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DISASTER RISK PRIORITY LOCATION ASSESSMENT TO PROVIDE A BASIS FOR CLIMATE RESILIENCE INTERVENTION: CASE STUDY OF SEMARANG CITY, CENTRAL JAVA-INDONESIA

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Abstract

The study aims to update the climate resilience policy of Semarang City, with the objectives are to assess the priority locations of vulnerable areas to disaster utilizing Vulnerability Index and provide specified location of prone area for the local climate resilience policy in Semarang City. The research applied Vulnerability Index that derived from a function of Exposure, Sensitivity, and Adaptive Capacity. Data source adopted from the Information System and Data of Vulnerability Index or SIDIK. This study compared two basic scales of Sensitivity and Exposure Index (SEI) and Adaptive Capacity Index (ACI) score from 0,5 basic scale and 1 basic scale ("zooming-in" method). The two basic scale can be drawn the different spots of categorization in smaller region (district). Based on the results of SIDIK data processing with the analysis based on 0,5 scale describes that all 16 districts in Semarang categorized as low risk category. Meanwhile, from 1 basic scale, there are 8 districts that are categorized as very high risk in quadrant I. In quadrant II (high risk), there is one district. Quadrant III (low risk) has three districts. Quadrant IV has four districts in this category. The application of "zooming-in" method for two basic scale can derive specified priority location in smaller region (district). Thus, the findings can provide precise information about vulnerable area and planning disaster resilience actions at the district level.

Introduction

Every region in the world is exposed in the climate change risks, but the impact of this tends to specific and localized to many different threats. Climate change becomes a challenge to global development due to increasing concentration of glass house gas stemmed from human activities, which mainly centred in cities (Intergovernmental Panel on Climate Change (IPCC), 2014). In a global sense, cities occupy 3% of areas in Earth, yet contribute to 60-80% of energy consumption and 75% of global carbon emission (United Nations Department of Economic and Social Affairs, 2018 and United Nation, 2022). Climate change had been acknowledged as one of a vital issue in producing sustainable development. The issue was stated as the 13th goal in the Sustainable Development Goals (SDGs). Here, SDGs suggest actions in a national level to manage the climate change and mitigate its impacts. The world inhabitants have experienced the impacts, such as the escalation of natural disaster like floods caused by a continuous rain, storm, a long dry season, increasing sea level, and the increasing population of disease vectors that may threaten human life. In addition, the impacts could increase poverty, specifically to people who earn their income in farming, plantation, and animal husbandry sectors.

Climate change has become triggered disaster that threaten humans and the balance of the universe. To reduce the losses suffered as a result of these disasters, anticipatory actions need to be taken. One of them is by determining priority locations prone to natural disasters due to climate change. Determination of priority locations for areas that have vulnerability to disasters can be done by using the Information System and Data of Vulnerability Index or SIDIK. In Indonesia, the information system has been built with the aim of being utilized to support the determination of disaster threatened areas and climate resilient development planning. This is implemented based on the mandate in Law No. 32/2009 concerning Protection and Management of the Environment and strengthened by Presidential Regulation No. 98/2021 concerning the implementation of carbon economic value for achieving Nationally Determined Contributions (NDC) targets and controlling carbon emissions in national development. Planning, implementation, and monitoring and evaluation in order to build national capacity in climate resilient conditions are described in articles 34-43. That is become the reason to conduct an assessment to determine priority disaster-prone areas and plan adaptation actions to the threat of climate change from the provincial level to the lowest level in the realm of districts.

Semarang City is the capital of Central Java Province which is threatened by natural disasters due to climate change conditions. In the future of Semarang City in the next decade will encounter uncertainties on the pattern of rainfall and season. Whereas, the air temperature remains increase and the threat of increasing sea level is continuing. In 2010, the air temperature across Semarang City is predicted to increase approximately 1.9^0-2.9^0C and the sea level increased into 48-60 cm (Asian Cities Climate Change Resilience Network (ACCCRN), 2014). This trend might be a normal state along with the climate change in a global scale. As such, Semarang City's plan to adapt to the change is mandatory. The Climate Resilience Development (CRD) policy and strategy needs to be synchronized with sectoral and local programs in Semarang City. In the scientific base studies used in the CRD document, there are still gaps that need to be refined and it is related to the hazard and economic loss parameters analysed which are still limited. Currently, the latest climate projection data parameters (5x5 km) are available and the update of potential hazards due to climate change is crucial. The results of the study are expected to update information on the priority locations of vulnerable areas to disaster in Semarang City.

The study aims to update the climate resilience policy of Semarang City, with the objectives are to assessed the priority locations of vulnerable areas to disaster utilizing Vulnerability Index and provide specified location of prone area for the local climate resilience policy in Semarang City.

Literature Review

Climate Change

Climate change refers to the change of climate stemmed from either direct or indirect human activities which cause composition change of atmosphere globally and also changes on the variability of natural climate that are observed in several comparable timeframes (Decree of the Minister of Environment and Forestry of Indonesia Republic Number 33/2016 on the Guidance of the Drafting of Adaptation Action on Climate Change). Whereas, according to the Intergovernmental Panel on Climate Change (IPCC), 2014), climate change is change on climate from time to time either caused by natural factors or the impacts of human activities.

In order to analyse the drift of climate condition in an area and within a time interval, a drafting of climate scenario is conducted. According to Decree of the Minister of Environment and Forestry of Indonesia Republic Number 33/2016 on the Guidance of the Drafting of Adaptation Action on Climate Change, climate scenario is a representation of climate circumstance in the future that is drafted based on the outputs of climate models. Such models are developed to study the anthropogenic consequences of climate change. In climate research, the scenario is utilized to investigate the extent of human contributions to climate change in the future that is seen through particular factors, such as population growth, economic development, and new technology development (General Directorate of Climate Change Control-Ministry of Environment and Forestry, 2015). The impacts of climate change can deliver losses to human life in physical, social, and economy states.

Vulnerability

Vulnerability is the degree of damage (Proag, 2014). It refers to the degree of lose or loss stemmed from a phenomenon occurrence. According to Decree of the Minister of Environment and Forestry of Indonesia Republic Number 33/2016 on the Guidance of the Drafting of Adaptation Action on Climate Change, vulnerability is a tendency of a system to experience negative impacts, including a sensitivity to negative impacts and the lack of adaptive capacity to handle such negative impacts. The vulnerability of a system to climate change is a function of Exposure, Sensitivity, and Adaptive Capacity. The equation is as follows:

Vulnerability = f (Exposure, Sensitivity, Adaptive Capacity)

Exposure

Exposure is a possibility of an area to experience negative impacts within the context of human existence, livelihood, species/ecosystem, life environment function, services and resources, and infrastructure or economic, social, and cultural assets (Ministry of Environment and Forestry-Republic of Indonesia, 2016). Exposure is highly affected by geographic function. For instance, inhabitants who live in the hillside are more prone to suffer from landslide whilst they who live in coasts have greater possibility to suffer from the rise of sea level (Mercy Corps Indonesia, 2017).

Sensitivity

Sensitivity is a level where a system will be affected or will response to climate stimulation and could transfer it into socio-economy changes (Ministry of Environment and Forestry-Republic of Indonesia, 2015). For example, non-permanent types of houses are more vulnerable to decay when disaster occurs.

Adaptive Capacity

Adaptive capacity is an ability of a system to adapt to climate change, including climate variances and extreme climate and therefore the potential of damage can be diminished or prevented (Ministry of Environment and Forestry-Republic of Indonesia, 2015). In a simple term, adaptive capacity is a capability of a city to adapt to climate change by reducing the possibility of damages, utilizing resources and the available chances, or by handling its consequences (Mercy Corps Indonesia, 2017). For instance, high-income individual possesses a greater capability to overcome consequences and to respond climate change or after a disaster occurs.

The size of the impact or consequence (K) caused by a disaster event (climate change) on a system will be determined by the level of exposure (Exposure, E), Sensitivity (S) and Capacity (C) of the system. Vulnerability describes the extent to which the system can tolerate a change or deviation (in relation to climate change). If the change/deviation exceeds the tolerance limit of the system, the system becomes vulnerable because the deviation or climate change causes negative impacts. Therefore, Vulnerability (V) can be represented by biophysical and environmental conditions, as well as socio-economic conditions, which are further expressed by the Sensitivity and Exposure Index (SEI). The risk value of climate impacts is not only influenced by the vulnerability index, but also by the probability of occurrence. As mentioned above, the magnitude of the impact is influenced by the level of tolerance of the system to climate deviations that occur. In terms of the risk of floods and droughts, the climate variable rainfall can be used as a trigger for disaster occurrence. Thus, the probability of occurrence of rainfall above a certain threshold (in the case of floods) or rainfall below a certain threshold (in the case of droughts) together with the vulnerability index can be used to categorize the risk value that will occur.

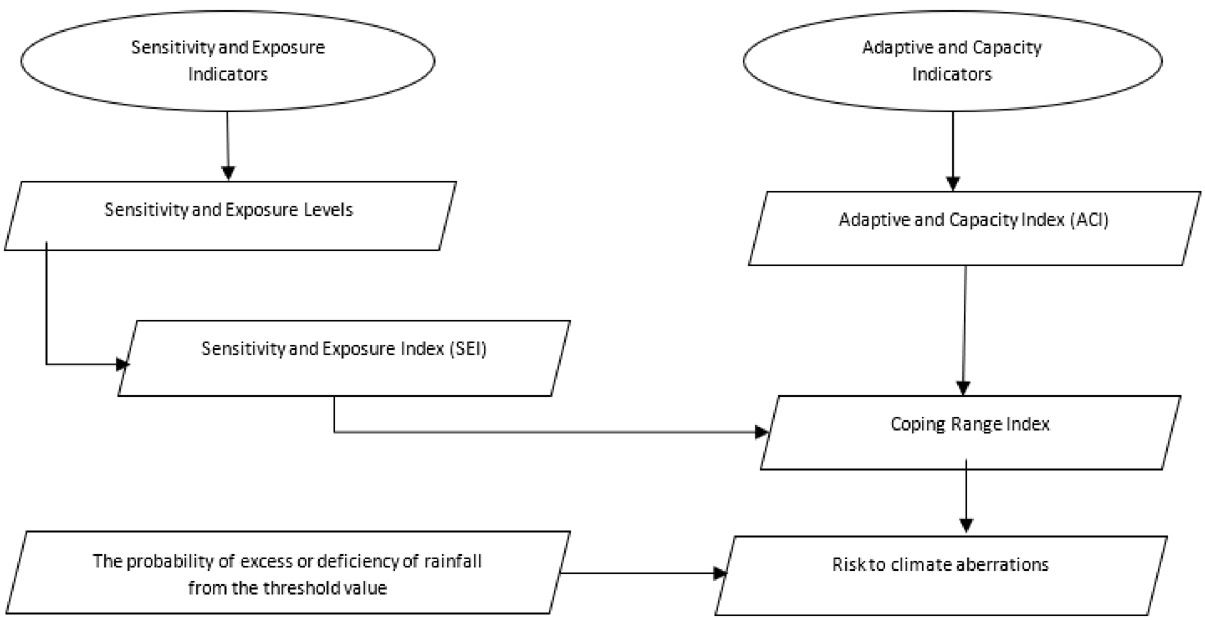

Figure 1: Framework for formulating risk categories for climate aberrations
Source: General Directorate of Climate Change Control-Ministry of Environment and Forestry, (2015)

Methods

The Index of Disaster Vulnerability

The vulnerability to climate change is determined by indicators that influence exposure, sensitivity, and adaptation capacity of a system within an environment (Brook, 20023; IPCC, 2014;). Such factors will change along with the implementation of development activities and adaptation efforts. The level of exposure and sensitivity can be reflected from the biophysics, environment, and socio-economic states.

The magnitude of impacts or Consequence (C) of disaster occurrence (climate change) in a system will be determined by its level of Exposure (E), Sensitivity (S), and Capacity (C). Whilst vulnerability describes the extent to which the system can tolerate changes or deviations in accordance to climate change. Provided the changes or deviations surpass the level of system tolerance, thus the system becomes vulnerable since the climate change delivers negative impacts. Therefore, such vulnerability can be represented by biophysics and environment, as well as socio-economic state, which in turn stated with a sensitivity index of vulnerability or Sensitivity and Exposure Index (SEI). For instance, poor people are more vulnerable than the rich ones, or people live at the edge of the river are vulnerable to floods threat.

Capacity (C) shows an ability to avoid or anticipate, handle or manage the impacts, or an ability to quickly recover from impacts. A high-capacity system should have a wide tolerance to variance or change of climate. The capacity is also represented by biophysics and environment and socio-economics associated with ability. For example, a farmer whom his or her only source of living is merely from farming could possess a lower capacity than another farmer who has various sources. Such adaptative capability is stated with an Adaptive Capacity Index (ACI) (General Directorate of Climate Change Control-Ministry of Environment and Forestry, 2015**)**

In this sense, in accordance to support efforts of risks mitigation and the impacts of climate change, The General Directorate of Climate Change Control through The Directorate of Adaptation to Climate Change developed Information System and Data of Vulnerability Index (Sistem Informasi dan Data Indeks Kerentanan or SIDIK). SIDIK provides data and information on vulnerability to climate change using village/sub-district as a unit. Currently, SIDIK utilizes social-economy, demography, geography, and environmental infrastructure data of Village Core (Data Pokok Desa or PODES). The aim is to provide information of vulnerability to climate change in order to support the development policy of central and municipal government, in accordance to the planning efforts on adaptation and risk mitigation of the impacts of climate change.

The first version of SIDIK was developed based on the data of PODES, recorded by Central Statistics Bureau (Badan Pusat Statistik or BPS). Then, several variables were chosen to represent the level of exposure and sensitivity-formulated in the Sensitivity and Exposure Index or SEI and the level of adaptive capability-formulated in the Adaptive Capacity Index or ACI. Higher SEI level shows more vulnerable state. On the contrary, higher ACI level shows a less vulnerable state.

SEI consists of 8 indicators: population density, fuel source, water closet facility, type of bin, main source of income, clean water source, poverty level, and the topography of part of village. ACI comprises of 13 indicators: road infrastructure, health facility, education facility, electrical facility, society institution, communication, micro and small business, economic facility, credit facility received by citizen, financial institution, activity of environment preservation, social activity, and health insurance. Table 1. shows the description of several indicators in SIDIK.

Table 1: The Sample of Indicators in SIDIK

Factor	Indicator	Description
Exposure	Geographic location of village	It portrays the relative position of village in accordance to the easiness to be exposed to diversity and climate change (coastal village, valley, highland, and so on). E.g., villages near to coast line have a greater exposure to the threat of rising sea level, villages around hillside are exposed to landslide, villages in valleys are exposed to floods, etc.
Sensitivity	Main source of income	It describes the sensitivity level of source of income of a family to climate condition. An area which its inhabitants' main source of income predominantly from farming and fishery activities is more sensitive to climate condition. The occurrence of climate anomalies will heavily determine the inhabitants' number of income. This causes them to be more vulnerable than those who earn their income other than farming or fisheries sectors.
Adaptive Capacity	Credit and cooperation facility	It describes the level of easiness of village society to access sources of funding and living needs. The number of facilities shows institutional circumstance in the village. The more facilities villages have, the better the adaptive capacity of their society.

Source: General Directorate of Climate Change Control-Ministry of Environment and Forestry, (2015)

In turn, the indicators are converted to 0-1 range using the principle of 1-10 percentile. The multiplication of weight and value of such indicators are then summed to gain the final SEI and ACI values of each area. In this study, the calculation of the SIDIK based-index of disaster vulnerability sourced from the 2019 Ministry of Environment and Forestry-Directorate of Climate Change Control (KLHK-PPI) data. The data are the ACI and SEI of Semarang City. Both indexes are used for determining the position of an area in a quadrant of class determination of disaster vulnerability. It is a downscaling method to compared the result of vulnerability index to capture in-depth analysis of prone area. SIDIK data can be calculate using 1 basic scale and 0,5 basic scale.

The analysis based on 0,5 basic scale. Based on the values, each area is mapped into a quadrant to determine the level of area vulnerability as portrayed in Figure 2. The values of SEI and ACI are transferred to -0.5 to 0.5 in order to drawn the quadrant position of each area. Prior to this, the ACI and SEI data is converted into an interval of -0.5 to 0.5, in order to be included in the 5 categories of vulnerability. The categories are Very Low (Quadrant 1), Low (Quadrant 2), Medium (Quadrant 3), High (Quadrant 4), and Very High (Quadrant 5).

SIDIK data calculation total scores are based on 1 basic scale. This basic scale is portrayed scores from every sub-district and give a specified SEI and ACI calculation. This research was carried out to determines scores of SEI and ACI to identified the vulnerability index and classified the priority location of prone area in smaller region (sub-district or kelurahan) then can produce the average of SEI and ACI district/kecamatan score. From this classification can be drawn into a quadrant which classified the district prone area with specification of risks, inter alia Quadrant I: Very High Risk; Quadrant II: High Risk; Quadrant III: Low Risk; Quadrant IV: Very Low Risk. This is the zooming in method to figure out the specified location of prone area that prioritized based on their risk to disaster and adaptive capacity.

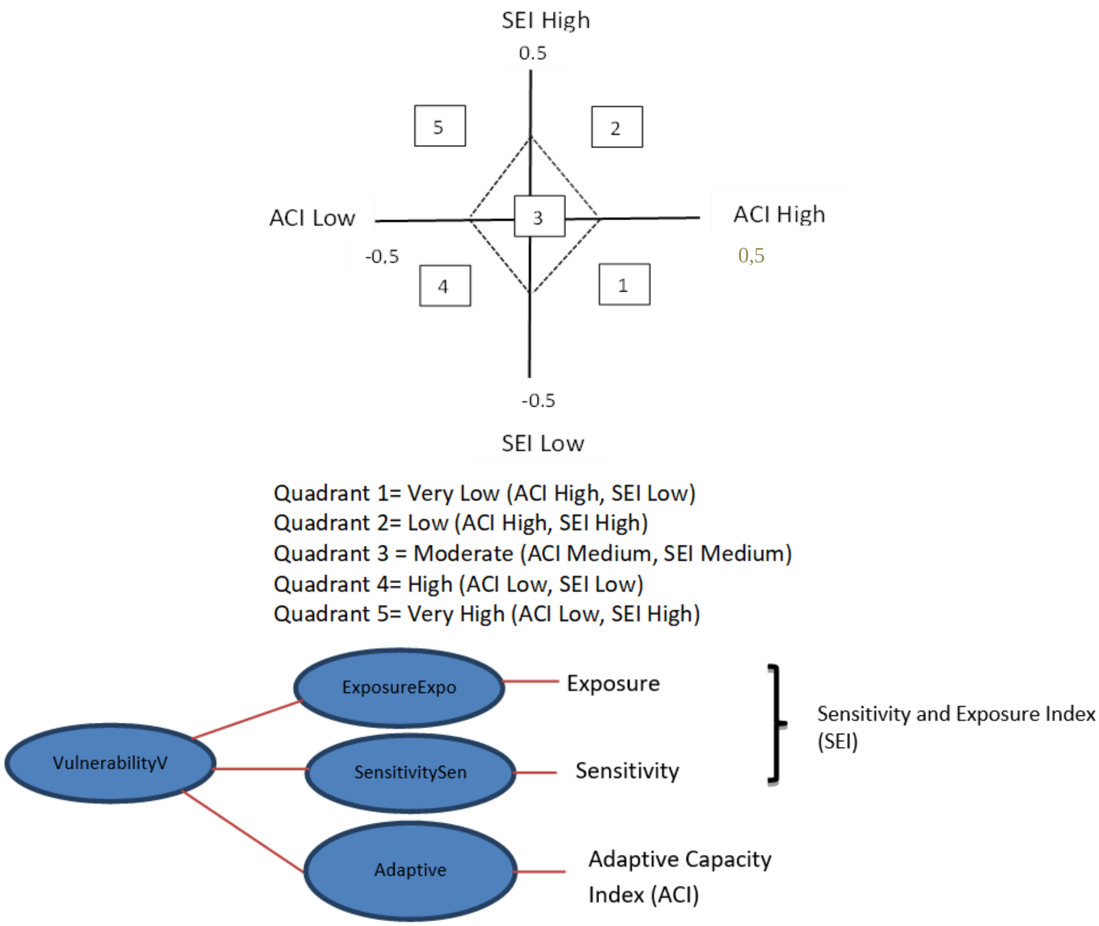

Figure 2: The Quadrant of Vulnerability to Disaster and Types of Vulnerability Indicator
Source: General Directorate of Climate Change Control-Ministry of Environment and Forestry, (2022)

Result and Discussion

Research Location Overview

Semarang City locates between 109º35’ – 110º50’ East Longitude and 6º50’ – 7º10’ South Latitude. The city owns a geo-strategic position as it is within the line of economic traffic of Java Island and is a development corridor of Central Java. Such corridor comprises of four gates. The north corridor is Java North Coast, the south corridor is heading to the dynamic cities like Magelang and Surakarta (they are known as Merapi-Merbabu corridor), the east corridor is heading to Demak or Grobogan Regencies, and the west corridor is heading to Kendal Regency. Semarang City and such regencies are included in an integrated area abbreviated as Kedungsepur (Kendal Regency, Demak Regency, Semarang Regency, Semarang City, Salatiga City, and Purwodadi/Grobogan Regency).

Semarang City widths 373.70 km^2 and occupies 1.15% of Central Java Province’s mainland. The administrative borders are as follows:

- West: Kendal Regency.
- East: Demak Regency.
- South: Semarang Regency.
- North: Java Sea.

The city has coastal length of 13.6 kilometres and consists of 16 districts (kecamatan) and 177 sub-districts (kelurahan). The details of each district are displayed in Table 2.

Table 2: The Administrative Division of Semarang City

ID	District	The Number of Sub-Districts	Wide (km^2)	Percentage (%)
1	Mijen	14	57.55	15.40
2	Gunungpati	16	54.11	14.48
3	Banyumanik	11	25.69	6.87
4	Gajahmungkur	8	9.07	2.43
5	Semarang Selatan	10	5.93	1.59
6	Candisari	7	6.54	1.75
7	Tembalang	12	44.2	11.83
8	Pedurungan	12	20.72	5.54
9	Genuk	13	27.39	7.33
10	Gayamsari	7	6.18	1.65
11	Semarang Timur	10	7.7	2.06
12	Semarang Utara	9	10.97	2.94
13	Semarang Tengah	15	6.14	1.64
14	Semarang Barat	16	21.74	5.82
15	Tugu	7	31.78	8.50
16	Ngaliyan	10	37.99	10.17
	Total	177	373.7	100

Source: Central Statistics Bureau (BPS) of Semarang City (2023)

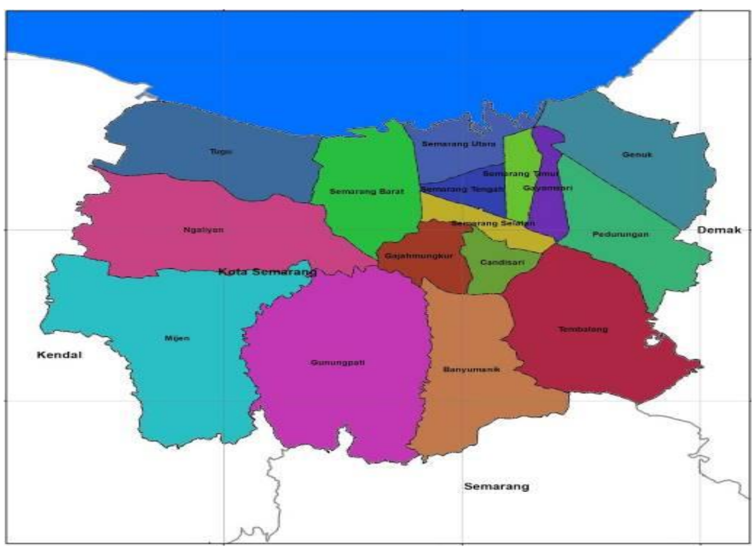

Figure 3: Map of Semarang City

Source: The Office of Regional Planning (Bappeda) of Semarang City (2020)

Demographics

The population of Semarang City reached 1,687,222 people in 2021. The most populated sub district is Pedurungan with 197,059 people or approximately 11.68% of Semarang City's total population. On the contrary, the lowest density resided in Tugu District at 34,120 people. These are shown in Table 3.

Table 3: The Population of Semarang City in 2022

District	Sex		Total
	Male	Female	
Semarang Tengah	28,201	30,596	58,797
Semarang Barat	76,870	79,382	156,252
Semarang Utara	60,744	62,285	123,029
Semarang Timur	34,546	36,426	70,972
Gayamsari	36,188	36,784	72,972
Gajah Mungkur	29,252	30,046	59,298
Genuk	61,055	60,536	121,591
Pedurungan	97,802	99,257	197,059
Candisari	38,793	39,892	78,685
Banyumanik	70,602	72,283	142,885
Gunungpati	48,718	48,973	97,691
Tembalang	93,041	93,649	186,69
Tugu	17,070	16,942	34,012
Ngaliyan	70,257	70,943	141,200
Mijen	39,179	39,289	78,468
Semarang Selatan	33,086	34,535	67,621
Total	835,404	851,818	1,687,222

Source: Central Statistics Bureau (BPS) of Semarang City (2023)

Table 3 shows on 2022 the growth had been decreased and the density slightly increased. The growth indicates a proper state as it remains below 2.5%, a threshold of Indonesian average growth rate. It also indicates the high density's sub-districts are those which possess characteristics of a developed industrial area. They are Gayamsari, Semarang Timur, and Semarang Utara.

SIDIK Data Results in 0,5 Basic Scale

The category of disaster vulnerability can be depicted in the position of the disaster vulnerability quadrant created by reducing the index of sensitivity and exposure index (SEI) and the index of adaptive capacity (ACI) to a base of 0.5. The scores of SEI and ACI from 0,5 basic scale, it appears that vulnerability in every district at Semarang City falls into low category. From table 4. shows Tugu District gains the highest ACI. It indicates the district has the best adaptation capability to disaster vulnerability among others across Semarang City. On the other hand, Pedurungan District has the lowest one and this indicates the district possesses the lowest adaptation capability. Notwithstanding, such circumstances do not mean that Pedurungan is more vulnerable than others in term of exposure to disaster. The SEI is an index that describes the vulnerability state of an area in the setting of exposure to disaster and the sensitivity of bearing the disaster losses. The three highest SEI in Semarang City are in Semarang Timur district (0.264), followed by Gayamsari (0.264) and Genuk (0.254).

The combination of ACI and SEI could be used for mapping the position of disaster vulnerability of each district and its ability to struggle and to fix onto its initial state. Figure 4. portrays the map in the form of joint quadrant of ACI and SEI. However, it is still important to be aware of the threat of sea level rise given that Semarang City is directly adjacent to the Java Sea. Such changes will impact the residential areas and threaten the job loss of small fishermen around the coast of Semarang City.

Table 4: The Average Values of ACI and SEI based on 0,5 scale

No.	District	ACI	SEI
1	Pedurungan	0,337	0,202
2	Gunung Pati	0,349	0,235
3	Genuk	0,351	0,254
4	Semarang Utara	0,347	0,253
5	Mijen	0,340	0,222
6	Gayamsari	0,351	0,263
7	Semarang Barat	0,387	0,232
8	Semarang Timur	0,349	0,264
9	Ngaliyan	0,339	0,249
10	Banyumanik	0,372	0,206
11	Candisari	0,343	0,236
12	Gajah Mungkur	0,363	0,229
13	Semarang Tengah	0,366	0,210
14	Tugu	0,391	0,206
15	Tembalang	0,357	0,198
16	Semarang Selatan	0,377	0,193

Source: SIDIK data of Semarang City (2019)

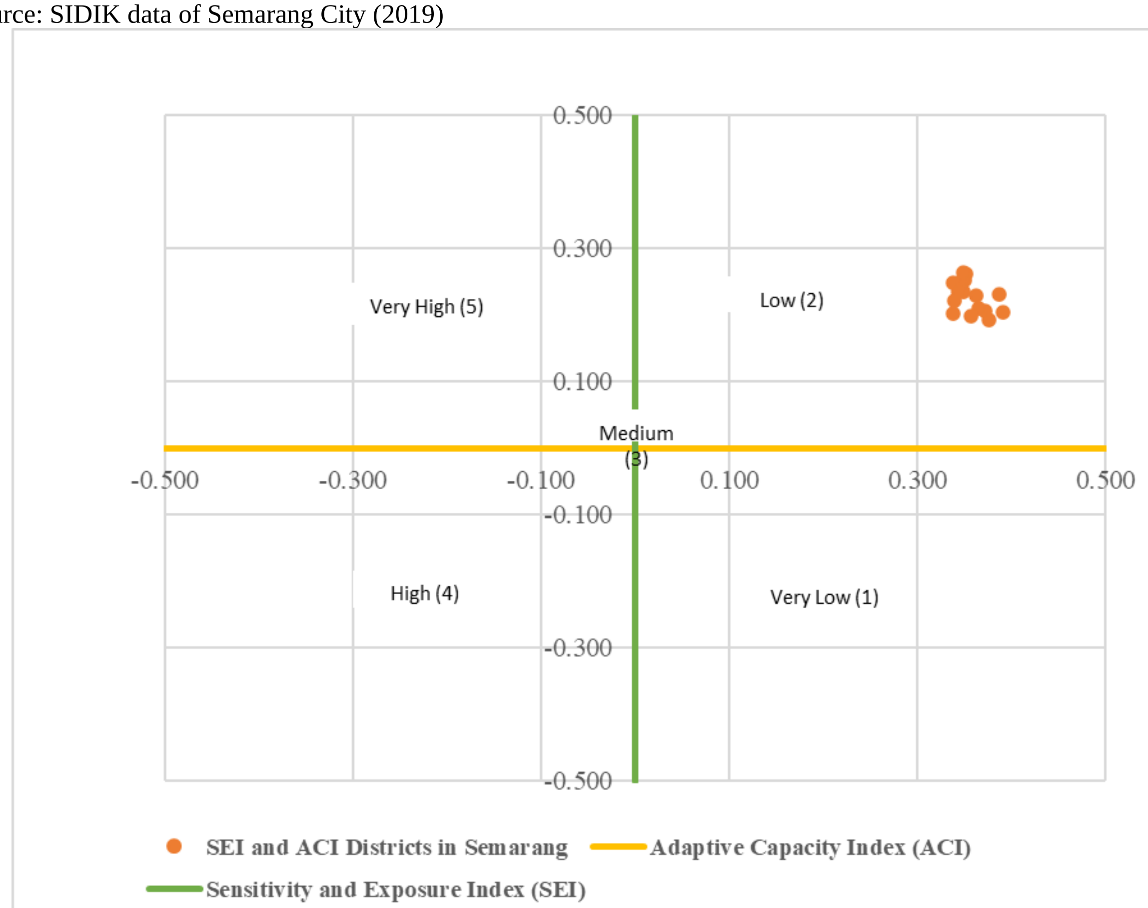

Figure 4: Vulnerable Categories Based on Vulnerability Index to Disaster (0,5 basic scale)

Figure 4. describes that the categories of disaster vulnerability can be depicted in the position of the quadrant of disaster vulnerability. The quadrant is formed by stating the SEI and ACI into a base of 0.5. Based on these categories, the disaster vulnerability in Semarang City is categorized into the low category. This quadrant shown the absolute rank of vulnerability index in Semarang City. Meanwhile, the relative rank of the vulnerability index (ACI and SEI score based on 1 scale) can describe more in-depth classification ("zooming-in" at district area).

SIDIK Data Results in 1 Basic Scale

The first result related to SIDIK data is the average values of ACI and SEI for each district in Semarang City, as shown in Table 5. The highest index of adaptive capacity (ACI) in Semarang City is Tugu District. This indicates that Tugu district has the best ability to adapt to disaster-prone conditions among the 16 districts in Semarang City. Pedurungan district is the lowest with an ACI of 0.675. This position means that Pedurungan district is less adaptable than the other 15 districts in Semarang. However, this does not mean that Pedurungan is more vulnerable than the others to disaster exposure. The index of exposure and sensitivity (SEI) is an index that describes the condition of an area's vulnerability to being exposed to disasters and sensitive to bearing disaster losses. The highest exposure and sensitivity index score in Semarang City is in East Semarang district (0.527). This is followed by Gayamsari district (0.526) and Genuk district (0.507).

The disaster vulnerability conditions contained in the disaster risk position quadrant provide information on how many sub-districts in Semarang City are vulnerable to exposure and sensitivity to climate change and the ability of each district to adapt to changing conditions due to disasters. Quadrant one (I) shows districts with very high disaster risk (low ACI and high SEI). Quadrant two shows a high disaster risk position (high ACI and high SEI). Quadrant III shows low risk (low ACI and low SEI), meanwhile quadrant IV shows very low risk due to high ACI and low SEI values. The exposure and sensitivity indices were combined with the adaptive capacity index to determine the disaster vulnerability position of the area and its ability to survive and recover. This condition is depicted in the form of a combined quadrant position of SEI and ACI in Figure 5.

Table 5: Average value SIDIK data in 1 basic scale

No.	District	ACI	SEI
1	Pedurungan	0,675	0,404
2	Gunung Pati	0,699	0,471
3	Genuk	0,701	0,507
4	Semarang Utara	0,694	0,505
5	Mijen	0,680	0,444
6	Gayamsari	0,703	0,526
7	Semarang Barat	0,774	0,463
8	Semarang Timur	0,697	0,527
9	Ngaliyan	0,677	0,498
10	Banyumanik	0,744	0,413
11	Candisari	0,686	0,471
12	Gajah Mungkur	0,726	0,458

13	Semarang Tengah	0,731	0,420
14	Tugu	0,782	0,411
15	Tembalang	0,714	0,397
16	Semarang Selatan	0,753	0,386

Source: SIDIK data of Semarang City (2019)

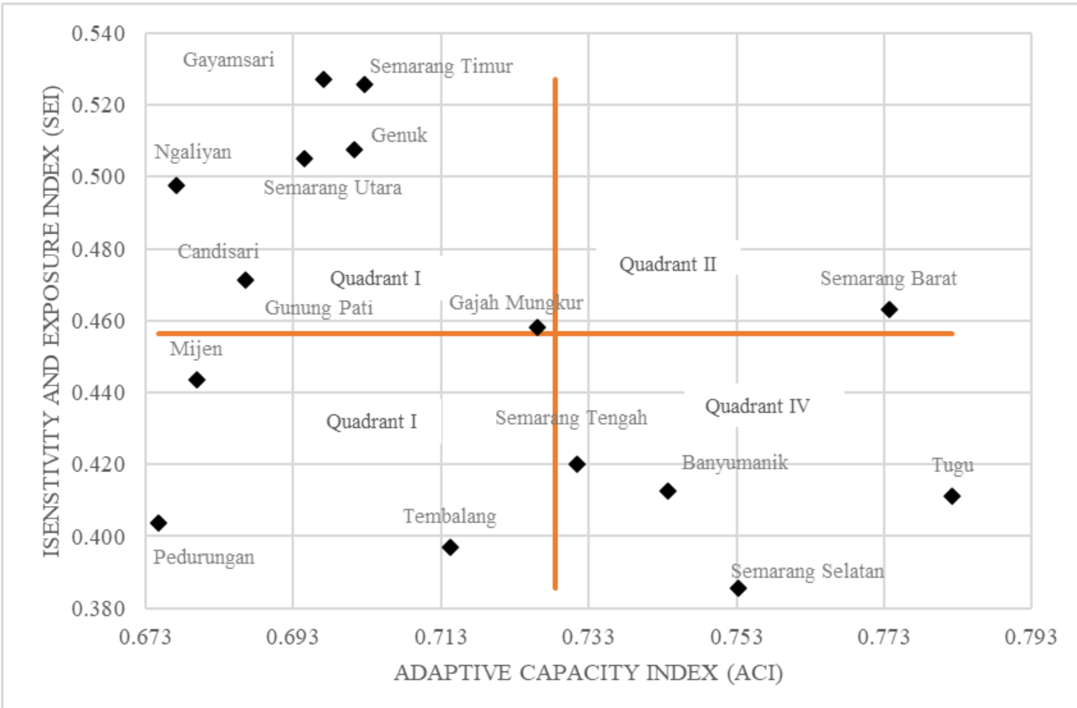

Figure 5: Disaster Risk Position Quadrant based on 1 basic scale per District

Description: Quadrant I: Very High Risk; Quadrant II: High Risk; Quadrant III: Low Risk; Quadrant IV: Very Low Risk

Based on the results of SIDIK data processing, there are 8 districts that are classified as very high risk in quadrant I. These are Gayamsari, East Semarang, Genuk, North Semarang, Ngaliyan, Candisari, Gunungpati, and Gajahmungkur. In quadrant II (high risk), there is one district, Semarang Barat. Quadrant III (low risk) has three districts, including Mijen, Pedurungan and Tembalang. Quadrant IV has four districts in this category, including Semarang Tengah, Banyumanik, Tugu and Semarang Selatan.

The the first rank of priority location is Gayamsari district then followed by Genuk, Semarang Timur, Semarang Utara, Ngaliyan, Candisari, Gunungpati, Gajahmungkur, Semarang Barat and Mijen for the 10th rank of vulnerable risk. Then the next rankings are Pedurungan, Tembalang, Semarang Tengah, Banyumanik, Tugu, and Semarang Selatan. This rank based on the average values of ACI and SEI (1 based value).

Meanwhile, from the analysis based on 0,5 scale describes that all district in Semarang categorized as low risk category. Notwithstanding, one must warrant the threat of sea level rise since Semarang City has a direct border with Java Sea. The rise could deliver impacts to people housing and may create threat on the job loose for the small fishermen along the coastal areas of Semarang City. The occurrence of sea level rise in Semarang City started in 1985. During 1985-1998, the sea level rise was 58.2 cm, with average rise of about 4.47 cm/year (Asian Cities Climate Change Resilience Network (ACCCRN), 2010).

The value of sea level rise stemmed from the influence of global warming is calculated by assessment of difference between total value of sea level rise and the value of decreasing land in the location of tide station. The 1985-1998 and 2003-2008 data are used for the study. The result, along with considering the land subsidence in the measurement location of about 5,165 cm/year, is that the sea level rise reaches approximately 7.8 mm/year. The result does consider the vulnerable position to disaster (high and extremely high) of several districts in Semarang which have a direct border with coastal areas: Semarang Utara, Semarang Barat, Genuk, and Semarang Timur. The intrusion of sea water stemmed from sea level rise often named as "rob" floods or coastal floods frequently occurs in such districts.

Table 6: Vulnerability Rank of Semarang District

Vulnerability Rank	District
1	Gayamsari
2	Genuk
3	Semarang Timur
4	Semarang Utara
5	Ngaliyan
6	Candisari
7	Gunungpati
8	Gajah Mungkur
9	Semarang Barat
10	Mijen
11	Pedurungan
12	Tembalang
13	Semarang Tengah
14	Banyumanik
15	Tugu
16	Semarang Selatan

In Semarang Utara District, the vulnerable areas to coastal floods are in Panggung Kidul, Purwosari, Tanjung Mas, and Bandarharjo Sub-Districts. In Semarang Barat District, the areas are within Tawangsari, Tawangmas, Krapyak, Tambakharjo, and Kalibanteng Kulon Sub-Districts. In Genuk District, the areas are in Genuksari, Bangetayu Kulon, Sembungharjo, and Penggaron Lor Sub-Districts. Whereas in Semarang Timur District, the areas are Kemijen, Rejomulyo, Mlatibaru, Rejosari, and Bugangan Sub-Districts. The coastal floods stemmed from the intrusion of sea water and land subsidence along the coastal areas of Semarang City. Such land subsidence reaches 10 cm per year, based on the research of ITB's geology expert Heri Andreas (CNN Indonesia, 24 May 2022). BAPPENAS (2019) finds the land subsidence occurs approximately between 1-20 cm per year. The drivers are groundwater intake, pressure of objects in the surface, tectonic activities, and natural consolidation (Adipradana, 2019).

Semarang City also flowed with many rivers and in total there are 37 watershed areas (Daerah Aliran Sungai or DAS). The ability of each watershed area to accommodate water debit in raining season does become a possibility of floods vulnerability. In this sense, there is also an urgency to monitor the shallowing of watershed area and the shift of land usage along watershed areas. These will impact to the decreasing ability of capacity of river flow which eventually result in the unstoppable rainwater runoff. This circumstance mainly drives floods in Semarang City. Higher the intensity and the amount of rainfall will trigger stronger water debit that flow along the watershed. The rainwater runoff will endanger housing and farming or plantation areas since it has a potential to create flash floods.

DAS which experience most frequent flash floods is the DAS Garang River. According to Suhandini (2012) research found the flash floods in DAS Garang River occurred five times (1963, 1990, 2000, 2002 and 2008). There are possibilities the heavy flash floods may happen in the future, in line with the increasing rainfall in the upstream of DAS Garang River. DAS Garang River's flash floods tend to getting more dangerous because the peak water debit be inclined to increase and the duration to achieve flash floods tend to be shorter. In order to anticipate heavy and super heavy flash floods, government needs to build floods control dam in Kreo River and Kripik River (Suhandini, 2012). The details of Semarang City vulnerable areas are shown in Figure 6.

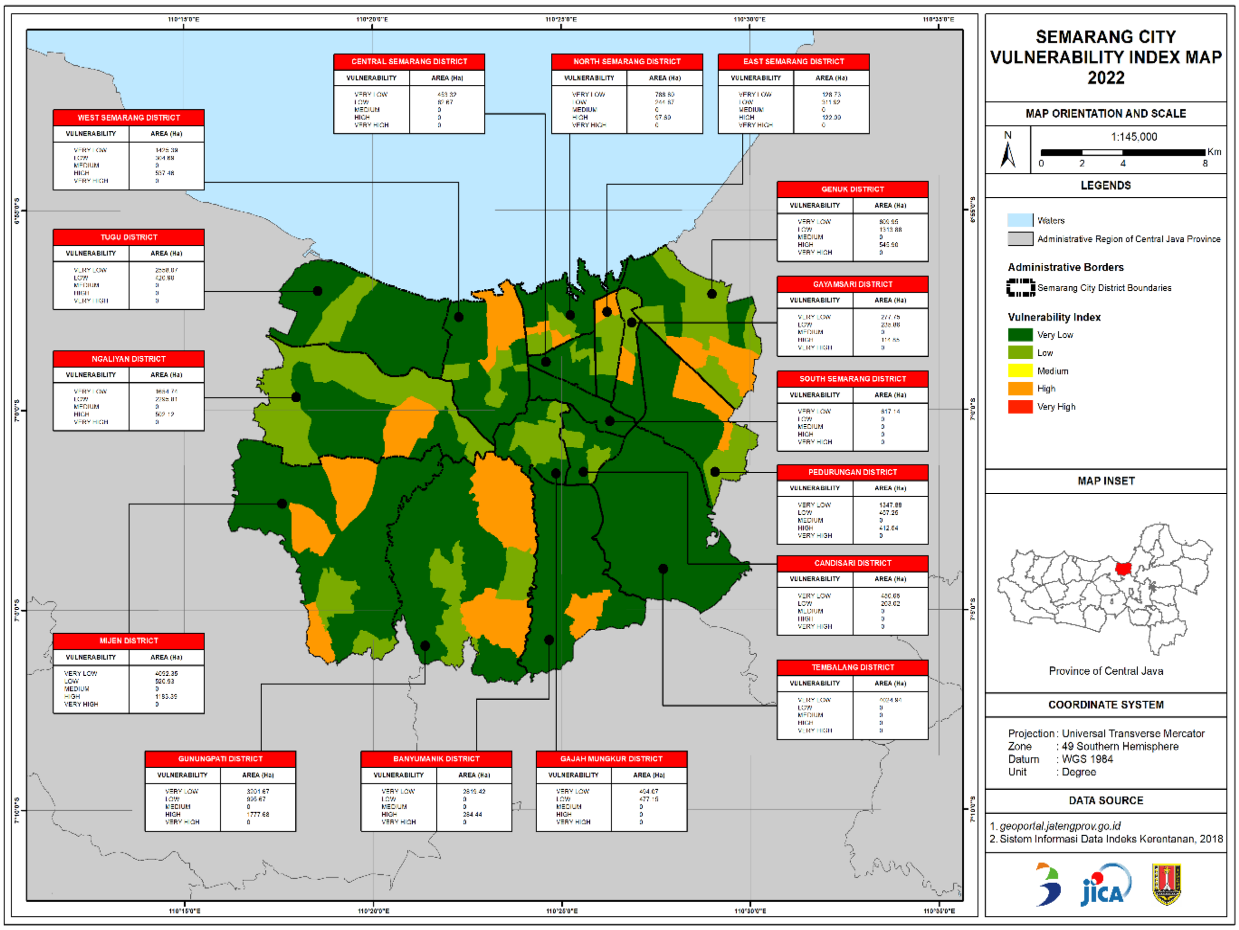

Figure 6: Map of Disaster Vulnerability per District

Conclusion

Based on the results of SIDIK data processing with on 0,5 scale describes that all districts in Semarang categorized as low risk category. Meanwhile, from the analysis based on 1 basic scale, there are 8 districts that are classified as very high risk in quadrant I. These are Gayamsari, Semarang Timur, Genuk, North Semarang, Ngaliyan, Candisari, Gunungpati, and Gajahmungkur. In quadrant II (high risk), there is one district, Semarang Barat. Quadrant III (low risk) has three districts, including Mijen, Pedurungan and Tembalang. Quadrant IV has four districts in this category, including Central Semarang, Banyumanik, Tugu and Semarang Selatan. The application of "zooming-in" method for two basic scale can derive specified priority location in smaller region (district). It can be concluded that by using 1 basic scale of SEI and ACI is more suitable to predict the location priority of prone area in district and sub-district. Thus, the findings can provide precise information about vulnerable area and planning disaster resilience actions at the district level.

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COMPETING INTERESTS

The authors have no compting interest to declare.

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