Analysis of environment, socio-economic, and stakeholder partnership for integrated coastal management in Semarang City, Indonesia

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Abstract

Land transformation is the main factor that may increase ecological vulnerability in coastal areas in Semarang City, Indonesia. Therefore, environmental damage in coastal areas should be restored using an integrated management strategy based on the ecosystem, social and economic condition, as well as stakeholder partnership. This research aimed to measure the resilience score of environmental and socio-economic conditions and to identify stakeholder partnership in arranging integrated coastal area management in Semarang City. A descriptive observational study was conducted in Mangkang Kulon and Tugurejo Sub-district, Tugu District, Semarang City using in-depth interviews, field observations and survey-mapping. The ecological conditions data was collected using image analysis of aerial photographs following the concept of environmental and geophysical. Meanwhile, the social-community conditions data were diagnosed using a socio-economic assessment. The result showed that changes in the coastline occured due to the disappearance of some area of mangrove that were turned indented close to the ocean. However, the socio-economic index showed a medium to a high score, which means high opportunities for the local community to develop their livelihood. Therefore, various community empowerment programs initiated by government, academics, the private sectors, and non-government organizations have increased the resilience of the community.

Keywords: coastal area, integrated coastal management, Semarang, sustainable development.

Resumo

A transformatio de zonas costerias é um des principari fatoras que pode aumentar a vulnerabilidade ecológica da cidade de Semarang, na Indonésia. Os danos ambientais na

área costeira devem ser restaurados usando uma estratégia de gestão costeira integrada com base no ecossistemicas, nas condições socials e economicas e na parceria das partes interessadas. Portanto, esta pesquisa foi realizada para medir a pontuação de resiliência das condições ambientais e socioeconomicas e identificar a parceria das partes interessadas para organizar a gestão integrada da área costeira na cidade de Semarang. Um estudo observacional explicativo que coleta dados por meio de observação e entrevista foi conduzido em Mangkang Kulon no subdistrito de Tugurejo, distrito de Tugu, cidade de Semarang. Os dados coletados incluíram a condição ecológica e foram analisados por meio de imagens aérease, fotografias aéreas baseadas em análises ecológicos e geofísicos. A condição sócio-comunitária foi analisada por meio da avaliação socioeconomica. O resultado mostrou que ocorra mudanças no litoral devido ao desaparecimento de algumas áreas de manguezais transformadas em edifícios que recuaram próximo ao oceano. A condição alterando as correntes da água e danificando o local da pesquisa. Mas o índice socioeconomico mostrou uma pontuação média a alta, o que significa que existem oportunidades para a comunidade local desenvolver seu os meios de vida. Isso fez com que vários programas de empoderamento da comunidade iniciassem o governo, academicos, setores privados e ONGs a aumentar a resiliência da comunidade..

Palavras-chave: área costeira, gestão costeira integrada, Semarang, desenvolvimento sustentável

1. INTRODUCTION

Semarang City is the capital of Central Java, Indonesia (6°50' – 7°10' S 109°35' – 110°50' E), located on the northern coastline directly adjacent to the Java Sea (Figure 1).

This makes it a strategic point for building commercial industrial, and trading.

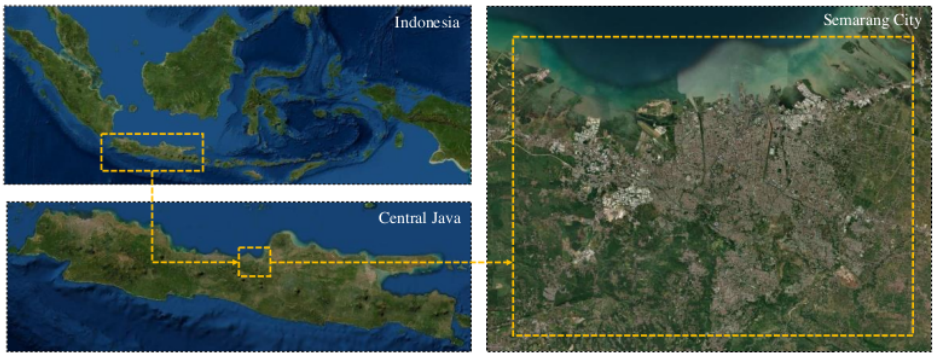


Figure 1. Location of Semarang City

In the current decade, massive destruction of coastal areas and their ecosystems was caused by land conversion into residential (Wijaya *et al*., 2018) and industrial area (Sariffuddin *et al*., 2017), as well as fish and shrimp ponds. On the other side, land transformation and mangrove destruction due to climate change caused a shift in the coastline of 49.54 m to the mainland that makes environmental loss (Mehvar *et al*., 2018). The data obtained from Semarang City Fisheries Office (2015) showed that coastal destruction due to an increase in sea level caused economic losses in the amount of 729 million per year, and 110 million from damaged 2,889 ha of pond areas. Sea level rise results in erosion 10,425 houses and damaged coastal infrastructure (Maimunah *et al*., 2011).

The coastal area provides mangrove forests as a protection against climate change (Blankespoor *et al*., 2017), and it is the primary source of economic income (Chang, 2018; Wahyudin *et al*., 2018), and cultural development (Syakir, 2019). Furthermore, the destruction of coastal areas threatens community life and city resilience from natural disasters (Komugabe-Dixson *et al*., 2019). Many parties have been involved in coastal restoration over the past decade. These include planting mangroves by the national and

private sectors and empowering community through university and non-governmental organizations (NGOs). However, due to the lack of synergies in the implementation of the programs, the result is not sustainable. An integration from all stakeholders is needed to take action in coastal rehabilitation from physical and community life (Dentoni *et al*., 2018; Gerkensmeier & Ratter, 2018; Martuti *et al*., 2020). The integrated program for improving ecological and social life as well as the cooperation of actors should be well prepared based on the current conditions to increase the resilience of the coastal area. Concerning these issues, this study aimed to measure the environmental, socio-economic conditions score and identify stakeholder partnership to arrange integrated coastal area management and support sustainable rehabilitation in Semarang City.

2. MATERIALS AND METHODS

This qualitative study is based on an explanatory observation conducted in coastal areas of Tugurejo and Mangkang Kulon Sub-district, Tugu District, Semarang City (Figure 2), from June to July 2019. The research loci were selected based on the following inclusion criteria: 1) high mangrove coverage areas; 2) the primary location for the rehabilitation program; 3) one of the sites for the acceleration of economic development, and 4) a well-developed community.

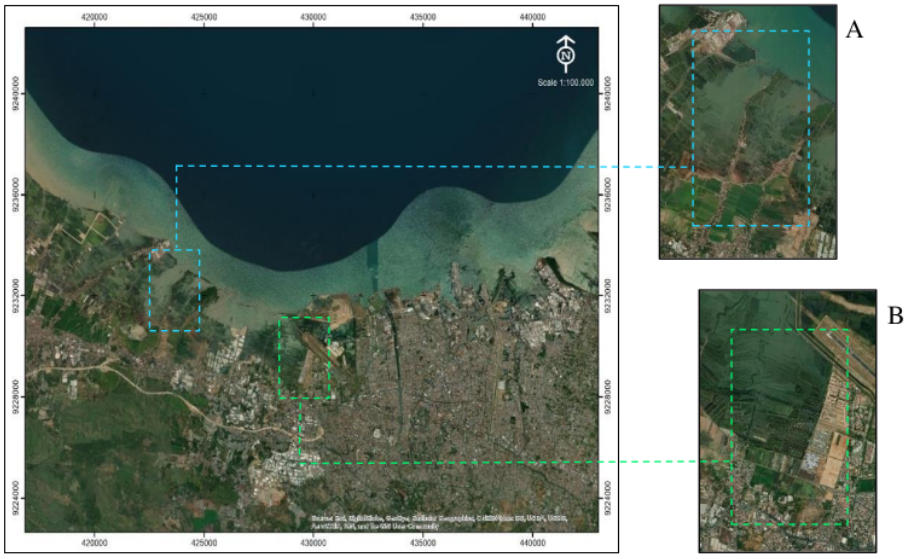


Figure 2. Location of data collection on the coast of Semarang City. A) Mangkang Kulon subdistrict and B) Tugurejo Subdistrict.

2.1. Land-Conversion of Mangrove Ecosystems

Ecological data was arranged using Digital Globe High-Resolution Imagery. All ecosystem condition maps were collected in July of each year to obtain high-quality resolution at the beginning of the dry season. During this time the cloud cover is decrease, and the images are clearer. Furthermore, a land conversion was also confirmed with field observation, community statements, government documents from the city spatial plan, mangrove conversion, and rehabilitation.

Primary data collection was conducted ut to support digital data by field observation and verify the mangrove ecosystem's damage level. The satellite imagery data was recorded in the time series format for the last five years. Furthermore, the interpretation was conducted by comparing the Digital Globe satellite imagery data and determining the

100 spatial distribution of mangrove density in the two villages. The land use data were also
101 analyzed to determine the destructed land areas, which was originally a mangrove
102 ecosystem. However, it was converted into productive lands, such as fish and prawn
103 ponds.
104
105 ***2.2. Socio-Economic of the Local Community***
106 A total of 105 members from six groups were determined as the research
107 population, then the number of the respondent was calculated following Slovin's formula
108 (1960). From the calculation, several respondents rejected to be involved. Finally, socio-
109 economic data was compiled from 63 respondents from local community groups in two
110 sub-districts randomly (Table 1).
111 Table 1. Origin of the respondent.

Community groups	Business Field	Members		Samples (person)		
		∑ (a)	% (c)	Proposed (b*c)	Unwilling	Involved
Tugurejo Subdistrict						
Putra Samudra	Fisherman	12	11.43	10	2	8
KWT Sumber Hasil	Urban farming	20	19.05	16	4	12
Subur Makmur	Fish processing	43	40.95	34	13	21
Putri Tirang	Fish processing	5	4.76	4	-	4
Mangkang Subdistrict						
Bank Sampah Melati	Waste management and urban farming	25	23.81	20	2	18

Total	105	84	21	63
Slovin's calculation (b)	83			

The data on community resilience were collected using a survey then confirmed using in-depth interviews and focus group discussions. The analysis was performed through a developed instrument based on the sustainable livelihood framework (SLF) to understand socio-economic assets that support community welfare. Five aspects were then further mentioned as socio-economic assets (Serrat, 2017), and the SLF indicators of human resources, natural, social, financial, and physic capital were arranged into positive statements to develop resilience index (Hahn *et al*., 2009; Huong *et al*., 2019; Koirala, 2015; Sujakhu *et al*., 2019; Williams *et al*., 2020). The socio-economic assets instrument was divided into 12 components, and was sub-divided into 38 indicators (Table 2).

Table 2. Variables and indicator for socio-economic assets instrument

Capitals	**Components**	**Indicator Issues**
Human Resources	Knowledge and Skills	Five issues including formal education, business experience, vocational training, business development skill, and business understanding
	Health care	Three issues including health facility access, health insurant, and chronic or acute disease issue
Natural Resources	Land	Three issues including land ownership, utilized land, and land productivity.
	Water	Three issues including: clean water access, water quality, environmental service on water availability.

Capitals	Components	Indicator Issues
Financial	Finance	Four issues including monthly income, jobs, bank account, and additional expenses.
	Assets	Assets value issue
	Financial support	Three issues about financial service, type, and number of the receiver.
Social	Networking and relationship	Six issues including social-mutual cooperation, religious activity, neighbourhood interaction, social organization, donation, and social networking.
	Technology and Social media	Two issues including technology skill and social media access.
Physical	Transportation	Private vehicle ownership
	House	Three issues including house ownership, habitable permanent house, and sanitation.
	Public services	Two issues including electricity power and public facilities.

Note: the indicator was developed from a Hahn et al., (2009); Huong et al., (2019); Koirala, (2015); Sujakhu et al., (2019); and Williams et al., (2020).

2.3. Data analysis

Most of the indicators were calculated and expressed on different units or scales, then standardized using equation index. The standardized index was calculated to estimate the socio-economic assets indices and determined as the final resilience index score for the community through Equation (1) (Hahn *et al*., 2009; Huong *et al*., 2019; Koirala, 2015; Sujakhu *et al*., 2019; Williams *et al*., 2020).

$$\text{Index} = \frac{\text{Observed value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}} \quad (1)$$

The scoring index was performed for all aspects and presented in scale points from 0.00 to 1.00. In addition, the average score per capital aspect represented the capital value and expressed by following criteria:

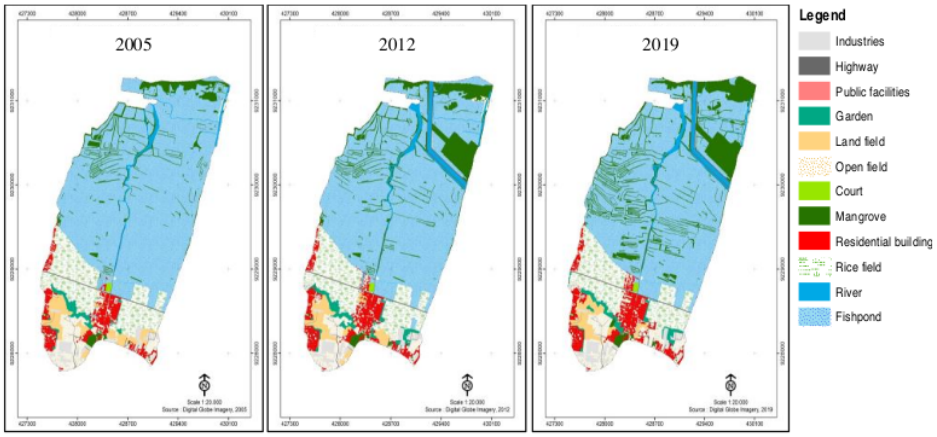
Table 3. Resilience criteria of capital value

Score	Resilience Criteria
≥ 0.75	High
0.50 – 0.75	Moderate
≤ 0.50	Low

3. RESULTS

3.1. The Identification of Land Use and Coastal Ecological Destruction

The coastline changing at Tugurejo is still relatively small compared to Mangkang Kulon. Furthermore, the stable condition in Tugurejo may be caused by a massive mangrove ecosystem that moderately increases in the past ten years. This can be seen in the annual increase in the size and spatial distribution of mangroves (Figure 3). The mangrove ecosystem has around 49.41 ha with an elongated pattern on the agricultural fields and pond embankments.



A

B

148

149 Figure 3. Land-use changes from 2005, to 2019 in Tugurejo (A) and Mangkang Kulon
150 (B) Sub-district.

151

152 In Mangkang Kulon, more than 50% of the total area was converted into fishponds.
153 However, it was then destroyed and vanished due to high seawater levels associated with
154 climate change. Subsequently, the mangrove ecosystem in the Mangkang Kulon
155 increased from 2005 to 2012 (Table 2; Figure 4), due to mangrove replantation activities
156 carried out by government agencies, the private sector, universities, and the local

community. However, the mangrove ecosystem has shrunk considerably in 2019, and it resulted in significant loss of the fishpond.

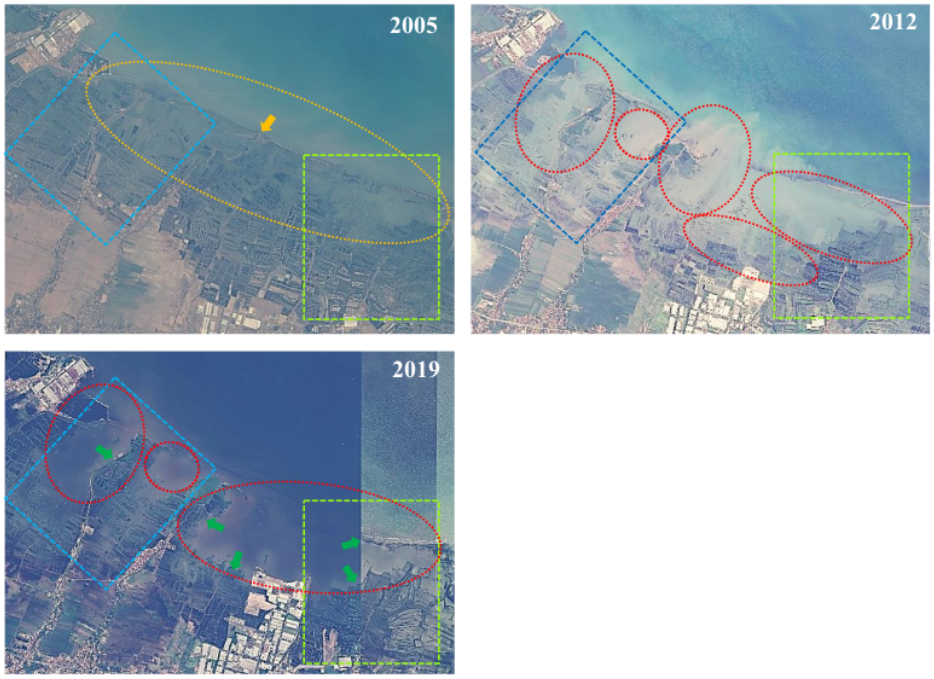


Figure 4. Coastal areas condition in Tugurejo (green square) and Mangkang Kulon (blue square) sub-district in 2005, 2012 and 2019. Yellow line representing existed mangrove forest; red ellipse indicating coastline destruction; green arrow representing mangrove replanting.

The mangroves species of the two areas are dominated by *Rhizophora apiculata, R. mucronata,* and *Avicennia alba, A. marina* species, and some additional *R. stylosa* and *Sonneratia alba*. However, high mangrove planting activities in Tugurejo may affect the agricultural field areas that have decreased in 2019. The massive mangrove plantation changes land coverage from the open areas to estuarine green-belt. The mangrove forests

protect irrigated rice fields, therefore, they can be harvested twice a year and used as the main product of community income.

In both sites, the mangrove areas extend from the river bank to the coastline and those with a sizeable swarming pattern. The green-line and square block on the maps showing in the constant distance indicates unnatural mangrove growth as a rehabilitation effortIn contrast, the agricultural field in Mangkang Kulon, directly exposed to the sea, makes it vulnerable to sea water rises. The effect of seawater rises has been proven by decreasing open space area alongside increasing the water bodies (Figure 5).

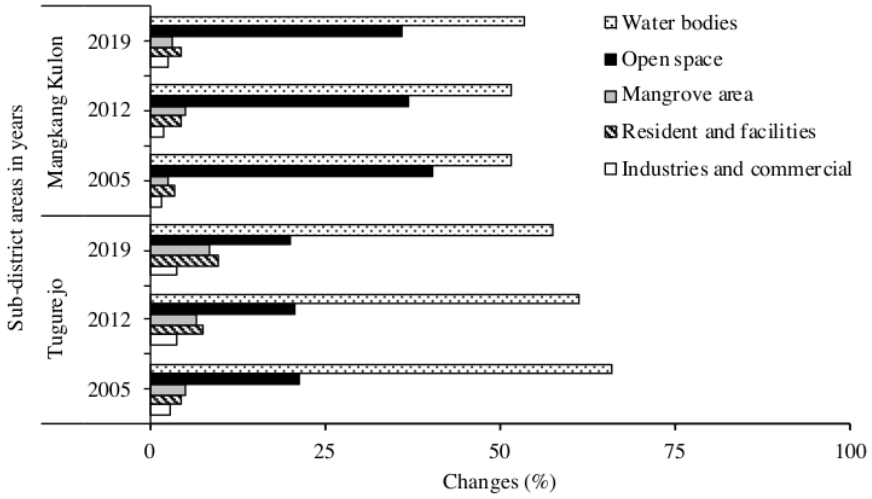


Figure 5. Percentage changes of the land-use in Tugurejo and Mangkang Sub-district in 2005, 2012 and 2019.

3.2. The Socio-Economic Calculation

This study analyzed human capital as a function of community access to wealth variables, including education and health care system. The variables were selected following the main priority programs of Indonesian government in increasing community welfare (Dini & Fauzan, 2020; Sumarto, 2017). The calculation showed that coastal communities in Tugurejo have a higher score or are more resilient than the Mangkang Kulon (Table 3). This is a good value for the human capital of Tugurejo to improve the quality of life in the communities and manage the capital asset more efficiently and sustainably.

191 Table 2 Time series of Tugurejo sub-district land use (2005, 20012, 2019)

Land Use	Tugurejo						Mangkang Kulon					
	2005		2012		2019		2005		2012		2019	
	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha
Industries and commercial												
Industries	1.83	10.48	2.03	11.66	2.08	11.91	0.71	3.79	0.77	4.12	1.12	5.99
Highway	1.22	6.99	1.72	9.87	1.82	10.46	1.08	5.76	1.23	6.57	1.36	7.26
Resident and facilities												
Government office	0.02	0.13	0.02	0.13	0.03	0.17	0.00	-	-	-	-	-
Residential building	3.49	20.03	4.09	23.46	4.57	26.23	2.86	15.33	3.14	16.80	3.19	17.07
Public facilities	1.12	6.40	3.46	19.86	5.33	30.58	0.83	4.44	1.39	7.43	1.39	7.45
Open space												
Garden	1.17	6.72	1.84	10.54	1.50	8.61	2.02	10.80	2.06	11.01	2.03	10.87
Land field	3.01	17.29	2.65	15.19	2.20	12.63	1.00	5.37	0.54	2.89	0.53	2.81
Open field	4.98	28.56	4.70	26.97	5.57	31.97	4.11	22.00	3.00	16.03	3.40	18.19
Court	0.13	0.77	0.13	0.77	0.13	0.77	0.00	-	-	-	-	-
Rice field	11.91	68.29	11.29	64.77	10.58	60.68	33.11	177.18	31.27	167.36	30.21	161.66
Mangrove area												
Mangrove plantation	5.02	28.79	6.82	39.12	8.61	49.41	2.67	14.31	5.10	27.30	3.34	17.86

Water bodies												
River	1.56	8.92	3.22	18.46	3.21	18.40	4.18	22.38	3.67	19.64	3.85	20.60
Fishpond	64.54	370.18	58.02	332.75	54.35	311.73	47.42	253.78	47.84	255.99	49.59	265.38
Total land		573.55		573.55		573.55		535.14		535.14		535.14

192 Source: Image Processing Results, (2019)

193

194 Table 3. The score of resilience potent of Tugurejo and Mangkang Kulon Sub-district

Variables	Capital	Indicators	Unit	Data Sources	Score index (point)		Explanatory Notes
					Mangkang Kulon	Tugurejo	
Human Capital	Knowledge and Skills	Respondents who finishing the 12 years compulsory education.	Percent	Survey	0.53	0.49	most of the community group's members have received empowering programs from university, government, and private sector
		Respondents experienced in developing business	Percent	Survey	0.70	0.75	
		Respondents have taken any kind of vocational training	Percent	Survey	0.61	0.67	

Variables	Capital	Indicators	Unit	Data Sources	Score index (point)		Explanatory Notes
					Mangkang Kulon	Tugurejo	
		Respondents who skilled in business development	Percent	Survey	0.60	0.61	
		Average assessment score of the business understanding	Ratio	Survey	0.49	0.53	
	Health care	Average time needed to go to the nearest health facility	Minutes	Survey	0.72	0.80	the health indicators was developed based on the social safety net program from the govemment by providing health services for vulnerable and underprivileged families
		Respondents with insurant	Percent	Survey	0.75	0.93	
		Respondents with no disease's issues	Percent	Survey	0.68	0.76	
		Capital score			0.64	0.69	
		Resilience criteria			Moderate	Moderate	
Natural	Land	Respondents who are owning their land	Count	Survey	0.61	0.73	
Capital		Utilized land	Meters	Survey	0.70	0.79	
		Average of land productivity index	Ratio	Survey	0.74	0.69	

Variables	Capital	Indicators	Unit	Data Sources	Score index (point)		Explanatory Notes
					Mangkang Kulon	Tugurejo	
	Water	Average score of water sources access	Meters	Survey	0.86	0.98	Clean, freshwater is the main issue in Semarang coastal, due to sea intrusion to the soil-water and polluted surface-water
		Average score of water quality	Count	Survey	0.78	0.79	
		Amount of water resources	Count	Survey	0.52	0.94	
		Average score of the environmental services	Ratio	Survey	0.39	0.68	
		Capital score			0.66	0.80	
		Resilience criteria			Moderate	High	
Financial	Finance	Average of monthly income	Count	Survey	0.68	0.51	
Capital		Respondents with a side job	Percent	Survey	0.45	0.52	
		Respondents with the bank account	Percent	Survey	0.63	0.65	
		Average score of bank deposit	Count	Survey	0.55	0.45	
		Average of additional expenses	Count	Survey	0.43	0.74	
	Assets	Average score of respondents' assets value	Count	Survey	0.68	0.69	
	Financial support	Respondents who are taking advantage of financial services	Percent	Survey	0.69	0.57	

Variables	Capital	Indicators	Unit	Data Sources	Score index (point)		Explanatory Notes
					Mangkang Kulon	Tugurejo	
		Average score of financial services type	Count	Survey	0.79	0.84	
		Financial support receiver	Percent	Survey	0.40	0.33	
		Capital score			0.59	0.59	
		Resilience criteria			Moderate	Moderate	
Social Capital	Networking and relationship	Respondents with social-mutual cooperation	Ratio	Survey	0.85	0.93	the modification was conducted based on the observation of coastal community culture in Semarang City
		Respondents who attend the religious activity in routine	Frequence	Survey	0.86	0.89	
		Respondents who has high neighborhood interaction	Percent	Survey	0.74	0.90	
		Respondents who joined in social-organizations	Percent	Survey	0.74	0.91	
		Respondents who are receiving the donation from family or relatives	Percent	Survey	0.84	0.71	
		An average score of social networking	Count	Survey	0.80	0.73	
		Respondents who able to use the smartphone	Percent	Survey	0.70	0.80	

Variables	Capital	Indicators	Unit	Data Sources	Score index (point)		Explanatory Notes
					Mangkang Kulon	Tugurejo	
	Technology and Social media	Respondents who accessed social media	Percent	Survey	0.72	0.73	
		Capital score			0.78	0.83	
		Resilience criteria			Moderate	High	
Physical capital	Transportation	Respondents with private transportation	Percent	Survey	0.61	0.66	
	House	Respondents who are owning the house	Percent	Survey	0.87	0.92	
		Average score of habitable permanent house	Count	Survey	0.86	0.99	
		Average score of proper sanitation	Count	Survey	0.87	0.97	
	Public services	Respondents with electricity power above 900 kWh	Percent	Survey	0.88	0.97	
		Average score of public facilities	Count	Survey	0.71	0.58	
		Capital score			0.80	0.85	
		Resilience criteria			High	High	

*) The instrument was developed by following previous research (Hahn *et al*., 2009; Huong *et al*., 2019; Koirala, 2015; Sujakhu *et al*., 2019; Williams *et al*., 2020)

**) The justification from the researcher is based on the current condition and adapted from the Indonesian government program.

In addition, all socio-economic assets were higher in Tugurejo compared to Mangkang Kulon, except financial capital. The assets are the lowest capital owned by the community, along with human resources (Figure 6).

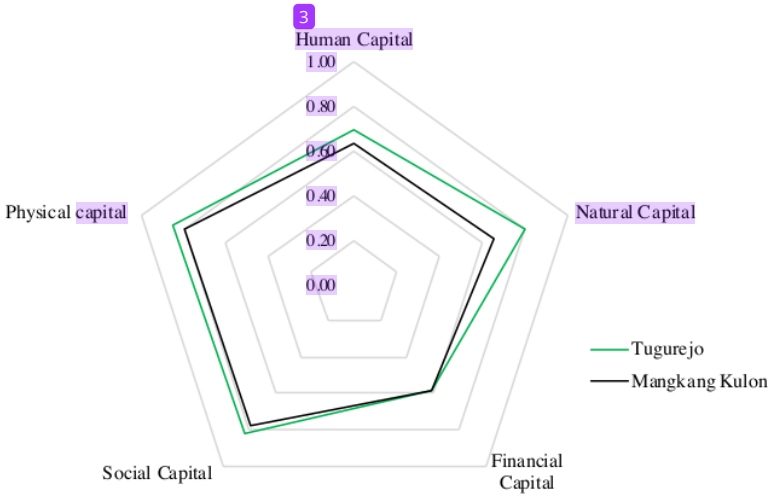


Figure 6. Capital value of socio-economic in Tugurejo and Mangkang Kulon Sub-district.

Low financial capital remains an obstacle for the community to develop their business capacity. Most of the respondents stated that they spend more money to make their house and fishpond still safe from the inundation and flood. Then, they rely on their financial capital for the development of their business through government or external empowerment programs. Most of the entrepreneur has an unwell education background and unskilled in business development. Furthermore, the community has not optimally utilized natural assets. The coastal area offers a mangrove forest and its biota that can be managed sustainably to increase income.

Social and physical assets have the best value among other capital. In the current condition of Tugurejo or Mangkang Kulon, the community's houses are permanently

habitable and relatively safe from tidal floods. Then, all houses unit have installed electricity, supporting their livelihood, and education. The city administration offers shuttles or inexpensive buses and is easily accessible from the place of transport.

3.3. Conducted Programs and Stakeholder Mapping

Several programs conducted by many stakeholders mainly focused on Tugurejo were identified as the reasons why high mangrove coverage areas and substantial socio-economic assets exist. However, they were implemented in the unintegrated plan in the last decade, therefore resulting in slow and unsustainable output achievement. The implementation was mainly oriented on the short-time programs and has to produce a product, but with lack of awareness on the community.

The knowledge and awareness about integrated management have changed the stakeholder mindset, especially from the government and private sectors. In addition, it engages academies and NGOs to build community resilience. The eight most active and standard existing programs conducted in both sub-district from the last ten years were grouped, and the collaborative implementations were found (Table 4).

Table 4. Existing program in Tugurejo and Mangkang Kulon in terms of environmental rehabilitation and community empowerment

Programs	**Tugurejo**	**Mangkang Kulon**	**Implementer**
Counseling and training on mangrove rehabilitation.	++++	++++	FFM, RCS
Supervision of activities that can damage the mangrove ecosystem.	++++	+++	FFM, NGOs
Coaching to encourage capacity building for Adaptation and Mitigation of the impact of	+++++	+++	NGOs, Indonesia Power, Pertamina,

climate change at the local level through the Climate Village Program (ProKlim).			MFD, AO, FFM, RCS, and companies through its CSR program
Providing mangrove seedlings and supervising mangrove forests, providing ecotourism packages, and shrimp/fish cultivation carried out in ponds around the coast (ProKlim).	++++	+++	MF, MFD, AO, EB, CEA, Facilitated by the NGOs
Women of Coastal Area: Fish-based food production, mangrove-based processed foods, and batik coloring with mangrove patterns and natural dyes (ProKlim).	++++	++	MFD, FFM, RCS, and companies through its CSR program, NGOs
The increasing diversity of mangrove ecosystem types by planting and monitoring on an ongoing basis, build a beach belt.	++++	++	FFM, RCS, NGOs, MFD, CSR, AO for mangrove diversity. ME, MF, EB, RDPA for sea belt
Utilization of the community and fishers group management.	++++	++	FFM, RCS, MFD
Arrangement of Mangrove Damage Standard in Central Java.	++++	++++	FFM, RCS, MFD

Note: plus mark (+) indicates how often/ intensity the programs are conducted in the research areas. Central Government: ME = Indonesian Republic of Ministry of Environment; MF = Indonesian Republic of Ministry of Marine and Fisheries; City Government: RDPA = Regional Development Planning Agency; EB = Environmental Bureau; MFD = Marine and Fisheries Department, AO = Agriculture Office; CEA = Community Empowerment Agency; Academician: FFM = Faculty of Fisheries and Marine; Universitas Diponegoro; RCS = Research and Community Services Institute of Universitas Negeri Semarang; Private Sectors: CSR = Corporate Social Responsibility.

The collaborative management of the implementation of coastal rehabilitation and community empowerment in Semarang City showed a pentagonal multi-stakeholder partnership model. In this model, the key partnership is built up by equal cooperation work among academies, private sectors, government, communities, and NGOs (Figure 7). Currently, several programs jointly conduct by the multi-stakeholders in the study site were identified (Table 4).

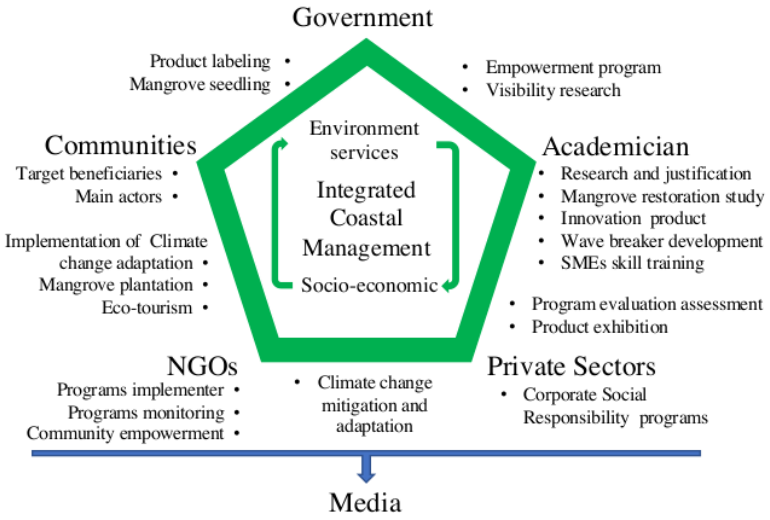


Figure 7. Adapted of pentagonal partnership model for a rehabilitation effort of coastal areas in Semarang from Halibas *et al*. (2017); Prabantarikso *et al*. (2018).

The main programs were arranged by the city's government as the policymaker executed by the academies and NGOs as the implementer and knowledge transfer. The private sector was involved as the program founder through their CSR program. As the beneficiary target, the community is the success key, therefore, the upgraded skill, willingness, and motivation should pop up to guarantee the program's sustainability. Social media and mass media play essential roles in program scaling up/ dissemination

successfulness, introducing the program, policy, and activities, and providing a product marketing platform. The press media can also educate people in Semarang City and others to keep the environment sustainable.

4. DISCUSSION

In 2019, there were 13 classes of land use in Tugurejo, and the most extensive area were ponds (water bodies) of about 311.73 ha for milkfish and shrimp. The ponds were partitioned with large mud and soil embankment for mangrove cultivation. In Tugurejo, there was a 1.76 m abrasion from 2005 to 2012 and an increase of 1.32 m as an accretion process from 2012 to 2019 (Irsadi *et al*., 2019). The coastal line abrasion increases as an impact of the profound change of land and mangrove forest into the cultivation pond, with only a few young mangroves trees in the embankment (Martuti *et al*., 2019). The cost of production ponds increased, after which the productivity of the fish decreased. It was also responsible for the annual increase in water masses in Mangkang Kulon (Figure 2 and 3), eroding the land surface and destroying mangrove ecosystems on the embankment (Nugraha *et al*., 2018; Widyasamratri & Aswad, 2017).

In the past decade, the abrasion has increased as the result of the new airport runway construction near the coast. The concrete structure of the runway makes current ocean turbulence on the west side, deflects and increases the destructive energy, and destroys the land. Meanwhile, the accretion between 2012 – 2019 was caused by the sediment load from the rivers, which eventually settles and solidifies. Therefore, it enlarges the land surface and can be the substrate for the growth of the mangrove plant (Ismanto *et al*., 2016). In Mangkang Kulon, the erosion lead by the wood industry's pier also makes ocean wave turbulence and destroys the coastline. The coastline is more robust due to the dock's construction, which is slightly tilted to the east and sea currents originating from the west (data not published). The physical structures including doc, water breakers and industrial

buildings are predicted as a main anthropogenic factor changing the ocean currents on the surface and underwater (Kim *et al*., 2018; Surya *et al*., 2019).

Climate change also has a spatial effect on sea-level rise, storms, high rainfall, and rising temperatures. The change affects mangrove forests in a coastal area at the local level (Ward *et al*., 2016). This study found that the lack of mangroves forests as front protectors may contribute to seawater intrusion and destroys the agricultural fields. However, a previous study stated that increased housing development is considered the main contributor to the reduced area of rice fields (Wijaya *et al*., 2018). In Mangkang Kulon, low mangrove coverage has proved to be destructive for the coastline as a result of abrasion, and it is a massive destructed area compared to Tugurejo.

The coastal communities, *e.g*., fisherman, fish-growers, fish traders, *etc*., conduct socio-economic activities related to resources in coastal areas and oceans (Freduah *et al*., 2017). Therefore, coastal communities have a high dependence on the potential and conditions of coastal and marine resources that affect their quality of life (Husain *et al*., 2019; Widyasamratri & Aswad, 2017). Land use and destruction of the coastal ecosystem can reduce independence and make it vulnerable, but communities have socio-economic assets that contribute to their sustainability.

4.1. The Socio-Economic Assets of Coastal Community

Climate change affects the environment, society, and economy of the people of Tugurejo and Mangkang Kulon. Satellite analysis showed that the Tugurejo and Mangkang Kulon coastlines have a high-level of vulnerability against climate change (Husnayaen *et al*., 2018). This will decrease the carrying capacity of nature and physical capital for the socio-economic life of coastal communities.

The reduced risk of vulnerability can be seen from physical aspects such as land ownership status, where the community's lands are primarily sited in the inundated area. Furthermore, productive land, such as agricultural areas, is shrinking, resulting in a decrease in rice productivity. In contrast, the shrinkage of fish ponds reduces milkfish production as the pond's leading commodity. Vulnerability reduction needs to be done by considering socio-economic aspects such as improving education quality, health, and job availability (Sariffuddin *et al*., 2017).

Adaptation activities by raising and maintaining fishpond embankment are continuously pursued annually and require a lot of money. To deal with this, planting mangroves as a mitigation and adaptation effort has helped keep the pond dam's shape while increasing environmental services for local livelihoods. Furthermore, the construction of a hybrid model of wave breaker is made from used tires and mangrove wood and bamboos to increase the accession process. It is also built along the fragmented coastlines in the Tugurejo and Mangkang Kulon areas to reduce wave energy and ocean currents.

Generally, Tugurejo and Mangkang Kulon communities have developed good adaptation capacities by utilizing coastal natural resources as materials for making food, fabric dye, and handicrafts. This becomes a side job or an alternative livelihood. However, access to carrying capacities such as education and training in business development and marketing, modernization of information flows, and financial support increase coastal communities' resilience through improved economic aspects (Astuti and Handayani, 2020). Health aspects such as the availability of health services and health insurance are still considered trivial, even though the need for this is considered very large since coastal areas are heavily affected by climate change. Besides, the government as

the policymaker should to consider about an assertiveness, holistic and integrated programming for improving communities' resilience (Suhelmi and Triwibowo, 2018).

4.2. Developed Multi-Stakeholder Partnership Strategy in Integrated Coastal Management

The importance of integrated coastal management can be divided into five reasons, 1) empirically, there are ecological and functional relationships between coastal ecosystems with mainland and community; 2) in a coastal area, there is more than one type of natural resource, artificial resource, and environmental services that can be utilized for development purposes; 3) the communities group capable to run various business job; 4) both ecologically and economically, the use of a coastal area in monoculture is very vulnerable to internal and external changes that can lead to business failure.

The development of collaborative works among stakeholders should be managed in an integrated cooperative approach to gain profit and sustain coastal areas (Prabantarikso *et al*., 2018). The parties interested in using natural resources should prepare an integrated management plan that applies to all stakeholders, especially the government and the community (Sariffuddin *et al*., 2017). Since 2005, ecosystems rehabilitation and community empowerment have been conducted by several parties (Table 3). Hence, independently, the community in Tugurejo has made nursery and mangrove planting, making water breakers from tires, and environmental education through ecotourism. These increase ecological services and community resilience from climate change disasters (Sari & Prayoga, 2018).

The interaction of multi-stakeholders made a pentagonal partnership that can be defined as a coastal rehabilitation model. This can encourage the restoration and balance

of the ecosystem through profitable collaboration and teamwork (Halibas *et al*., 2017). The program approach with the multi-stakeholder partnership model increases the legality and program success (Martuti *et al*., 2020; Soesilowati *et al*., 2017). On the contrary, mass media plays an essential role in making the program popular, especially for community product marketing (Ahmad *et al*., 2016). It plays a role in introducing social change (agent of social) broader, disseminating the program, and engaging other parties in collaborative works. It shows that the mass media introduces modernization efforts (Ekanayake, 2016), stimulate the decision-making process (Mukhtar, 2020), and accelerates the process of transitioning from a traditional society to a modern one (Colbran, 2020; Narayana and Ahamad, 2017; Schrape, 2017).

5. CONCLUSIONS

This study showed that the capital aspect in Mangkang Kulon and Tugurejo had moderate to high resilience. Meanwhile, the human resource and financial capital have moderate capacity, and social and physical capital have a high capacity in supporting the community resilience in both sub-districts. However, the natural capital in Tugurejo performed high value because of the existing well-managed mangrove forest, compare to Mangkang Kulon. The lack of mangrove forests and massive dock construction increase the coastal erosion and seawater intrusion to agricultural fields. The financial capital is the lowest value that indicates a low community income and support to develop their business. Most of the economic income from fishing or food processing business spend on adjusting houses, environment, and fishpond to avoid the destruction from sea level rises.

The communities in directly involved in the empowerment program from the government, private sector, academies, and NGO as the target beneficiaries. It gives various activities for local people to be involved in managing and rehabilitating coastal

quality, including build the water-breaker, mangrove nurseries, and planting. However, most of the programs in the coastal area were conducted separately and overlapping. A multi-stakeholder partnership approach should be conducted to strengthen integrated coastal management and increase program effectiveness. It is necessary to identify and profile the role of each party to make a collaborative action plan. The government as a policymaker can involve the academies and NGOs as the professional expert in arranging annual regulation or short and long-term plans. Corridors should also be created for direct empowerment programs, which should be then implemented by the private sector together with academies and NGOs through CSR program. In addition, the media should disseminate and educate the community about resiliency against climate change catastrophes in coastal areas.

6. CONTRIBUTIONS

NKTM: research concept.; RP: enhance research concept.; NKTM: research funding.: NKD, NKTM: instrumentation and administration.; WABNS, DPM: data collection. NKTM, RP, DPM: analyzed the data.; WABNS: area mapping and illustration.; NKTM, DPM: wrote the manuscript.; DPM, NKD: publication. All authors read and approved the final version of the document.

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