Serious Flooding in Pekalongan City: What are the Government Policies in Tackling this Problem?

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Abstract. In Indonesia, the rate of sea level rise is expected to continue to increase. As a result, 115 small islands in Indonesia are threatened with sinking in 2100. Not only because of the high intensity of rain, this condition is also closely related to current environmental problems where weather changes occur due to global warming. A warmer earth will eventually have an impact on increasing the volume of seawater due to the melting of icebergs. This increase threatens the lives of people living in coastal areas. In fact, this condition is exacerbated by the phenomenon of land subsidence that has occurred in 112 coastal districts/cities in Indonesia, where the highest land subsidence occurs in the coastal city of Pekalongan. The combination of sea level rise and land subsidence makes tidal disasters unavoidable, resulting in the vulnerability of the people living in the area. Not only hinders community activities, but also causes damage to infrastructure, so a flood prevention and management strategy is needed. Various studies on tidal flooding have been carried out in Pekalongan City with various perspectives, such as the use of Geographic Information Systems/GIS, disaster prevention strategies, social and economic vulnerability to tidal flooding, environmental service assessment, and changes in land use. This study analyzes the government's policy on tidal flooding in Pekalongan City and its impact on urban flooding. This type of research is qualitative, using primary data and secondary data. The head and staff of the service are the main sources of research, to analyze existing policies related to flood inundation in Pekalongan City, especially in North Pekalongan District as the research location.

Keywords: tidal flooding policy, flood inundation, sea level rise, land subsidence

1 Introduction

Over the past decade, environmental issues have become the most discussed topic due to increasingly worrying environmental conditions, especially related to climate change issues. Climate change is a serious challenge for the world community. Climate change occurs due to the increasing temperature of the earth, known as the phenomenon of Global Warming which among others results in weather change patterns throughout the world.

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Weather change can be a threat to human populations both in terms of public health and well-being (Bunz and Mücke 2017). An increase in global average temperature not only impacts various physical and biological systems followed by a higher potential for social conflict (Ipcc 2018; Straßer et al. 2022), but also to people's physical and mental health (Bunz and Mücke 2017). Although many people are aware of these environmental issues, many of them fail to act climate-friendly (Straßer et al. 2022). According to Campbell et al. (Richards, H.L. Gauch, J.M. Allwood, 2023) climate change that has an impact on weather change can worsen the entire food production system, thus weakening the availability of accessibility, utilization, and stability of food security. Therefore, these impacts have serious consequences for the well-being and health of people around the world. Not only that, but these changes also contribute to the melting of polar ice so that there is a rise in sea level and has a severe impact, especially on coastal areas that have low altitudes (Macias, et. al., 2021). There are various impacts in coastal areas, such as flooding.

Pekalongan City is one of the coastal cities that is vulnerable due to tidal floods with the threat of economic losses of up to 7 trillion IDR (Mercy Corps Indonesia 2022). Thus, government policy is very important to reduce and prevent the spread of impacts. For that, this article aims to discuss: (1) How does the flood occurs in Pekalongan City?; (2) How is the development of government policy towards tidal flooding in Pekalongan City?

2 Research Methods

The method used in this study is qualitative descriptive research using primary data and secondary data with the following details: (1) ***Primary Data:*** The main subjects for interview of this study are the Head and staff of Regional Disaster Management Agency (BPBD), Development Planning Agency at Sub-National Level (Bappeda), and 7 village heads of impacted tidal flood area (Panjang Wetan, Bandengan, Panjang Baru, Padukuhan Kraton, Krapyak, Pandang Panjang, and Degayu) in Pekalongan City, to analyze existing policies related to tidal flood disasters in Pekalongan City; (2) ***Secondary Data:*** Presidential Regulation Number 79 of 2019 concerning the Acceleration of Economic Development in Kendal - Semarang - Salatiga - Demak - Grobogan, Purworejo - Wonosobo - Magelang - Temanggung areas, and Brebes - Tegal - Pemalang areas, National Medium-Term Development Plan (RPJMN) for 2020-2024, Regional Medium-Term Development Plan (RPJMD) of the Pekalongan City Government for 2021-2026, Mayor Regulation Number 72 of 2020 concerning the Position, Organizational Structure, duties, and functions as well as the Work procedures of the Public Works and Spatial Planning Office for flood and tidal management and infrastructure arrangement, articles, documents, images, etc. that are related to the focus of research.

3 Overview

Pekalongan City is a city covering an area of 46.41 km2 with coordinates 6°50'42"- 6°55' 44" South Latitude and 109 37'55" -109 42'19" East Longitude and is located on the lowland coast of Java Island with an altitude of approximately 1 meter above sea level. Broadly speaking, Pekalongan City is a line of cities that play an important role in the economic sector. This is because Pekalongan City is included in the northern coastal area (Pantura) of Java Island which has a large role in contributing to the national economy and has a *comparative advantage so* it

is expected to contribute to improving the progress and welfare of the community sustainably. However, Pekalongan City is also one of Indonesia's cities that experienced the worst tidal flood disaster.

When looking at topographic conditions, the height of land in the north is between 1 meter and in the south is 6 meters above sea level accompanied by a land slope of between 0-5% (Lutfitiana, et.al, 2022). This condition illustrates that Pekalongan City is very flat and has a height below sea level, indicating the occurrence of land *subsidence* in the Pekalongan area. Moreover, in the last decade, global warming has affected the volume of seawater so sea water has increased. Consequently, Pekalongan City as a coastal area is impacted.

The population of Pekalongan City has a total of around 308,310 people, consisting of 152,609 women and 155,701 men in 2021. The population density of Pekalongan City is in the range of 6,813 people/km2, higher than in 2020 which has a density in the range of 6,813 people/km2. Reporting from the RPJMD of Pekalongan City for 2021-2026, the people of Pekalongan City tend to work in the processing industry such as the batik handicraft industry and its derivatives, and in the trade sector such as wholesale and retail trade. Given that Pekalongan City has a great advantages in the batik industry, the government makes Pekalongan City a tourist destination by organizing festivals/arts as an effort to preserve the batik. The existence of these efforts makes Pekalongan City hold the title of the world city of batik.

4 Results and Discussion

4.1 Flooding in Pekalongan City

As an archipelagic country, Indonesia is one of the regions that experiences many flood events. The issue of flooding is one of the most frequent issues in Indonesia. Even reported by the National Disaster Management Agency (BNPB), in 2023 there have been 2,477 natural disaster events with floods totaling 825 events from January 1 to July 31, 2023 (BNSP, 2023). The following is data on the number of disaster events in 2023:

Table 1. Number of Natural Disasters in Indonesia (1 January – 31 July 2023)

No	Disaster Name	Disaster Value/Event	Percentage
1	Flood	825	33,31%
2	Extreme weather	802	32,38%
3	Landslide	427	17,24%
4	Forest/land fires	343	13,85%
5	Tidal wave/abrasion	24	0,97%
6	Earthquake	19	0,77%
7	Volcanic eruptions	2	0,08%
8	Drought	35	1,41%
	Sum	**2.477**	**100%**

Source: Indonesia Disaster Data Geoportal, BNPB 2023

Based on Table 1 above, it can be concluded that floods almost occupy half of the total number of natural disaster events in Indonesia throughout 2023. This is also supported by data from the Indonesian Disaster Data Geoportal which recorded that from 2021 to 2022, floods occupied the top position with 3,326 disasters, followed by extreme weather disasters of 2,642, and landslides of 1,987. Therefore, flood disasters are one of the challenges of the Government

of Indonesia in providing improvements in infrastructure and comfort and security for the community (Hadi, et al, 2020). Flooding occurs due to several factors such as extreme rainfall, tidal waves, or river flow discharge, which can cause major damage (Ningtyas, T, 2021; (Thakur and Mohanty 2023).

Furthermore, floods also occur not only due to high rainfall, but global warming can have major implications for Indonesia because one of the impacts of global warming is sea level rise which occurs due to melting polar ice due to an increase in earth's temperature (Halla, Harvey, Manning, 2019; Princess, Musrifin, Mubarak, 2021; Mann, 2023).

Sea level rise can have a serious impact on people's lives, especially those in low-lying areas in coastal areas as the most vulnerable areas affected (Susanto & Mardiatno., 2010; Handoko, Yuwono, Reny, 2020; Shalsabila, et.al., 2022(Pariartha et al. 2023). The poor in the northern area of Semarang City coast, for example, are impacted by flooding around 1-7 times monthly, up to 30 cm height and with the duration of inundation around 6 hours (Muktiali et al, 2023).

The rate of sea level rise in Indonesia is expected to continue to increase. Based on the IPCC Report in 2021, there was a sea level rise of 3.2-4.2 mm/year with an average increase of 3.7 mm/year in the 2006-2018 period (EGSA, 2023). This has resulted in 115 small islands in Indonesia being threatened with sinking by 2100 (CNN, 2021), in addition to floods that will hit many coastal cities, including Pekalongan City on the north coast of Java Island. The northern coastal area of Java is not only hit by common flood, but also bu inundiation flood, occurs during the moon light when the sea rice increase because of gravitation (Hadi, et al, 2020)

Pekalongan City is a city bordering the coastal area of the Java Sea so it is vulnerable to flooding due to sea level rise. The existence of this vulnerability causes the community to experience the impact of tidal floods that they often feel. When tidal floods occur, people are even forced to continue to evacuate because their homes are often affected by the disaster. Not only the difficulty of housing, the community also finds it difficult to find a livelihood because they often have to evacuate, tidal floods make it difficult for them to make a living (Hariandja, 2023). If these conditions are not immediately overcome, their health can also be affected (Macias, et.al, 2021).

Fig. 1. The Eternal Inundation of Tidal Floods
Source: Field Activity (2022)

The soil type of Pekalongan City is soft soil so it is more vulnerable to land subsidence, which has the potential to increase the risk of increased waterlogging (Lutfitiana, et.al., 2022). This is to the opinions expressed by Whittaker and Reddish (Prasetya, Bambang, &; Moehammad, 2017; Miftahudin, 2021; Lutfitiana, et.al., 2022) who stated that land subsidence is influenced by various factors, such as geotechnical conditions in the form of groundwater extraction, natural consolidation, mining activities and building loads, and geological conditions such as tectonic factors and underground cavities.

The combination of sea level rise and land subsidence creates inevitable tidal disasters. This triggers the emergence of inundation that hampers community activities and causes damage to infrastructure, so flood prevention and mitigation strategies are needed. Various studies on tidal flooding have been conducted in Pekalongan City with various perspectives, such as the use of Geographic Information Systems / GIS, disaster prevention strategies, social and economic vulnerability to tidal floods, valuation of environmental services, and land use change. However, there has been no research specifically discussing various flood management policies in Pekalongan City. Therefore, it is interesting to conduct research related to this topic, considering that for the handling of serious natural disasters such as tidal floods in Pekalongan, a public policy that is a form of use of authority and resources owned by the government has a central role.

The tidal flood disaster in Pekalongan City is an environmental issue that cannot be avoided, and at the same time a complicated public administration problem. Moreover, if you look at the topographic conditions of the area that continue to decline, resulting in tidal floods in Pekalongan City getting worse over the past 5 years. The following are the conditions of flooding and tidal inundation in Pekalongan City:

Table 2. Flood and Rob Puddles in Pekalongan City in 2016-2020

Year	Area of Pekalongan City	Puddle Area	Percentage
2016	4,525 Ha	1,870 Ha	41,33%
2017	4,525 Ha	1,396 Ha	30,85%
2018	4,525 Ha	1,391 Ha	30,75%
2019	4,525 Ha	1,057 Ha	23,35%
2020	4,525 Ha	1,730 Ha	38,23%

Source: RPJMD Kota Pekalongan 2021-2026

Based on Table 2 above, it can be seen that there are fluctuating conditions where from 2016 to 2019 the percentage of flood and tidal inundation has decreased. However, from 2019 to 2020 there was a high increase where in 2019 flooding and tidal inundation were 1,057 hectares (23.35% of the area) to 1,730 hectares (38.23% of the area) in 2020. The increase illustrates that if the problem of tidal flooding is not handled as soon as possible, it can have a major impact on the affected communities.

4.2 Flood Management Policy in Pekalongan City

Based on these conditions, the central and regional governments have made various efforts as a way out of the problem of tidal flooding through policies and programs that have been set. This is done because the government is the main milestone of the government that is responsible for protecting its people. As stated in paragraph IV of the Constitution of the Republic of Indonesia Year 1945 which mandates that "the government or the Unitary State of the Republic of Indonesia protects the entire Indonesian nation and all Indonesian bloodshed...". The

statement regarding this role is also affirmed in the form of government responsibility in disaster management which is affirmed in Law Number 24 of 2007 concerning Disaster Management which states that "the government and local governments are responsible for the implementation of regional management". Therefore, the existence of Law Number 24 of 2007 became a foundation that gave birth to various other policies.

There is a National Medium-Term Development Plan (RPJMN) for 2020-2024 which discusses the development of the northern coastal area (Pantura) of Java Island which has the potential to face the challenges of sea level rise, tidal flooding, and land subsidence in various regions, including Pekalongan. By the vision carried out in the form of "The Realization of an Advanced Indonesia that is Sovereign, Independent, and Personality Based on Gotong Royong", this RPJMN has a benchmark to provide strengthening of the transformation process in the economic sector to achieve the 2045 development goals so that infrastructure strengthening is needed. Given that Pekalongan City is included in the ranks of the northern coastal area (Pantura) which plays a major role in the national economy, the government has scheduled coastal security of Pantura Java as stated in the *RPJMN Major Project* as an effort to overcome floods and tidal disasters.

There is also a flood management policy in the Regional Medium-Term Development Plan (RPJMD) of the Pekalongan City Government for 2021-2026. Broadly speaking, the plan contains various opportunities to be achieved by Pekalongan City from various aspects, including flood and tidal mitigation which is affirmed in "Mission 4: Realizing Urban Infrastructure Facilities Based on the Principles of Sustainable City Development". Floods and tidal disasters are included in the ranks of 4 main problems focused by the Pekalongan City Government, but floods and tidal floods are the top priorities. This is because the disaster has an interrelated relationship so that it can provide interesting other problems, namely environmental quality, availability of basic infrastructure, and environmental quality. Therefore, the RPJMD makes it easier for the government to carry out strategies and innovations that have been carried out to solve these problems.

Currently, the Pekalongan City Government has also sought various ways to deal with the problem of tidal flooding in the city. This is marked by the tidal flood management program located in Pekalongan City as stated in Presidential Regulation Number 79 of 2019 concerning the Acceleration of Economic Development in Kendal - Semarang - Salatiga - Demak - Grobogan, Purworejo - Wonosobo - Magelang - Temanggung areas, and Brebes - Tegal - Pemalang areas. The regulation discusses flood and tidal control with a focus on the City and Regency of Pekalongan. Not only controlling floods and tidal floods, but also accelerating economic development with the construction of TOD (*Transit Oriented Development)* and improving the degree of public health through the creation of Regional General Hospitals (RSUD). The existence of this regulation indicates that the central government contributes to providing solutions to the problem of tidal floods. The regulation also regulates funding provided by the government through the State Budget (APBN).

The Pekalongan City Government also has Mayor Regulation Number 72 of 2020 concerning the Position, Organizational Structure, duties, and functions as well as the Work procedures of the Public Works and Spatial Planning Office for flood and tidal management and infrastructure arrangement. The regulation discusses the duties and functions of the DPUPR of Pekalongan City in which there are tasks in handling floods and tidal disasters. The presence of these regulations resulted in various programs such as repairs to coastal and river embankments, cleaning rivers and waterways, building pumps and retention ponds, to programs involving other parties such as cooperation with the River Basin Center (BBWS) and the Public Works Office of Water Resources and Spatial Planning (Pusdataru) Central Jaa Province under embankment

construction (DPUPR, 2021). In addition, there is also a revision of the 2020 Pekalongan City Drainage Master Plan as a guideline for structuring a more targeted city drainage system (Miftahudin, 2021). The drainage master plan was prepared by the Regional Development Planning Agency (BAPPEDA) of Pekalongan City which has been adjusted to the conditions of Pekalongan City to deal with floods and tidal disasters.

However, until now in Pekalongan City tidal flood disaster events still exist and even increase in intensity. Despite these efforts, further actions are needed to effectively manage and mitigate tidal flooding in Pekalongan City According to (Hariandja, 2023), people who experience this certainly feel disturbed, both in terms of activity, economy, and society. Firstly, there is a need for improved coordination and collaboration between different government agencies and stakeholders involved in flood management. This includes better integration of land use planning, water resource management, and climate change adaptation strategies. Additionally, there should be a focus on implementing nature-based solutions, such as restoring mangrove forests and wetlands, which can act as natural buffers against tidal floods.

Furthermore, there is a need for increased investment in research and technology to better understand the dynamics of tidal flooding and develop innovative solutions. This includes the use of remote sensing and modeling techniques to accurately predict flood events and assess their impacts. Additionally, efforts should be made to enhance community resilience through capacity building and the provision of financial support for flood-affected households and businesses.

5 Conclusion

One of the main reasons why floods are a major issue in Indonesia, especially in coastal areas like Pekalongan City, is the combination of sea level rise and land subsidence. Sea level rise refers to the increase in the average global sea level due to the melting of glaciers and ice caps, as well as the expansion of seawater as it warms. This phenomenon is primarily caused by climate change and has significant implications for low-lying coastal regions.

In Pekalongan City, the effects of sea level rise are exacerbated by land subsidence. Land subsidence occurs when the ground sinks or settles, often due to the extraction of groundwater or the compaction of soil layers. In Pekalongan City, excessive groundwater extraction for agriculture, industry, and domestic use has contributed to the sinking of the land. As a result, the city is more vulnerable to tidal floods, as the sea can easily breach the lower elevation areas. These tidal floods have severe consequences for the affected communities. Infrastructure such as roads, bridges, and buildings are damaged or destroyed, disrupting transportation and communication networks. Additionally, the floods contaminate water sources, leading to health risks and the spread of waterborne diseases. The livelihoods of the local population, which heavily rely on agriculture and fishing, are also severely impacted, as crops are destroyed and fish populations are disrupted.

To address this problem, the government has implemented various policies and programs. These include the construction of flood control infrastructure such as embankments, seawalls, and drainage systems. The government has also invested in early warning systems and evacuation plans to minimize the loss of life during flood events. Furthermore, efforts have been made to raise awareness about the impacts of climate change and the importance of sustainable land and water management practices. In conclusion, tidal floods are a significant issue in Indonesia, particularly in coastal areas like Pekalongan City. The combination of sea level rise

and land subsidence has led to devastating consequences, damaging infrastructure and impacting the livelihoods of the affected communities. While the government has taken steps to address this problem, further efforts are needed to effectively manage and mitigate tidal flooding in Pekalongan City. By implementing comprehensive and integrated strategies, investing in research and technology, and enhancing community resilience, it is possible to reduce the impacts of tidal floods and ensure the long-term sustainability of the city.

Reference

1. Act of the Republic of Indonesia Year 1945
2. Anggarda, AA; Purnaweni, H; Suwitri, S; Afrizal, T, (2021) Analysis of Flood Disaster \Mitigation Policy in Lamongan District, International Jpuirnal of Social Science and \Business, Vol 5(4), 2021, DOI: .
3. _____. (2019). "Women and Children 14x Greater Risk of Death". *bnpb.go.id*. Retrieved August 17, 2023 via https://bnpb.go.id/berita/perempuan-dan-anak-anak-berisiko-meninggal-14x-lebih-besar
4. National Disaster Prevention Agency (BNSP). (2023). "Geportal Data Bencana Indonesia".*gis.bnpb.go.id*. Retrieved Tuesday, August 8, 2023, via https://gis.bnpb.go.id/
5. Bevacqua, E. et al. 2019. "Higher Probability of Compound Flooding from Precipitation and Storm Surge in Europe under Anthropogenic Climate Change." *Science Advances* 5(9): 1–8.
6. Bouwer, Laurens M. 2011. "Have Disaster Losses Increased Due to Anthropogenic Climate Change?" *Bulletin of the American Meteorological Society* 92(1): 39–46.
7. Bunz, Maxie, and Hans-Guido Mücke. 2017. "Climate Change – Physical and Psychological Consequences." *Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz* 60(6): 632–39. http://link.springer.com/10.1007/s00103-017-2548-3.
8. CNN. (2021). "BRIN's Explanation on the Threat of 115 Indonesian Islands Sinking". *Cnnindonesia.com*. Retrieved Wednesday, August 9, 2023 via https://www.cnnindonesia.com/teknologi/20211129152437-199-727466/penjelasan-brin-soal-ancaman-115-pulau-indonesia-tenggelam.
9. Daughter, Gloria Setyvani. (2021). "112 Regencies and Coastal Cities of Indonesia Experience Land Subsidence, the Worst in Pekalongan". *Kompas.com*. Retrieved Wednesday, August 9, 2023 via https://www.kompas.com/sains/read/2021/09/17/162500123/112-kabupaten-dan-kota-pesisir-indonesia-alami-penurunan-muka-tanah-yangDepartment of Public Works and Spatial Planning (DPUPR). (2021). "Synergy of Flood Management and Rob and Other Infrastructure Arrangements". *Bappeda.pekalongankota.go.id*. Retrieved Sunday, August 13, 2023 via https://bappeda.pekalongankota.go.id/web/storage/pengumuman/FPD%20II%206%20April%2021/DPUPR.pdf
10. EGSA. (2023). "Investigating the Impact of Climate Change on Sea Level Rise and Rob Flooding on the North Coast of Java". *Egsa.geo.ugm.* Retrieved Tuesday 8 August 2023 via https://egsa.geo.ugm.ac.id/2023/01/03/diskusi-eksternal-egsa-bersama-icci-ugm-menyelisik-imbas-perubahan-iklim-terhadap-kenaikan-muka-air-laut-dan-banjir-rob-di-pesisir-utara-jawa/
11. García-Sánchez, I. M., Monteiro, S., Piñeiro-Chousa, J. R., & Aibar-Guzmán, B. (2023). Climate change innovation: Does board gender diversity matter? *Journal of Innovation and Knowledge, 8*(3).
12. Hall, J. W., Harvey, H., & Manning, L. J. (2019). Adaptation thresholds and pathways for tidal flood risk management in London. *Climate Risk Management, 24*, 42–58.
13. Haloho, EH, and Purnaweni, H, .Adaptasi Masyarakat Terhadap Banjir Rob Di Desa Bedono Kecamatan Sayung, Kabupaten Demak, Jawa Tengah/58/Adm. Publik/2020 2020/10/2, Faculty of Social and Political Science

14. Handoko, E. Y., . Y., & Ariani, R. (2020). Analysis of Indonesia's sea level rise in 1993-2018 using altimetry data. *Geoid, 15*(1), 58.
15. Handriandja, Richaldo Y. (2023). "When Pekalongan Batik City Experienced Rob's Flood". *Mongabay.co.id*. Retrieved Wednesday, August 9, 2023 via https://www.mongabay.co.id/2023/04/30/kala-kota-batik-pekalongan-alami-banjir-rob/
16. Hasna, A. L., &; Darumurti, A. (2023). Collaborative Governance in Mitigation of Rob Flood Disaster in Pekalongan City. *JISIP UNJA (Journal of Social and Political Sciences, Jambi University), 7(*1), 25–37.
17. Hadi, SP; Anggoro, S; Purnaweni, H; Yuliastuti, N; Ekopriyono, A; Hamdani, RS, (2020) Assesing the giant sea wall for sustainable coastal development: case study of Semarang City, Indonesia, AACL Bioflux, Vol 13(6).
18. IPCC, V. 2018. "Masson-Delmotte, P. Zhai, H." *Global Warming of* 1.
19. Islam, Aznarul et al. 2023. "Translating Victims' Perceptional Variations into Policy Recommendations in the Context of Riverine Floods in a Tropical Region." *International Journal of Disaster Risk Reduction* 87: 103557. https://linkinghub.elsevier.com/retrieve/pii/S2212420923000377.
20. Law Number 24 of 2007 of the Republic of Indonesia on Disaster Management
21. Macías-Tapia, A., Mulholland, M. R., Selden, C. R., Loftis, J. D., & Bernhardt, P. W. (2021). Effects of tidal flooding on estuarine biogeochemistry: Quantifying flood-driven nitrogen inputs in an urban, lower Chesapeake Bay sub-tributary. *Water Research, 201*.
22. Mann, Michael E. (2023). "Global warming: Definition, Causes, Effects, Solutions, & Facts". *Britannica.com*. Retrieved Tuesday, August 8, 2023 via https://www.britannica.com/science/global-warming
23. Miftakhudin, S. (2021). Rob Flood Management Strategy in Pekalongan City. *Journal of R&D of Pekalongan City*, *20*.
24. National Medium-Term Development Plan (RPJMN) 2020-2024
25. Ningtyas, T., Larasati, E., Warsono, H. and Purnaweni, H. (2021) "Optimization of Destana policies (Resilience Disaster Village) to improve community preparedness for flood disaster in Bojonegoro District, Indonesia", *Management and Entrepreneurship: Trends of Development*, 1(15), 2021. Available at: https://management-journal.org.ua/index.php/journal/article/view/245 (Accessed: 6 March 2021).
26. Nurdiantoro, D., &; Arsandrie, Y. (2020). The impact of tidal flooding on settlements in Wonokerto District, Pekalongan Regency. Proceedings of SIAR: *Scientific Seminar on Architecture*, 8686, 286–295.
27. Okai, Asako. (2022). "Women are hit hardest in disasters, so why are responses too often gender-blind?". *Undp.org*. Retrieved Thursday, August 17, 2023 via https://www.undp.org/blog/women-are-hit-hardest-disasters-so-why-are-responses-too-often-gender-blind
28. Palmeiro, et. al., (2023). Identifying gaps on health impacts, exposures, and vulnerabilities to climate change on human health and wellbeing in South America: a scoping review. *The Lancet Regional Health.*
29. Pariartha, I.P. Gustave S. et al. 2023. "Compounding Effects of Urbanization, Climate Change and Sea-Level Rise on Monetary Projections of Flood Damage." *Journal of Hydrology* 620: 129535. https://linkinghub.elsevier.com/retrieve/pii/S0022169423004778.
30. Prasetya, A. B., Yuwono, B. D., &; Awaluddin, M. (2017). Semarang City Land Subsidence Monitoring in 20166 using Gamit 10.6 software. *Undip Geodesy Journal, 6,* 2.
31. Pustandpi. (2023). "Hydrometeorological Disasters and How to Anticipate Them". *Pustandpi.or.id*. Retrieved Friday, August 25, 2023 via https://pustandpi.or.id/2023/01/31/bencana-hidrometeorologi-dan-bagaimana-mengantisipasinya/
32. Putri, E. E., Galib, M., & Mubarak, M. (2021). Analysis of Inundation Area as an Impact of Sea Level Rise in Kota Pariaman District, West Sumatera Province. *Journal of Coastal and Ocean Sciences, 2*(3), 193–200.
33. Puzyreva, Kseniia, and Daniel H. de Vries. 2021. "'A Low and Watery Place': A Case Study of Flood History and Sustainable Community Engagement in Flood Risk Management in the County

of Berkshire, England." *International Journal of Disaster Risk Reduction* 52: 101980. https://linkinghub.elsevier.com/retrieve/pii/S2212420920314825.
34. Presidential Regulation Number 79 of 2019 concerning the Acceleration of Economic Development in Kendal - Semarang - Salatiga - Demak - Grobogan, Purworejo - Wonosobo - Magelang - Temanggung, and Brebes - Tegal - Pemalang areas.
35. Regional Medium-Term Development Plan (RPJMD) of Pekalongan City Government, 2021-2026
36. Richards, C. E., Gauch, H. L., & Allwood, J. M. (2023). International risk of food insecurity and mass mortality in a runaway global warming scenario. *Futures, 150.*
37. Sa'diyah H, Buchori I, Amirudin A. 2020. Exposure index of flood and tidal flood in the city and regency of Pekalongan. *In:* Herlinda S *et al. (Eds.),* Proceedings of the 8th National Seminar on Suboptimal Land 2020, Palembang October 20, 2020. pp. 400-408. Palembang: University Publishers & Printing.
38. Shalsabilla, A., Setiyono, H., Sugianto, D. N., Ismunarti, D. H., &; Marwoto, J. (2022). Study of Sea Level Fluctuations as an Impact of Climate Change in Semarang Waters. *Indonesian Journal of Oceanography, 4*(1), 69–76.
39. Srivijaya (UNSRI). Susanto, K. E., & Mardiatno, D. (2010). Projections of sea level rise and its impact on coastal flooding. *Indonesian Geography Magazine, 24*(2), 101–120.
40. Straßer, Patrick et al. 2022. "Environmental Issues Hidden in Medical Education: What Are the Effects on Students' Environmental Awareness and Knowledge?" *Zeitschrift für Evidenz, Fortbildung und Qualität im Gesundheitswesen* 174: 97–102. https://linkinghub.elsevier.com/retrieve/pii/S1865921722001386.
41. Thakur, Dev Anand, and Mohit Prakash Mohanty. 2023. "A Synergistic Approach towards Understanding Flood Risks over Coastal Multi-Hazard Environments: Appraisal of Bivariate Flood Risk Mapping through Flood Hazard, and Socio-Economic-Cum-Physical Vulnerability Dimensions." *Science of The Total Environment* 901: 166423. https://linkinghub.elsevier.com/retrieve/pii/S0048969723050489.
42. United Nations Office for Disaster Risk Reduction (UNDRR). (2015). "Sendai Framework for Disaster Risk Reduction 2015-2030". *www.undrr.org*. Retrieved Friday, August 18, 2023 via https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030
43. Zheng, F, Seth Westra, M Leonard, and Scott A. Sisson. 2014. "Surge To Estimate Coastal Flooding Risk." *Water Resources Research*: 2050–71.