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Slum Upgrading Spatial Model Based on Level of Vulnerability to Climate Change in Coastal Area of Semarang City

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Abstract

Slum settlement is one of the significant global problems which requires special concern in the discussion agenda of Sustainable Development Goals (SDGs) of 2016-2030. The Sustainable Development Summit held in New York in September 2015 formulated that one of SDGs goals is to build inclusive, safe, resilient, and sustainable cities and settlements. In Indonesia, the achievement of this goal is stated in National Medium-Term Development Plan 2015-2019, i.e. creating 0% urban slum settlement which is supported by policies expected to accommodate the achievement of national development targets. Semarang Mayor Decree No. 050/801/2014 concerning the Determination of the Location of Housing Environment and Slum Settlements in Semarang City has been issued as the basis to identify slum settlements scattered throughout Semarang city, in terms of location, physical condition, and social conditions. This study was conducted by case studies on slum settlements in Trimulyo Village and Mangkang Wetan Village, Semarang city, Central Java Province, Indonesia, to formulate a slum upgrading model based on the resilience level of coastal communities towards climate change. The analysis included identifying the characteristics of slum settlements, scoring analysis to determine the resilience level possessed by coastal communities, and analysis of pentagon assets used to formulate slum upgrading models. The results of the study showed that these two research areas had a moderate level of vulnerability, with several different characteristics of asset ownership, particularly those related to human and social assets. Increasing the quality of human resources and social relations in the community was more intensified in the environment and community in Trimulyo, while improving the physical quality of the environment through housing improvements was carried out in Mangkang Wetan.

Introduction

Trend on population growth is dominated by urban areas which not only function as centers for development activities but also as centers of population growth (Carter et al., 2015). The increasing number of urban residents throughout the years results from various socio-economic backgrounds and some of them come to cities without a clear purpose (Olthuis et al., 2015).

Based on data from the UN Urbanization Prospect Projection, it was estimated that more than 54% of the world's population in 2016 lived in urban (Population Divisions Department of Economic and Social Affairs, 2018). Such a high population in urban areas is often insufficiently balanced by the readiness of urban system plans which may accommodate the developments. Consequently, the increasingly diverse activities but not integrated with the planned urban activity system cause many implications for the emergence of other various urban problems. The need for housing in urban areas is an essential basic need with high demand; when housing prices are nevertheless not affordable for the poor living in cities, this certainly will worsen the conditions in urban areas, one of which is the increasing number of developing slum settlements (Saad et al., 2019).

The increasing population growth in the East Asia and Pacific (EAP) Region over time has caused this region as the largest slum population in the world. There are approximately 75 million people (out of 250 million people) in EAP who live in slum areas living under the poverty level with income below US$ 3.10/day. Cities with the highest number of urban poor people are located in China, Indonesia, and the Philippines, while the highest rates of urban poverty are in the Pacific Island countries of Papua New Guinea and Vanuatu, Indonesia, and the Lao People's Democratic Republic (Judi L. Baker & Gadgil, 2017).

This issue does not only occur in one or two countries, but it has been a global issue. Thus, managing slum areas has been one of the global agendas contained in Sustainable Development Goals (SDGs) 2016-2030 (Meredith & MacDonald, 2017; Yulianto, Ibrani, P.Zakaria, & Bona Tua P.P., 2019). The handling of slum settlements in the SDGs is the 11th of the 17 goals and 169 targets expected to be achieved by 2030. The 11th goal describes "Building Inclusive, Safe, Resilient and Sustainable Cities and Settlements", with the first target is to ensure access for all communities to decent, safe, and affordable housing, including slum management and access to basic urban services. As an effort to achieve this goal, UN-Habitat formulated Participatory Slum Upgrading Program (PSUP) in 2008 as a result of discussions conducted with several representative countries of Africa, the Caribbean, and the Pacific (ACP), and the European Mission (EC). UN-Habitat assists countries to develop and implement housing policies, strategies, and programs aimed at increasing access to adequate housing, improving the living conditions of slum inhabitants, and preventing the proliferation of new slum settlements (De Schutter, 2014).

The implementation of PSUP has been seen in various countries such as the Asia Coalition for Community Action (ACCA) Program targeting an increase in inclusive slum settlements for the urban poor in Thailand (Judi L. Baker & Gadgil, 2017) and the Kenya Slum Upgrading Program (KENSUP) which seeks to improve the quality of life for people living in slum neighborhoods in Kenya by improving housing quality, community income, providing tenure security, and improving infrastructure (Meredith & MacDonald, 2017). Moreover, under the supervision of Housing and Urban Renewal Authority Inc. (HURA), a slum upgrading program is carried out in the Philippines by updating or rebuilding damaged slums and other urban communities, developing resettlement sites, and mostly by improving and promoting urban development (Minnery et al., 2013).

In Indonesia, improving the quality of slum upgrading in urban areas is one of the national priority programs towards cities without slums (KOTAKU) based on the National Medium Term Development Plan (local term: RPJMN) 2015-2019 (Bappenas, 2017). KOTAKU program is an effort to accelerate the handling of slum settlements to support the achievement of the "100-0-100" target, i.e. 100% access to drinking water, 0% slum areas, and 100% access to proper sanitation by 2019 (Public Works Office/Dinas Pekerjaan Umum, 2017). According to the Central Statistic Bureau (local term: *Biro Pusat Statistik/BPS*) data stating that by the end of 2013, access to drinking water achieved in urban areas was 67%, 11.6% for slum areas, and 59% for access to proper sanitation. Since the trend for population growth continues to increase (BPS, 2017), it is necessary to create integrated efforts to achieve the targets of this program involving the central government, local governments (provincial, regency or city, villages), and the community. Therefore, it is fundamentally reasonable that the government should gradually reduce the areas of slum settlement and increase the achievement of settlement infrastructure, specifical access to drinking water and sanitation for urban communities (Dirjen Cipta Karya, 2015a).

KOTAKU program is nationally implemented in 34 provinces involving over 268 regencies/cities in 11,067 villages (*desa* and *kelurahan*) (Dirjen Cipta Karya, 2015b). In addition, the target achievement of KOTAKU program has been carried out moderately from 2015 until 2019. Moreover, at the end of 2015, urban slum areas were targeted to be reduced to 8%; around 6% in 2016; and respectively reduced to 4% and 2% for the following years 2017 and 2018; until the target of 0% was achieved by the end of 2019.

Semarang city is one of the targets for the implementation of KOTAKU program in Indonesia. There are some slum settlements scattered in this city of which are located in coastal areas. This definitely affects the characteristics of the slum settlements in the area as seen physically from the building condition, the existence of environmental infrastructure in the settlement, as well as disaster threat like rob (seawater flooding) which frequently becomes an obstacle in managing slum areas problems. Furthermore, it can also be non-physically identified from the social life pattern of the community, how they earn money (livelihoods), and people's daily living habits. The characteristics of the people living in coastal areas certainly cannot be

separated from the current global phenomena which are closely related to climate change that directly or indirectly has implications for the lives of coastal communities (Sariffuddin et al., 2017) including those who live in the slum settlement at the coastal area. Accordingly, the efforts to improve the conditions of the slum environment must be holistically concerned both physically and non-physically regarding the characteristics of the community in dealing with the conditions they own. Thus, community participation can be considered as a significantly integral approach that needs to be implemented to achieve the goals of KOTAKU program (Yu et al., 2016).

To support the realization of the '100-0-100' program, the handling and management of slum settlements specifically in coastal areas, therefore, needs to be carried out integratively through a slum upgrading model considering the resilience level of coastal communities toward climate change which differs from one region to others.

Data and Method

Scope

The scope area of this research covered Mangkang Wetan Village (local term in Semarang city: *kelurahan*) located in Mangkang Village and Trimulyo Village, a part of Genuk subdistrict. Both villages are included in the administrative local government of Semarang City. These two areas were selected as the research areas because these villages are listed in the Decree of Semarang city Mayor No. 050/801/2014 about the Determination of the Location of Slum Housing and Settlements Environment of Semarang City, and became part of the pilot projects to improve coastal community resilience by strengthening mangrove ecosystem services and developing sustainable livelihoods in Semarang City in collaboration between Semarang City Government and NGO (Mercy Corps Indonesia) with funding assistance from the Rockefeller Foundation.

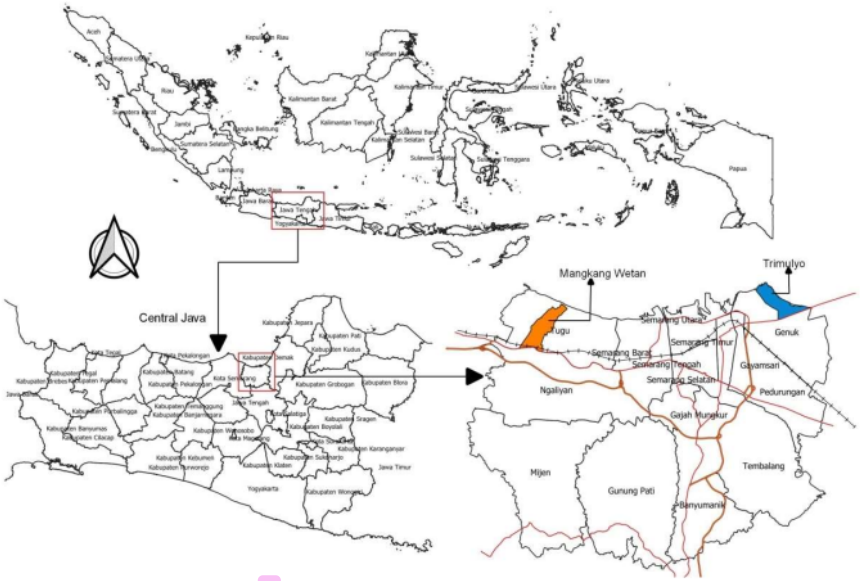

Figure 1. Location of Study Area

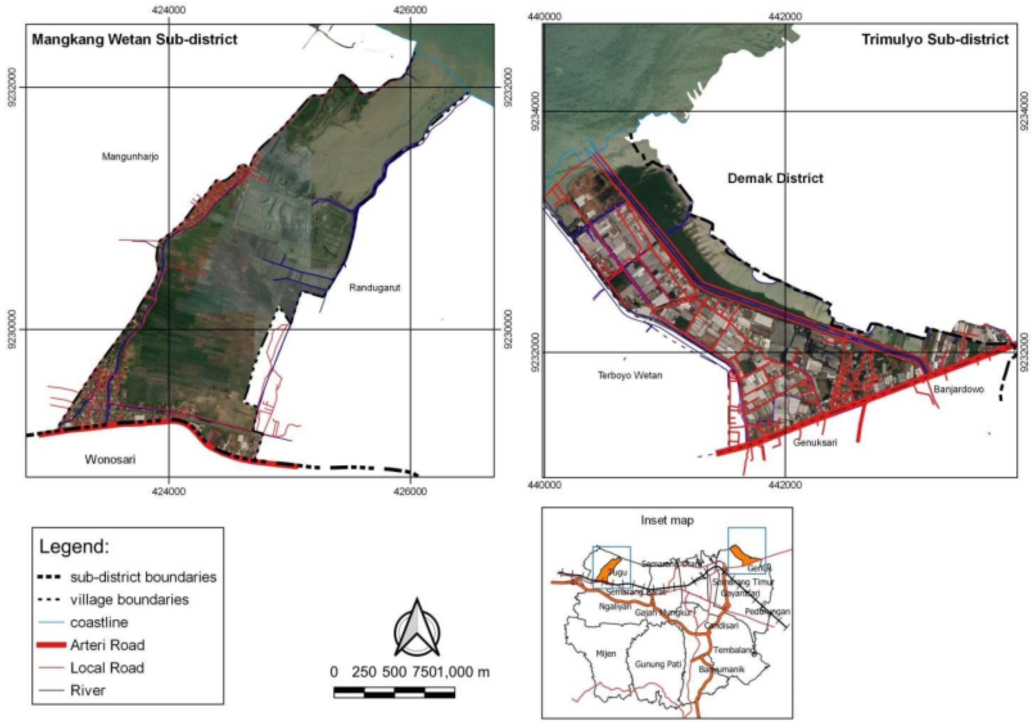

Figure 2. Map of Mangkang Wetan and Trimulyo Villages

Method

The method used in this study was quantitative. The method was used to analyze the vulnerability level of the community toward the climate change in the coastal area and formulate the slum upgrading strategy based on-field characteristics. Data gathering was performed using questionnaires and observation, also document assessment. Samples were taken using simple random sampling, with 18 respondents from Mangkang Wetan Village and 14 respondents from Trimulyo Village. There were 3 stages to answer the aim of the study:

a. Slum settlement characteristic identification

Slum settlement characteristic identification was based on few aspects which had been determined by Dirjen Cipta Karya which consists of: building condition, road condition, drainage condition, water supply condition, wastewater management, waste management, and fire extinguish system condition. Those aspects and criteria could be seen in Table 1.

b. Vulnerability level of community in the coastal area

The analysis technique used to identify the vulnerability level of the community in the coastal area was scoring. This analysis technique was performed to identify the score of every sub-variable in each exposure variable, sensitivity variable, and adaptation capability variable (Boer, 2012). The highest score from each sub-variable was different, the score was based on how much the indicator used for the scoring. In the exposure variable, the highest score was 5 points, while in the sensitivity variable the highest score was 3 and 4 points for the adaptation capability variable. However, the lowest score from every variable was all the same as, i.e. 1 point. Thus, after counting each variable, there would be 3 scores for each respondent. The formula for each respondent could be seen at equation (1) and (2):

$$\text{Variable cumulative score} = \frac{\text{Sub variable score amount}}{\text{Sub variable highest score amount}} \quad \ldots\ldots (1)$$

As explained previously, the vulnerability was affected by the exposure level, sensitivity, and adaptation capability. The vulnerability formula could be seen below:

$$\text{Vulnerability rate} = \frac{\text{exposure score x sensitivity score}}{\text{Adaptation capability score}} \quad \ldots\ldots\ldots\ldots (2)$$

Table 1. Slum Settlements Criteria (Dirjen Cipta Karya, 2015a)

No	Aspects	Criteria
1.	Building condition	Building regularity (dimension, orientation, footprint, and building form)
		Building compactness
		Building technical requirement (structure system, lighting safety, weather control, lighting, sanitation, and building material)
2.	Road condition	Service area
		Road condition
3.	Drainage condition	Inundation presence (inundation duration, inundation frequency)
		Service area
4.	Water supply condition	Technical requirement (pipe network, non-pipe network)
		Service area
5.	Wastewater management	Technical requirement (personal wastewater management, communal and center wastewater management)
		Service area
6.	Waste management	Technical requirement (warehouse, sorting, gathering, and management)
		Service area
7.	Fire extinguish system condition	Water supply to extinguish the fire (natural resource: pond, lake, river, deep well; artificial resource: water tank, pool, water reservoir, water tank car, hydrant)
		The road for the fire truck

Table 2. Sub Variable and Scoring that Affected Vulnerability Level (Analysis, 2018)

No	Variable	Sub Variable	Weight	No	Variable	Sub Variable	Weight
Exposure Variable				Adaptation Capability Variable			
1	Occupation	Fishpond owner	5	1	Group program	Exist	2
		Fishpond worker	4			Nothing	1
		Fisherman	3	2	Group program involvement	Often	4
		Processing fishery products	2			Sometimes	3
		Don't have a job	1			Never	2
2	Fishpond ownership	Yes	2			Not active	1
		No	1	3	Skill training involvement	Yes	2
3	Fishpond productivity	Not productive	2			No	1
		Productive	1	4	Training advantages	Yes	2
4	Fishpond is stricken by flood	Yes	2			No	1
		No	1	5	Training result utilization for income resource alternative	Yes	2
5	Home is stricken by flood	Yes	2			No	1
		No	1	6	Routine meeting involvement	Yes	2
6	Flood frequency in every house in a month.	> 2 x	2			No	1
		< 2 x	1	7	Routine meeting frequency	Once a week	3
7	Flood duration in every house	> 2 hour	3			Once a month	2
		1-2 hour	2			More than once a month	1
		< 1 hour	1	8	Routine meeting benefits	Exist	2
8	Source of clean water	Well	3			Nothing	1
		artesian well	2	9	Media information (group meeting, meeting in	>4 of media	3
		PDAM	1			2-3 of media	2
9		>4 people	3			<2 of media	1

No	Variable	Sub Variable	Weight	No	Variable	Sub Variable	Weight
	Family member amount	2-3 people	2		RT/RW, Radio, SMS)		
		< 2 people	1	10	Group meeting	Very effective	4
	Number of Exposure		24			Effective	3
	Sensitivity Variable					Less effective	2
1	Monthly income	< IDR 1.500.000	3			Not effective	1
		IDR 1.500.000-IDR 2.000.000	2		Meeting (RT/RW)	Very effective	4
		> IDR 2.000.000	1			Effective	3
2	Monthly outcome	> IDR 2.000.000	3			Less effective	2
		IDR 1.500.000-IDR 2.000.000	2			Not effective	1
		< IDR 1.500.000	1		Radio	Very effective	4
3	Asset ownership (Land, House, Boat, Fishpond, Etc.)	< 1 asset	3			Effective	3
		1-3 assets	2			Less effective	2
		> 4 assets	1			Not effective	1
4	Capital access/ loan	No	2		SMS/ WA	Very effective	4
		Yes	1			Effective	3
	Number of Sensitivity		11			Less effective	2
						Not effective	1
				11	Information media usage	Yes	2
						No	1
				12	Weather information needs	Yes	2
						No	1
				13	Media used to spread the information	>4 of media	3
						2-3 of media	2
						<2 of media	1
					Number of Adaptation Capability		45

c. Spatial Analysis of community in the coastal area

Spatial analysis was carried out on the results of the questionnaire in two research locations. In addition to using random sampling to determine the number of samples, the location of the sample is determined by spatial sampling. Spatial sampling is a sampling activity based on geographic/coordinate locations (Buchori & Pangi, 2015; Thompson, 1997). Respondents are marked based on their location coordinates. The results of the questionnaire answers were mapped based on sample locations and continued with interpolation analysis. The results of the interpolation analysis of the questionnaire data were used to perform spatial analysis based on the vulnerability criteria.

Results and Discussion

Slum settlements characteristic

The slum settlements area used in this study was the settlements in Mangkang Wetan village and Trimulyo village. Mangkang Wetan village is part of the Tugu subdistrict which is located in the western part of Semarang City, while Trimulyo village is one of the coastal areas located in Genuk subdistrict, Semarang City.

a. Mangkang Wetan Village

The location distribution of slum settlements in Mangkang Wetan village is in RW 5, 6, and 7 with a total slum settlements area of 13,59 hectares. The distribution of slum locations in Mangkang Wetan Village can be seen in Table 6 (Appendices).

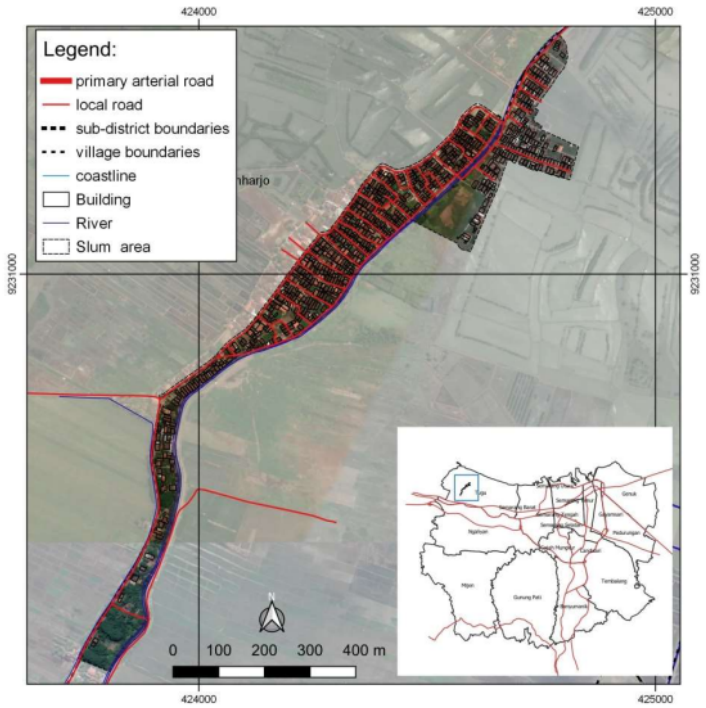

Figure 3. Map of Slum Settlements Distribution in Mangkang Wetan Village (BKM, 2017)

There were approximately 388 units of houses in the slum settlements area. Some of them were permanent units with plaster (cemented floor) or ceramic made floor, brick or wood mass wall and the roof was constructed by using the tin roof and/or wavy tile roof. The rest, 136 units, were semi-permanent buildings and 46 units were non-permanent buildings. Generally, the status of the houses in the slum settlements was personal ownership.

Based on the identification results during the field research, infrastructure in the slum area in Mangkang Wetan includes a road network in the form of footpaths and some of which were already damaged, especially in RW 05 and RW 07. The drainage system in the slum settlements area was in the form of the open canal and close canal. The drainage system of the settlements mostly had got shallower and some of the canals were already damaged. The inundation from flood location or the area with the high frequency of precipitation was the effect of this suboptimal drainage system. In addition, the clean water supply system is fulfilled through drilled wells because the PDAM (drinking water regional company – a company owned by the city government) piping system has not yet reached the location. Meanwhile, concerning wastewater treatment infrastructure (Sanitation), approximately 92% of the houses already had sanitation facilities/toileting; however, 8% of the community which does not possess the toileting yet still use the communal sanitation facilities.

b. Trimulyo Village

The location distribution of slum settlements area in Trimulyo village is in RW 3, particularly in RT 3 and RT 4 with 3.55-hectare total slum settlements area. The distribution of slum locations in Trimulyo Village can be seen in Table 7 (Appendices).

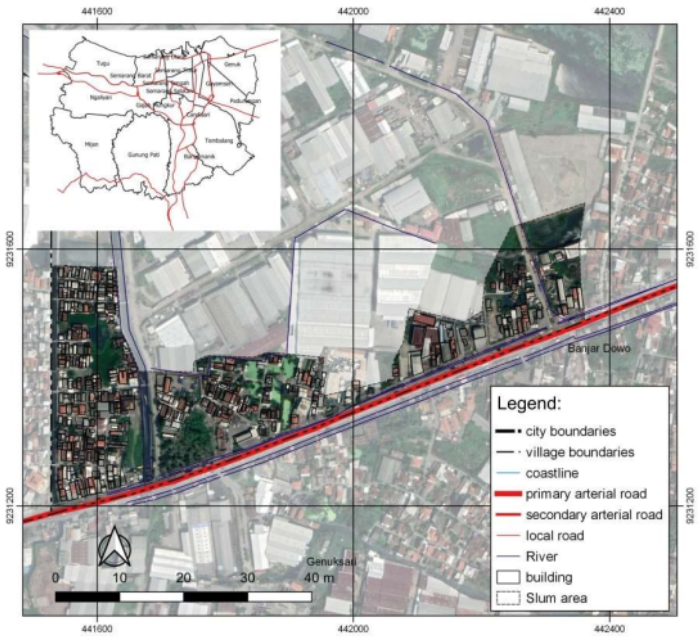

Figure 4. Map of Slum Settlements Distribution in Trimulyo Village (BKM, 2017)

The houses in slum settlements area of Trimulyo village were entirely permanent units with plaster/ceramic made floor, brick or wood mass wall and the roof was constructed by a tin roof and wavy tile roof. The status of the houses in the slum settlement was personal ownership. The road network was in the form of local environmental roads and they were generally in good condition and usable, while the drainage network was dominated by soil and masonry construction but less optimal function due to silting. As the supply of clean water in Mangkang Wetan Village, Trimulyo has not been reached by the local drinking water company (PDAM) network; thus, the community meets their clean water needs by using drilled wells. However, for sanitation, all of the people in Trimulyo Village already have their own sanitation facilities.

Vulnerability Level Analysis of Coastal Area Community in Mangkang Wetan Village and Trimulyo Village

As one of the global warming effects, the rise of sea surface has caused a change in sea current and also made the land near the seashore logged, and thus it often affects the settlements in the coastal area (Susandi et al., 2008). The settlements near the shore/river are commonly more susceptible than any other settlements far from the shore/river. It could happen since the land far from the shore/river or any waters would spend a longer duration to get logged (Wulandari, 2013).

A damaged mangrove ecosystem is another effect of the rising sea surface. Therefore, if mangrove existence cannot be revived anymore, the abrasion of the land will occur more frequently than before because there is no backup when the wave comes. This phenomenon will affect the economic condition of the community in the coastal area; thus the coastal community will be more susceptible the climate change. In concordance, the relative escalation of sea surface would bring some consequences toward the coastal area, such as littoral area would be logged (1 cm escalation of the sea surface would decrease 1 cm of the shore), erosion would occur more frequently, the salt concentration of the soil will increase so it would no longer suitable for human to consume, and also the escalation of the sea in estuary area (Suhelmi & Prihatno, 2014).

This study aimed to assess the vulnerability level of coastal areas in Semarang city by considering Mangkang Wetan (west coastal area) and Trimulyo Genuk (east coastal area) as the location of this case

study. There were 3 variables analyzed in this study, i.e. exposure, sensitivity, and adaptation capability. Based on the data acquired in the field study, the result of those variables can be described as follow:

a. Exposure

Gallopin (2006) stated that exposure level represents the level, duration, and/or chance of a system to contact with disturbance or shock (Boer, 2012). The exposure level in Trimulyo and Mangkang Wetan villages was categorized as high, i.e. 76% and 74% respectively. Moreover, the exposure level in Mangkang Wetan village was affected by the occupation of the people living mostly as pond owners. Since the expense of pond maintenance was quite high, when the abrasion came it would bring more disadvantages toward the people. Meanwhile, the vulnerability of Trimulyo village was affected by the community occupation as fishermen. Trimulyo community had no land to make a pond and there were only 2-3 people of Trimulyo village whose pond for fish cultivation. However, the land used as a pond was a government-owned one. In addition, the majority of the community worked as fishermen. Furthermore, another indicator of vulnerability level was that there were more houses damaged by the flood in Trimulyo village than those in Mangkang Wetan village. Nevertheless, in some points, flood duration in Mangkang Wetan village was much longer than in Trimulyo village. The exposure levels are depicted spatially in Figure 5. The spatial characteristics of exposure levels between Mangkang Wetan and Trimulyo village are different since Mangkang Wetan exposure level is higher than that of Trimulyo (Appendices-Table 8).

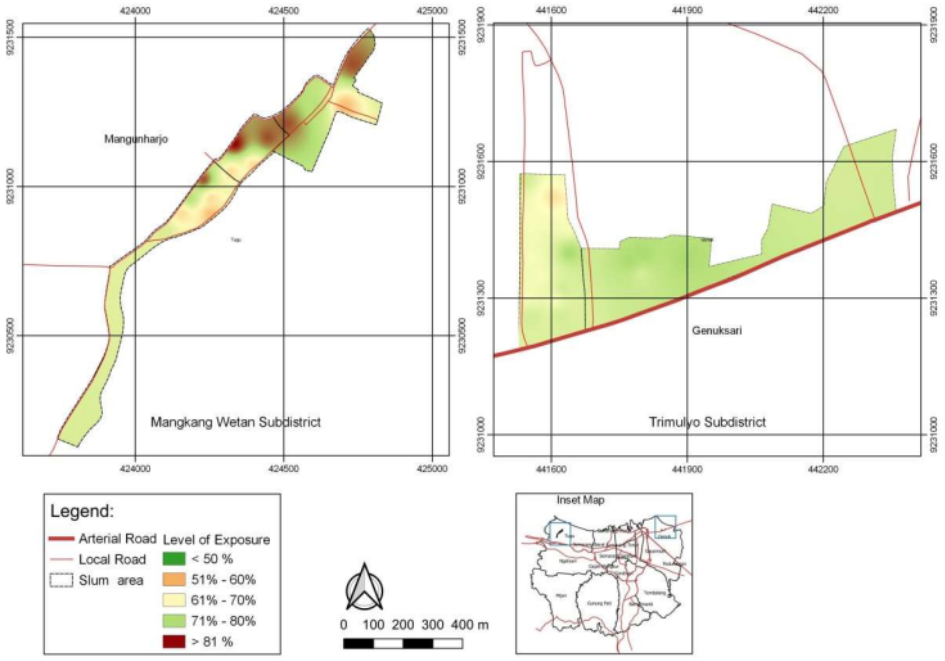

Figure 5. Map of Exposure Level in Mangkang Wetan and Trimulyo Villages

b. Sensitivity

Sensitivity was the internal condition of the system representing the vulnerability level toward any disasters (Boer, 2012). The sensitivity level of Trimulyo village was lower than that of Mangkang Wetan village (Figure 6). Moreover, Mangkang Wetan village's sensitivity level was affected by higher monthly income gained by the community than that in Trimulyo village. Furthermore, Mangkang Wetan village income ranged from IDR 1,874,931, while Trimulyo village was only ranging from IDR 1,438,889,-. Therefore, the community in Mangkang Wetan village had generally more assets than Trimulyo village's community. The assets were mostly in the form of land, house, boat, fishpond, etc. In addition, the sensitivity level of these two villages is illustrated in Table 9 (Appendices).

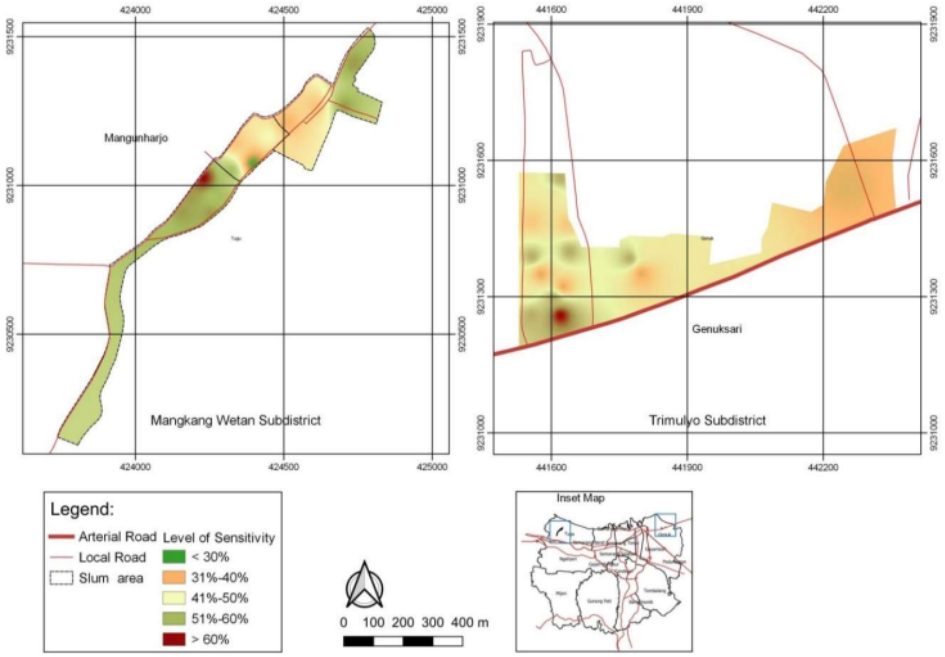

Figure 6. Map of Sensitivity Level in Mangkang Wetan and Trimulyo Villages

c. Adaptation capability

Adaptation capability represents the ability of a system to adapt toward the climate change phenomenon to reduce the negative effect and to maximize the positive effect or in other words, it could handle the consequences of climate change (Boer, 2012). The approach conducted to fishing groups was by doing some attempts to increase the community's adaptive capability toward disaster vulnerability such as training to improve skills in processing fishery products and mangrove tourism entrepreneurship as alternative sources of income for the community. Regular meetings and the use of information media are some means used by the community to respond to disasters as they live in coastal areas. Table 10 (Appendices) describes the level of adaptation capability found in this study.

Based on the result of three variables, the vulnerability level of both villages was then being counted. Vulnerability level was categorized in 3 groups: High vulnerability (>0,6), moderate vulnerability (0,3-0,6), and low vulnerability (<0,3).

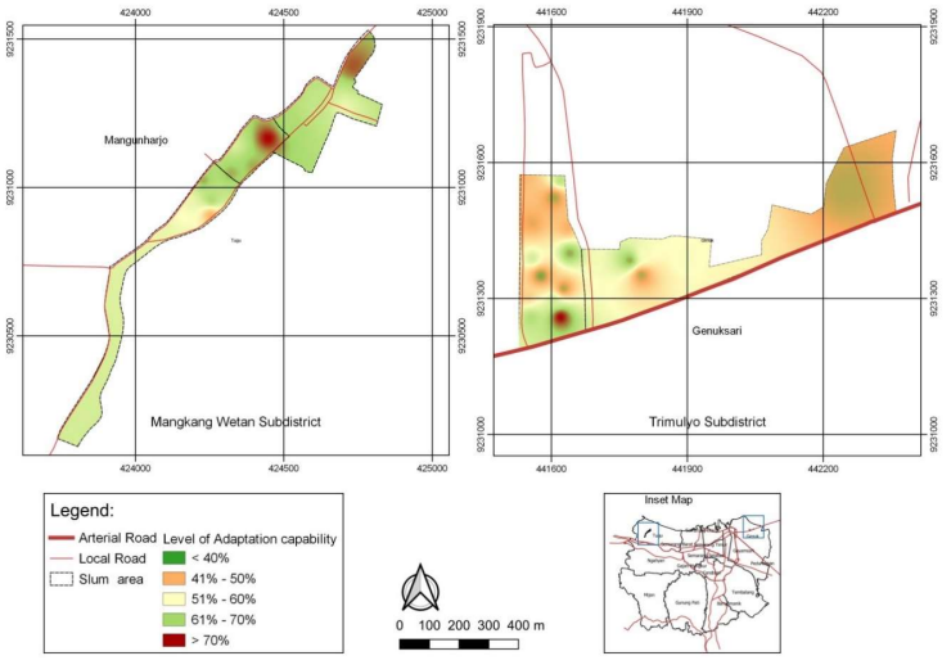

Figure 7. Map of Adaptation capability in Mangkang Wetan and Trimulyo Villages

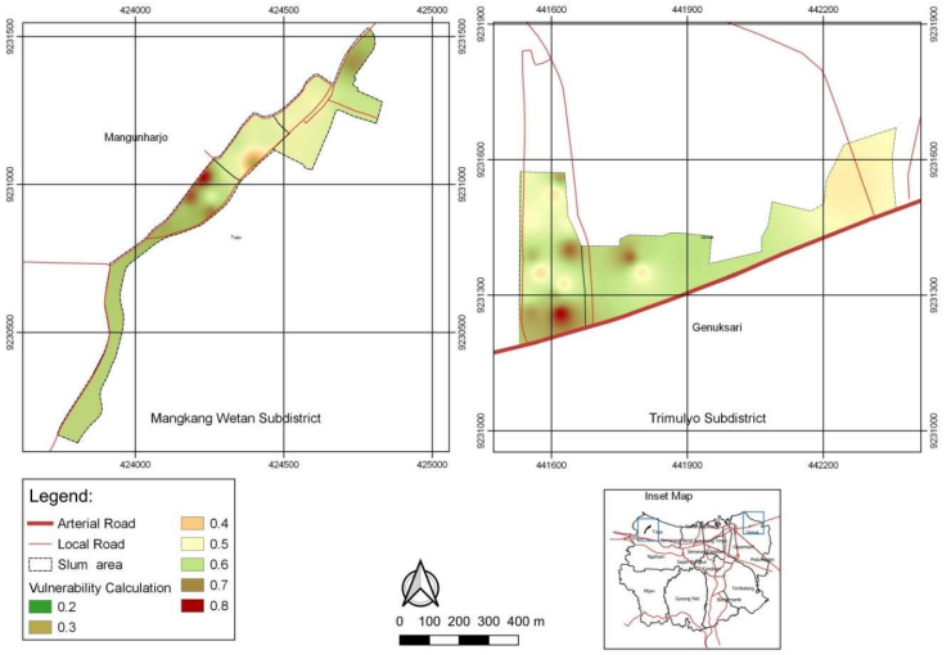

Figure 8. Map of Vulnerability in Mangkang Wetan and Trimulyo Villages

Table 3. Result of Vulnerability Calculation in Mangkang Wetan dan Trimulyo Villages

(Analysis, 2018)

Vulnerability Variable	Village	
	Mangkang Wetan	Trimulyo
Exposure (K)	76%	74%
Sensitivity (S)	54%	49%
Adaptation(A)	74%	69%
Vulnerability Level (KxS/A)	0,56	0.53

The level of vulnerability in Mangkang Wetan and Trimulyo villages was categorized in moderate, i.e. 0.56 and 0.53 respectively. However, the vulnerability level of Mangkang Wetan village showed a higher rate (74%) than Trimulyo village (69%). This result showed that the vulnerability of Mangkang Wetan community was stronger than that of Trimulyo village. In addition, the vulnerability level represents the survival rate of the community in handling the climate change phenomenon.

Slum Upgrading Spatial Model

The formulation of the slum upgrading model is based on the characteristics of the slum settlements in Mangkang Wetan and Trimulyo Villages by paying attention to the level of community vulnerability to climate change. This is done considering that both villages (local term: *kelurahan*) are coastal areas that are at risk from the impacts of climate change. This is in line with the implementation of the Asian Cities Climate Change Resilience Network (ACCCRN) program which seeks to make Semarang a resilient city through increasing attitudes and behavior as well as knowledge and skills capabilities, building networks to increase knowledge and skills for the community (Sariffuddin et al., 2017).

Vulnerability and risks to climate change are influenced by the existence of social relations between the community and its surrounding environment, both related to their physical, social and economic conditions (Folke, 2006). Various asset limitations and conditions in accessing existing resources become obstacles in improving the quality of slum settlements (Olotuah, 2012). Therefore, strategic efforts as a solution to improve the quality of the slum environment are needed to involve all relevant stakeholders. Slum upgrading, which is an effort to improve the quality of the slum environment, is realized through the community's active participation and involvement. This is because slum upgrading is realized through a social program and a series of democratic activities with a clear direction of communication (deliberation for instance) to accommodate the aspirations of the community, as well as to increase the capacity of its human resources. Improving the quality of the environment in slum settlements is also inappropriate if it is carried out through a top-down approach by ignoring the role of the community (Habitat, 2016; Meredith & MacDonald, 2017; Olotuah, 2012).

The pattern of activities in the community is influenced by asset ownership and community livelihoods (Singh & Gilman, 2000). In this study, asset ownership was identified from 5 components: human capital, physical capital, social capital, finance capital, and natural capital, which were obtained through observations and questionnaires. Human capital represents the ability of someone in acquiring better access to their lifestyle (Nugroho et al., 2017). Human capital assessment in this study was measured by education, involvement, and creativity inside the group, using the training result as an income alternative (Singh & Gilman, 2000). In addition, social capital was identified through social connections or relations among the community to support their social lives. In this study social capital was being assessed using 6 indicators: group program, group program involvement in both villages, routine meeting involvement, group meeting, and media usage for transferring information in daily life, especially for the matters related to coastal area community adaptation toward the vulnerability of each region also how much the network of stakeholders involved in giving training in every village.

Slum settlement area of the coastal area had a physical characteristic which may be seen from their dwelling or the infrastructure. The physical capital in this study was identified using 5 indicators, i.e. house condition assessed from the permanence of their building, road condition seen from the damage of the road itself, drainage system, clean water accommodation, and also sanitation system. Then, financial capital was

related to income or salary acquired by the individuals of the community each month, monthly outcome, and access to get capital or loan for their business or their asset ownership. That financial capital can encourage community participation in improving the quality of their lives (Das, 2015). Natural capital assessed in this study was based on 5 indicators: Fishpond productivity, Fishpond damaged by flood, house damaged or stricken by flood, flood duration in every house, and flood frequency in a month.

Table 4. Result of Pentagon Asset Assessment (Analysis, 2018)

No	Indicator	Mangkang Wetan	Trimulyo	No	Indicator	Mangkang Wetan	Trimulyo
1	Human Capital	0.88	0.53	4	Finance Capital	0.69	0.75
	Education	0.26	0.11		Monthly income	0.13	0.13
	Involvement inside the group	0.22	0.20		Monthly outcome	0.13	0.13
	Creativity (using the training result as income alternative)	0.18	0.11		Capital access/ loan	0.06	0.06
	Participation in skill training	0.22	0.11		Fishpond ownership	0.13	0.06
2	Social Capital	1.00	0.78		Land ownership	0.06	0.13
	Group program	0.17	0.11		House ownership	0.13	0.13
	Group program Involvement	0.17	0.17		Boat ownership	0.06	0.13
	Routine meeting involvement	0.17	0.17	5	Natural Capital	0.12	0.15
	Group meeting	0.17	0.17		Fishpond productivity	0.17	0.08
	Media usage for information transfer in daily life	0.17	0.11		Fishpond damaged by flood	0.17	0.08
	Network (government and NGO)	0.17	0.06		Damaged houses because they were stricken by flood,	0.08	0.17
3	Physical Capital	0.80	0.73		Flood duration in every house	0.10	0.25
	House condition	0.20	0.20		Flood frequency in every house in a month.	0.08	0.17
	Road condition	0.20	0.13				
	Drainage system	0.07	0.07				
	Clean water accommodation	0.13	0.13				
	Sanitation system	0.20	0.20				

Based on vulnerability analysis of the community in the coastal area, Mangkang Wetan Village and Trimulyo Village both had moderate vulnerability levels. Mangkang Wetan village represented the coastal area of West Semarang, while Trimulyo village represented the coastal area of North Semarang. Although both villages were categorized as slum settlement areas with similar vulnerability levels, the slum upgrading model for these two villages was different. The result of the pentagon asset analysis showed that *Human Capital* and *Social Capital* aspects in Mangkang Wetan village were higher than those in Trimulyo village, while the other capital conditions were almost similar both in Mangkang Wetan and Trimulyo villages.

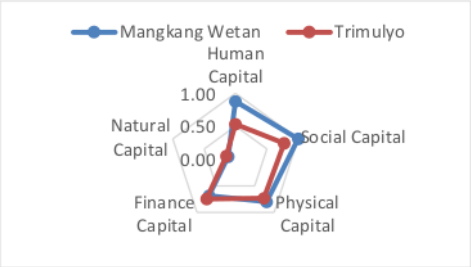

Figure 9. Analysis of *Pentagon Asset* in Mangkang Wetan and Trimulyo Villages (Analysis, 2018)

Table 5. Slum Upgrading Strategy in slum settlements of Mangkang Wetan and Trimulyo Villages (Analysis, 2018)

No.	Pentagon Asset	Mangkang Wetan	Trimulyo
1.	Human Capital	Training improvement should be maintained to support the creativity of Mangkang Wetan community.	Increasing the training and skill among the community in Trimulyo village. This program was aimed to increase the creativity of the people to take every benefit from the training activity.
2.	Social Capital	Innovation in group programs so that people are not bored and increasingly interested in engaging in the program	Increasing the government network involvement and NGO in the village was necessary. Along with the improvement of the network, it could open the access to increase the training process toward the community.
3.	Physical Capital	• Building regulation and physical condition refinement of the house • Reducing inundation spots and increasing the capacity also the quality of drainage in the settlements. • House system improvement to access decent sanitation. • Fire hydrant availability for fire safety.	• Road quality and access improvement. • Fire hydrant availability for fire safety. • Reducing inundation spots and increasing the capacity also the quality of drainage in the settlements
4.	Financial Capital	Capital access improvement.	Capital access improvement.
5.	Natural Capital	Pond protection using APO (wave breaker equipment)	House protection through mangrove cultivation on the side shore.

Conclusion

Slum upgrading as a program to improve the environmental quality of slum settlements area should consider various aspects such as physical, social, and economic aspects. However, besides these three aspects, it is necessary to observe human resource quality in the area and also natural resource availability which could be used for the community interests. Pentagon asset analysis was used in this study to assess those five aspects based on the existing condition in the research location.

Based on the analysis result, it showed that there was a difference in the characteristic of Mangkang Wetan village in Mangkang village and Trimulyo village in Genuk subdistrict. The vulnerability level of the coastal area community toward climate change, social capital, and human capital in Mangkang Wetan village was relatively higher than Trimulyo village. This result was affected by various programs which had been performed to handle the effect of climate change along with intensive involvement of the community in Mangkang Wetan village.

Therefore, slum upgrading can be conducted by concerning the improvement of human resource quantity and quality and making social relation in the community more intensively to the community of Trimulyo village. Physical quality improvement of the environment may be established by repairing and refining houses in Mangkang Wetan village as there are still 30% non-permanent houses. Meanwhile, drainage quality network improvement is necessary for both villages since the drainage function is not optimal yet because of the silting which causes inundation formation.

Previous studies have discussed more the resilience of coastal communities, but have not yet been concerned about how the resilience of these communities affects the efforts to improve slum settlements. However, through this research, the output of the analysis shows that differences in community characteristics, including the community's response to the disasters they face in coastal areas, will affect the efforts to improve the quality of life.

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APPENDICES

Table 6. The Location Distribution of Slum Settlements in Mangkang Wetan Village (BKM, 2017)

No.	Slum Area (RW/RT)		Slum Wide (Ha)	Population		Poor Population		House Building*	
				House-hold	People	House-hold	People	Number	Slum
1.	RW.05	1	3,81	74	252	43	171	35	4
		2		62	216	31	123	35	6
		3		49	177	18	70	38	3
		4		44	162	13	51	30	2
		5		44	162	13	52	19	2
2	RW.06	1	4,34	39	147	8	32	23	1
		2		43	159	12	47	22	3
		3		41	153	10	40	20	1
		4		36	138	5	18	25	1
		5		43	159	12	46	40	3
		6		42	156	11	42	27	3
3	RW.07	1	5,43	41	153	10	39	22	5
		2		48	174	17	67	23	4
		3		39	177	8	32	27	2
		4		44	162	13	51	23	3
		5		52	186	21	83	31	6
		6		57	201	26	104	39	18
		7		61	213	30	119	39	8
		8		49	177	21	85	30	11
		9		40	150	9	37	24	7
Total			13,59	948	3474	331	1309	572	91

*) *Slum building is a house that is not a decent place to stay review by the main building construction (roof, floor, and building wall)*

Table 7. The Location Distribution of Slum Settlements in Trimulyo Village (BKM, 2017)

No.	Slum Area (RW/RT)	Slum Wide (Ha)	Population		Poor Population		House Building*
			Household	People	Household	People	Number
1.	03/03	0.64	138	138	19	100	33
2.	03/04	0.68	136	136	23	103	47
	Total	3.55	415	415	66	286	117

Table 8. Exposure Level of Mangkang Wetan and Trimulyo Villages (analysis, 2018)

No	Indicator	Mangkang Wetan	Trimulyo
1	Occupation	20.83%	12.50%
2	Fishpond ownership	6.55%	4.17%
3	Fishpond productivity	5.65%	8.33%
4	Fishpond is stricken by flood	7.44%	4.17%
5	Houses are stricken by flood	5.95%	8.33%
6	Frequency of houses stricken by flood	3.27%	8.10%
7	Duration of houses stricken by flood	7.74%	9.49%
8	Source of clean water	7.44%	7.41%
9	Family member amount	11.31%	11.34%
	Number of Exposure	76 %	74%

Table 9. Sensitivity Level of Mangkang Wetan and Trimulyo Villages (analysis, 2018)

No	Indicators	Mangkang Wetan	Trimulyo
1	Monthly income	12.34%	13.64%
2	Monthly outcome	19.48%	15.66%
3	Asset ownership (Land, House, Boat, Fishpond, Etc.)	5.56%	2.72%
4	Capital access/ loan	16.88%	17.17%
	Number of Sensitivity	54%	49%

Table 10. Adaptation capability Level of Mangkang Wetan and Trimulyo Villages (analysis, 2018)

No	Indicators	Mangkang Wetan	Trimulyo
1	Group program	2.22%	2.22%
2	Group program involvement	7.46%	8.89%
3	Skill training involvement	3.33%	2.47%
4	Training advantages	3.65%	2.47%
5	Training result utilization for income resource alternative	3.17%	2.22%
6	Routine meeting involvement	3.17%	1.98%
7	Routine meeting frequency	4.29%	4.07%
8	Routine meeting benefits	6.03%	4.44%
9	Information media (group meeting, meeting RT/RW, Radio, SMS)	4.29%	4.44%
10	Information media	4.29%	4.44%
11	Group meeting	6.67%	8.64%
12	Meeting (RT/RW)	7.46%	6.67%
13	Radio	2.22%	2.22%
14	SMS/Whatsapp text messaging	4.44%	2.47%
15	Information media usage	4.29%	4.44%
16	Weather information needs	4.44%	4.44%
17	Media used to spread the information	2.38%	2.22%
	Number of Adaptation Capability	74%	69%

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18