools and methods in order to adapt (Pambudi et al., 2023). All of these are efforts in order to face climate change challenges in Gorontalo and an effort for the local community has their needs met.

3.3. Discussion

According to the various data above from each city's progress and initiatives to build resilience combating climate change risk and impact, we can conclude that climate change is not just an environmental issue, but also related to social, economic, and political challenges that should be improved (Putri et al., 2025). All residents in every city have their own way to adapt, but there are still some common adaptations in order to survive. Many residents impacted by climate change in coastal cities work as fishermen whose lives are highly dependent on natural resources in the sea (Alidrus & Wiyono, 2024; Putalan et al., 2025; Barlian, et al., 2021). In order to adapt, many of them have reactive adaptation when it comes to floods or tidal floods, but are hesitant to permanently move to another settlement as an adaptation with economic considerations as it did in Demak Regency (Rahman et al., 2022; Suhendra & Benardi, 2025). So many of them chose to stay. When it comes to the decision to stay, they have another challenge in the economy. Climate change impacts their economic resources, leading them to seek other jobs or make income diversification, along with their family's help, which occurs in Jakarta, Cirebon, Bandar Lampung, Padang, and Gorontalo. Some also seek government help. But there is limited help that the government can offer. The government intervention mainly focuses on structural adaptation, such as building sea walls, embankments, and dredging the river, rather than on how to build the community's resilience, as it did in Jakarta, Semarang, and Demak. The non-structural adaptation at the policy level is considered not sufficient to address the climate change risk problems at coastal cities. Those occurrences can happen because there is no specific legal framework for climate change impacts in Indonesia (Nurhidayah & McIlgorm, 2019). Another insight also comes from another city outside Java Island, that every place has its own local wisdom that correlates with the environment, especially in Bandar Lampung and Ternate. This local wisdom holds an important role in society and can be

integrated into how residents or communities adapt to climate change impacts. Many studies above also mention how the role of families, especially their wives, plays part in increasing income in order to survive. Such as they are help in managing marine catches and make it into something that has a high value to be sold, or help to dry the fish and have another job in order to increase income. This highlights that women's voice and role also need to be considered in terms of building community resilience, since many solution also comes from women as they are bridging the coastal community and its natural environment (Nopianti & Hanum, 2019).

Based on the community adaptation in each city, there is a pattern of adaptation that should be recognized and categorized. Biagini's adaptation typology based on Global Environment Facility adaptation projects throughout 70 developing countries becomes relevant to this research since it employs inductive approaches in many countries to develop the concept. However, it is still important to look at the local context in order to selecting appropriate typology. Based on Global Environment Facility adaptation projects, Biagini et al. (2014) identified ten categories of adaptation, including capacity building, management and planning, practice and behaviour, policy, information, physical infrastructure, warning or observing systems, green infrastructure, financing, and technology. In the context of community adaptation, based on the findings from the cities studied, the researcher adopted three typologies: physical infrastructure adaptation, practice and behaviour adaptation, and green infrastructure adaptation. Physical infrastructure adaptation refers to improvements in physical structures that provide protection against both direct and indirect impacts of climate change (Biagini et al., 2014). Meanwhile, Practice and Behaviour Adaptation is the expansion of actions that are related to building resilience, and the Green Infrastructure adjustment refers to the improvement of natural infrastructure to face climate change impact directly or indirectly (Biagini et al., 2014).

Biagini also noted that there is a possibility that the typology could be combined with the practical grounding of adaptation activities that might evolve (Biagini et al., 2014), since the adaptation capacity also varies across regions, countries, and socioeconomic status of the affected group, and it could vary over time (IPCC, 2001). Therefore, to make a more comprehensive adaptation typology that can capture within the community adaptation context in Indonesia, this research also creates another typology to be combined with Biagini's typology, referring to the IPCC adaptation definition that adaptation activities are an adjustment in ecological, social, and economic response to face expected climate change impacts (IPCC, 2001). Based on that, the Social and Cultural Adaptation and Economic Adaptation are being used in this research after looking at the reviewed data in order to localize within Indonesia context. The Social and Cultural Adaptation refers to how the community adapts in a social and cultural context, ranging from the social relations within the family and neighborhood, the roles of religious beliefs, and their indigenous or cultural knowledge, in order to tackle climate change risks and impact. Then, the Economic adaptation refers to how the community take an actions to maintain their economic capabilities that are impacted directly or indirectly by climate change risks.

Table 3. Community adaptations type based on each city

City	Adaptation type	Adaptation action
Jakarta	Physical infrastructure adaptation	Floor or foundation elevating; Constructing concrete in front of the door; Constructing the second floor; Build boat mooring piers to avoid boats being destroyed.
	Practice and behaviour adaptation	Safeguarding valuable possessions on the second floor or higher place, evacuate them outside, and float them into a plastic basket; Move to another house; Wrapping administrative documents; Relocate to a higher place: climbing to the house roof; Cleaning waterways;

		River Cleaning.
	Social and cultural adaptation	Rely on family and kin for infrastructure adjustment; Rely on traditional neighbourhood institution (RT); Rely on CSO-Supported Group.
	Economic adaptation	Borrow money from family, neighbourhood, and non-banking institutions.
Cirebon	Physical infrastructure adaptation	Build a small dam; Floor or foundation elevating.
	Practice and behaviour adaptation	Safeguarding valuable possessions on the second floor or higher place such as on the top of a wardrobe; Put sandbags in front of the door; Make a habit of not throwing garbage to the river.
	Economic adaptation	Changing job; Increasing fishing range; Diversifying fishing gear and catches.
Demak	Physical infrastructure adaptation	Constructing embankments around the property; Floor or foundation elevating; Build a multistory building or a stilt house; Build walls; Build taluds at every entrance to the residential area; Elevate the land around cemeteries each year; Road filling; Build a new house in the same location.
	Practice and behaviour adaptation	Abandoning their ground floor; Relocate to a higher place; Safeguarding valuable possessions on the second floor or higher place; Living close to their relatives through connecting settlements; Permanently migrate.
	Social and cultural adaptation	Parents teach their children to understand nature signs and self-evacuate; Religious and local leaders have an important role in communicating flood risks.
	Economic adaptation	Seek financial support from government; Rent out a room for a village in the Demak case that is near an industrial area.
	Green infrastructure adaptation	Mangrove restoration.
Semarang	Physical infrastructure adaptation	Floor or foundation elevating; Rebuild buildings that have come down; Build the levees in front of the house.
	Practice and behaviour adaptation	Made a warning system for people to not throw the wast on channel streams.
	Social and cultural adaptation	Perceive to live in harmony with disasters influenced by religious belief.
	Economic adaptation	Changing jobs.
	green infrastructure adaptation	Mangrove restoration.
Bandar Lampung	Social and cultural adaptation	Indigenous knowledge about the house structure called Lamban Langgakh in Bandar Lampung in order to face flood risks.
	Economic adaptation	Borrow money from family, neighbourhood, and non-banking institutions; Fishermen make another stream of income; Wives helps to increase income.
Padang	Practice and behaviour adaptation	Cleaning waterways; Encourage not to burn garbage and throw it into the sea; Encourage not to cut trees carelessly;

		Remove places for breeding mosquitoes.
	Social and cultural adaptation	Combine the nature sign and the moon with indigenous knowledge to have a perfect time for fishing and increasing skill; Form a group of mothers to give support to each other.
	Economic adaptation	Sell snacks, foods, and coconut; Renting out boats as tourist transportation; Wives helps to increase income; Change the time for fishing; Change the fish species.
Ternate	Practice and behaviour adaptation	Developing an environmentally mindset and awareness through education; Doing household waste management.
	Social and cultural adaptation	Have indigenous knowledge in Ternate called Fere Kie Kololi Kie that encourages protecting nature both in the mountain and the sea, and Barangka that dictates where an area should be avoided to build a settlement.
	Green infrastructure adaptation	Maintain mangrove vegetation.
Gorontalo	Economic adaptation	Increasing fishing range; Collective movement to help with fishing gear; Make a fish catch profit-sharing system; Wives and children help to increase income.
	Green infrastructure adaptation	Wives contribute to mangrove plantation.

Based on the table, we can conclude that the adaptation that is much more significant to do is the economic adaptation in nearly all cities except for the Ternate case. This is because climate change adaptation action is difficult to separate from action triggered by social or economic events (Adger et al., 2005) make this type of adaptation inevitable when the community faces the climate change risks and impacts their livelihoods. Then, after the economic adaptation, the Social and Cultural Adaptation is dominant within six cities, except for Cirebon and Gorontalo, followed by Practice and Behaviour Adaptation, except for Lampung and Gorontalo. This indicates that within each city and on different islands, there are a lot of differences in the community adaptation type that is being used. Meanwhile, the Physical Infrastructure Adaptation is being used in four cities, except for Bandar Lampung, Padang, Ternate, and Gorontalo. This creates a pattern that cities outside Java Island are not showing the Physical Infrastructure Adaptation and improvement. Even though adaptation action in developing countries tends to be reactive, focusing on adjustment, avoiding, and securing income or resources (Biagini et al., 2014), it is still important to gather all stakeholders, including the government, NGO, and the private sectors in order to build a more sustainable resilience and help with infrastructure adaptation. Another cities that show Physical Infrastructure Adaptation, shows that climate change risks and impacts play a significant role in damaging their place and belonging, it is also connected to their ability to do economic activities. In addition, the scale of Physical Infrastructure Adaptation is also determined by the socioeconomic capabilities of each household in line with the IPCC explanation that adaptive capacity is determined by socioeconomic characteristics (IPCC, 2001). Furthermore, the Green Infrastructure Adaptation that occurs in four cities also gives a sign that there is environmental degradation that might be caused by climate change and exacerbated by human factors involved in it, so the Green Infrastructure Adaptation was needed. The presence of social adaptation also gives significant support in facing climate change impact, along with cultural adaptation.

Each city or regency have their unique circumstance that influence adaptability to climate change risks, especially with the growing population and the availability of living space that pushes people with low economic resources into low elevation coastal zone. In addition, land subsidence caused by excessive groundwater withdrawal, anthropogenic

factors, and natural factors, such as in Jakarta and Semarang (Sarah, 2022), indicating that population growth also plays a great part in adding to the complexity for each city. There is a difference regarding the population for each city, but there is no definite classification to classify the small coastal city or regency, and the large coastal city or regency. If referring to Government Regulation Number 26 of 2008, a large city is referred to as an area with more than 500,000 people registered, and 50,000-100,000 people registered for a small city (Government of Indonesia, 2008). However, due to the population growth for more than a decade, the regulation is not being used in this research, and referring to Government Regulation Number 59 of 2022 that city size classification is one of it is based on its population (Government of Indonesia, 2022).

In this research, the researcher decides that below 1,5 million inhabitants in a certain area is categorized as a small to mid-sized coastal city or regency. Therefore, the distinction of community adaptation between small to mid-sized and the large coastal cities or regencies can be recognized, with the large cities such as Jakarta and Semarang having adopted a minimum of four types of adaptation in order to face climate change risk, and Cirebon Regency with three types of adaptation. Meanwhile, another small to mid-size cities also adopt 2-3 types of adaptation, that it goes the same as the Cirebon Regency case, except for Demak Regency, that adopt all five types of adaptation. If referring to its density for the three large regions, Cirebon Regency has the lowest density compared to Jakarta and Semarang. However, for small to mid-sized regions, Demak Regency has the lowest density of 1,269/Km^2 compared to other small to mid-sized regions, despite Demak Regency adopting all five types of adaptation and having a smaller density compared to Cirebon Regency, as the large coastal region category adopts just three types of adaptations. Meanwhile, Bandar Lampung, that have the highest density in the small to mid-sized category for 6,609/Km^2, has two types of adaptation being adopted. In addition, Jakarta, as a large coastal city that has the highest density in Indonesia, with 15,978/Km^2 have four types of adaptation being adopted. This pattern indicates that the density of the population in a coastal city or regency is not always correlated with the range of community adaptation types being adopted. This is in line with the IPCC report that the capacity of adaptation varies among regions, even countries, and might vary over time (IPCC, 2001). The Demak Regency case is an example, based on its population and density, which is lower than the large coastal regions, and at the same time has the highest population and the lowest density among small to mid-sized coastal regions, the community still can offer various types of adaptation in their daily life.

Aside from community adaptation, the coastal city's problems in order to face climate change cannot be addressed just by building the community's resilience alone. Apart from the agency, there should be a resolution addressed systematically at the policy level. The research by Gaborit (2022) that talks about climate adaptation ambition and challenges in Indonesia shows a significant framework to understand the alignment of this paper.

Based on the figure above, we can see that the community faces a risk caused by natural factors, human activity-related push factors, and anthropogenic factors (Gaborit, 2022). This is in line with this paper that many risks that the community faces aside from those caused by natural events, are exacerbated by human activity through industrialisation and household waste mismanagement (Mulyadi, 2024). The urbanization is also taking place because of the industrialization growth, which has more pressure in Jakarta, Semarang, Demak, and Cirebon. The population growth, urbanization, development, and land use change push many vulnerable communities into a corner. Socio-economic and political response becomes crucial in this problem, demanding good governance, the power of decentralization that is expected to be able to address this problem, funding and infrastructure adjustment, long-term planning in land use, and socio-economic solution, also expected to be presented (Gaborit, 2022). With decentralization of politics, hopefully, every region can offer solutions based on its regional risks, characteristics, and resources. But in reality, many local governments difficult to shift their focus on climate adaptation without proper funding from ministries, which lead to many easy problems to be tackled such as managing domestic waste, contingency planning, make evacuation routes,

relocation programs, and build early warning sign tend to be put aside (Gaborit, 2022). In addition, as we can see in the Ternate case, the immaturity of decentralization of politics is also impacting their performance in order to navigate the climate and natural disaster problems. This led to spatial planning in Ternate that is not based on their natural reserves (Abbas et al., 2023). Furthermore, land use in Indonesia is closely related to conflict because of unsustainable planning with increasing demand for land with different interests (Gaborit, 2022). Those make the problem more complex, but the policies regarding spatial planning are still needed.

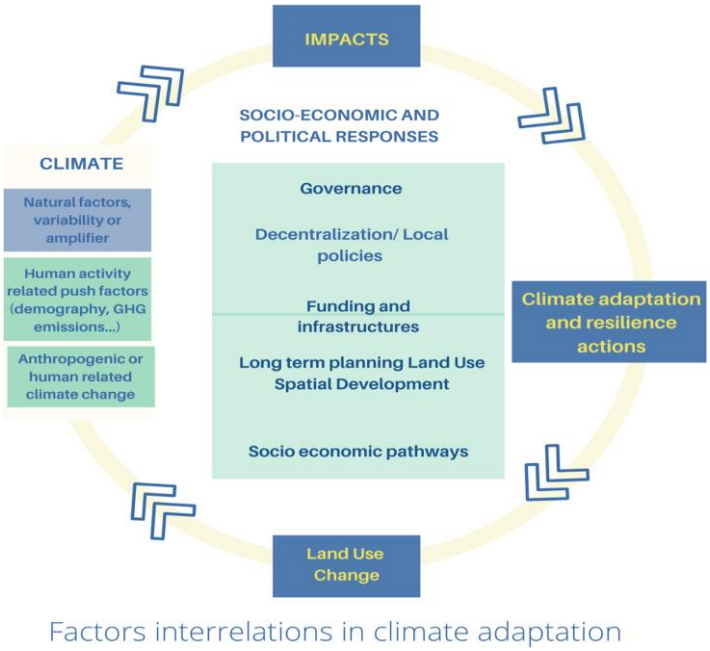

Fig. 2. Factors Interrelation in Climate adaptation framework in Indonesia (Gaborit, 2022)

Another problem mentioned at Cirebon about there are overlapping policies (Regional Regulation No. 6 of 2016) between central and regional government institutions, caused by a lack of coordination (Mahardeka et al., 2025). Therefore, it's important to have the same vision and cooperation between the national government and local government institutions to tackle this issue, including taking local communities voices into account to build climate change adaptation and resilience. Based on the study by Gaborit (2022), there are several stakeholders needed to build a proper climate risk management. This includes both in national agencies such as BMKG (National Climate Agency), and local agencies such as Bappeda dan Litbang Kota (Development Planning and Research Board), Dinas Pekerjaan Umum dan Penataan Ruang Kota (Public Work and Spatial Planning Department), Badan Pusat Statistik Kota (Statistical Agency), Badan Penanggulangan Bencana Daerah Kota (Disaster Management Board BPBD), Private sectors, School and University, Civil Society Organization, and Religious Authorities (Gaborit, 2022). Implementing the indigenous knowledge with a modern pathway to face climate change, and supporting the community economic resilience are also crucial in order to face climate change risk. This also aligns with another study statement that Indigenous knowledge has its function to help communities with weather prediction, early warning systems, and disaster preparedness, including water management, fisheries, and income diversity activities (Dorji et al., 2024) that is a relevant part for the coastal communities in this research. By combining all of those institutions to build a better climate risk management system, along with encouraging climate change risk adaptation within the community, encouraging women's voices to be heard, and bridging the Indigenous knowledge and scientific knowledge in order to comprehensive option to adaptation, might be the best solution to tackle the issues related to climate change risk in coastal cities.

4. Conclusions

Coastal cities both small and large coastal cities or regencies in Indonesia have various conditions that need to be addressed in order to face climate change risk. There are several community adaptation options that can be chosen for local residents. The adaptation option ranges from Physical Infrastructure Adaptation, Practice and Behaviour Adaptation, Social and Cultural Adaptation, Economic Adaptation, and Green Infrastructure adaptation, with the Economic Adaptation being the most chosen across cities, except for Ternate. This indicates that climate change risks are impacting the community's livelihoods, followed by Social and Cultural Adaptation within six cities, which shows how the social relations and cultural aspects are involved in strengthening their adaptation. All actions within the same typology are also different for each city. Another adaptation type, such as Practice and Behaviour Adaptation, Physical Infrastructure Adaptation, and Green Infrastructure Adaptation, also exists and varies across regions. Demak Regency is also an example that the population and its density are not always correlated with the range of community adaptation options.

The community adaptation action also ranging in each typology, such as infrastructure adjustments, like the floor elevation, making embankments, relocating to a higher floor, and and build the small dam. Some people also choose to migrate from coastal areas impacted by climate change. In order to survive economically for people who stay, many local residents either change their job or still maintain their main job, mostly as fishermen, but have diversified income through their family members help in trading or another sector. The presence of local wisdom and the role of women also exacerbates the community's resilience. To tackle this issue, it is important to collaborate in several sectors, including government, NGO, and local communities in order to create a comprehensive legal framework about climate change impact and adaptation under an existing law about disaster management, collaborate with private sector for adaptation-projects funding, coordinating policies between central and regional government institution to avoid overlap policies and funding, build economy resilience in community, encourage womens voices to be heard and include in every decision, and implementing Indigenous knowledge or local wisdom to face climate change risk in coastal cities.

This paper has its strengths for exploring in detail the conditions for each coastal city or regency, but also at the same time has its limitations for not being able to discover more areas caused by the availability of the data, and it did not delve into complementing it with the government projects and initiatives in all cities for a better understanding of the situation. For further research, the research on the communication risk framework and its channel for addressing climate change risks in coastal cities at the community and government level should be addressed in order to have a comprehensive picture regarding the flow of the adaptation strategies. Another research about the regional legal framework and policy (including projects and initiatives) in order to tackle climate change impact for each region and its alignment with national government policy and law needs to be addressed, as a complement to this paper, which mainly talks about the community perspectives in order to adapt to climate change risk in coastal cities. Exploring the role of women in each city and the situation of children as the most vulnerable population is also needed. In addition, the research about the definition of coastal cities itself is also needed, so that there are standardized indices in categorizing coastal cities, or not in order to discover more areas.

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