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MULTI-LEVEL MITIGATION AGAINST ABRASION AT THE RING-1 LOCAL TRANSMIGRANT AREA OF BUGEL VILLAGE, KULON PROGO, INDONESIA

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ABSTRACT: Abrasion has impacted the Local Transmigrant Area of Bugel Village, Kulon Progo, Yogyakarta, Indonesia. In the past 5 years, abrasion has diminished distance between houses and shoreline up to 45,66 – 80,66 meters. Z-Score based quantitative method is implemented for vulnerability study, whilst descriptive qualitative based on cross tabulation is used for SWOT analysis. As a majority, 29% among 55 houses are classified as highly-vulnerable against abrasion. SWOT analysis indicated that in order to have a proper multi-level mitigation scenario, it is paramount to mitigate among each household by doing adaptation scenario amid rainy season, gaining non-agricultural skills, create savings, and involved in local communities. Also, within community level, it is considerably important to plant and make more coastal vegetations especially *cemara udang* (C*asuarina equisetifolia*) along with limestone as protection. Lastly, within collective level, mitigation might be done by make cooperation with academists and local government for a better implementation of 6M which consists of (1) measurement of coastal abrasion, (2) mechanism of coastal abrasion understanding, (3) modelling for predictions, (4) monetary aspects (Cost Benefit Analysis/CBA), (5) measures' implementation, as well as (6) monitor and evaluate the progress of abrasion.

Keywords: Vulnerability Analysis, SWOT Analysis, Mitigation Planning

1. INTRODUCTION

Bantul, Gunung Kidul, and Kulon Progo Regency included as area which highly susceptible against abrasion and extreme waves in Yogyakarta Province [1]. Changes in coastlines have a negative impact on coastal communities, damaging settlements, agriculture, disrupt and eliminate fishermen's livelihoods. One of the example, is the Local Transmigrant Area of Bugel Village, Kulon Progo. Since the very beginning of its development in 2002, it was built merely 200 meters away from the shoreline [7].

Abrasion occurred since 2015. The incidence of abrasion in the last 5 years has tended to increase. The coastal area of Bugel Village which was eroded by abrasion since 2016-2020 has reached 45.82 km^2. Since it was first inaugurated in 2002, the number of residents of local transmigrant has decreased from 100 to 55 households in 2016 [7].

On the other hand, the Kulon Progo Regency Spatial Plan (RTRW) 2012-2032 emphasizes that the coastal boundary has the main objective as an area to maintain coastal functions with a maximum distance of 100 m from the highest tide point towards the land. In 2020, the distance of the Ring-I Local Transmigration houses to the coastline has reached the range between 41.84 up to 87.21 meters.

In addition, [11] has conducted a study related to the effectiveness of ecosystem-based abrasion mitigation efforts in Kulon Progo Regency with the main locus, namely Glagah Beach. Even though, it explained solely regarding the effectiveness of its lagoon and the coastal vegetation. On the other side, research conducted by [2] related to physical, social and economic vulnerability studies carried out based on the Spatial Multi-Criteria Evaluation (SMCE) method and marking the character of coastal area in Samas Beach, Bantul Regency. This research is similar to [7] who also conducted a vulnerability study, at the local transmigrant area of Bugel Village.

Eventhough, [7] did not explain the detail of mitigation that should be proposed for it. In addition to assess vulnerability related studies, the two studies also reviewed the recommended mitigation strategies, though merely explaining such general explanation that could be carried out. Consequently, this study aimed to concept multi-level mitigation based on the results of vulnerability assessment and SWOT analysis.

2. METHODS

Data collection techniques were carried out primarily and secondarily. The primary method through in-depth interview, field surveys, and taking aerial photographs, were happened in November 2020, whilst the secondary method were carried out by literature reviews of scientific articles, theses, and related planning documents. The tools used in data collection consisted of interview questionnaires, drones, and cameras. Data processing and analysis were carried out through Google Maps, Google Earth and ArcGIS as mapping software, and Microsoft Excel as the Z-Score processing software.

The location selection was based on severity of abrasion's impact on Ring-1 local transmigrant area which come to Pedukuhan I. Mixed quantitative and qualitative approach are applied to achieve the research objectives. To be precise, the research process in this study is using the convergent mixed-parallel design which both data are collected and processed concurrently.

Table 1. Indicators of vulnerability analysis

Factor	No.	Indicator	Source
Physical	1	Distance of the house to the coastline	Choirunisa And Giyarsih (2018)
	2	Distance of the farm assets to the coastline	Choirunisa And Giyarsih (2018)
	3	Protective vegetation density near the beach	Resti (2016)
	4	Living condition	Primary data analysis
Economy	1	Agricultural asset variants	Resti (2016)
	2	Possession of both physical and financial assets	Sunarti et al (2016)
	3	Agricultural land area	Resti (2016)
	4	variety oflivelihoods	Choirunisa And Giyarsih (2018)
Social	1	The number of adult residents per KK	Sunarti et al (2009)
	2	Number of elderlies per KK	Choirunisa And Giyarsih (2018)
	3	The number of children (>5-11 yearsold) KK	Choirunisa And Giyarsih (2018)
	4	Number of toddlers (0-5 years) KK	Choirunisa And Giyarsih (2018)
	5	Community involvement at village community	Resti (2016)
	6	Number of female family members (>12 years)	Choirunisa And Giyarsih (2018)

Qualitative method is applied at the SWOT analysis by explaining the result of in-depth interview with some representatives of the Village Government as well as head of local transmigrant's farmers community. On the other hand, the Z-Score is applied to the vulnerability assessment. Variables and indicators used for the quantitative analysis is stated in Table 1.

The data obtained is then carried out by an assessment based on the conditions of each household and classifies them into 1 to 5 from very low to very high in terms of its affect on vulnerability towards abrasion. Hence, data was processed with the Z-Score formula as follows:

$$Z - score = (X - r)/Sd$$

Zscore = Value of the Z-score
X = Classification of data according to scoring criteria for each indicator
r = Mean of data X
Sd = Standard deviation

Subsequently, the result undertook by Z-score analysis should be seen as 5 levels of household vulnerability from very low to very high.

3. RESULTS AND DISCUSSIONS

3.1. Vulnerability Analysis

The Physical Vulnerability of the local transmigrant Ring-1 area is dominated by Very High level with a percentage of 35% since there are still many people who live without coastal vegetation. [7] stated that the

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existence of coastal vegetation might exacerbate the vulnerability of transmigrant in coastal areas since they are easily exposed to coastal disasters such as tsunamis, tidal waves, and abrasion.

The Economic Vulnerability is dominated by medium level with percentage of 49%. This happened due to the most transmigrants have no savings, lack of variety and narrow land in agriculture, and less varied livelihoods. The social vulnerability of the local transmigrant Ring-1 area is dominated by medium level with percentage of 43%. This happened due to many transmigrants who did not join the village or hamlet community such as *Gapoktan*, KSB, and *Yasinan*. whereas if the transmigrant involved in the community, it will increase social capital for themselves.

Z-core results show 29% of families at the Ring-1 local transmigrant area of Pedukuhan 1 are classified as high. This was happened due to the distance between houses and farmland which are getting closer to the coastline due to abrasion, the lack of coastal vegetation around transmigrant houses.

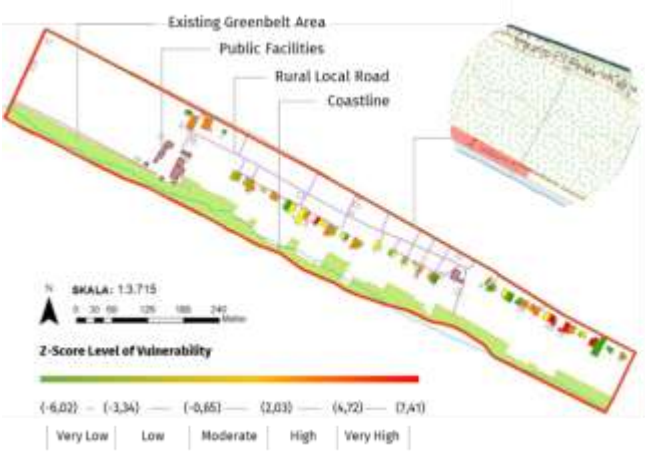

Fig. 1. Level of family's vulnerability against abrasion in the study area

Fig.1 explains 20 houses which located at 41.84 - 77.40 meters from the coastline which dominated by moderate vulnerability class. These houses have fewer sand dunes and less covered with *cemara udang* (C*asuarina equisetifolia*), even though there are 35% transmigrant not living in these houses. Households have fiscal assets like vehicles, though they do not have savings other than agricultural assets which are merely 25.53 - 44.67 meters away from the coastline. As much as 10 houses located at 80.00 - 98.57 meters from the coastline are more dominated by highly vulnerable households' classificationsince most of them do not have any sand dunes or *cemara udang*. Moreover, most households do not have varied agricultural assets other than livestock. Thus, we need mitigation strategies, both structural and non-structural mitigation to overcome the abrasion problem in Bugel Village.

3.2. SWOT (Strengths, Weaknesses, Opportunities, and Threats) Analysis

SWOT analysis combined many resources of data, thus we made it as a bridge to the mitigation strategies. It also used to evaluate internal strengths and weaknesses which will be used to analyze the external threats and opportunities [5].

3.2.1 Strength

- ***The existence of KSB & FPRB as community capacity***

Bugel Village has already had Kampung Siaga Bencana (KSB) since 2014 and Forum Pengurangan Risiko Bencana (FPRB) since 2019. KSB as one of its capacities in community level, it leads to the presence of management on social barn. FPRB has also created assessment on many of disaster that could be happened in Bugel Village, such as flood, earthquake, tsunami, and typhoon. As a complementary, FPRB also made evacuation map in terms of tsunami and earthquake scenarios, followed by arranging the signage of evacuation way.

- ***The existence of Village Tourism Community* (Kelompok Sadar Wisata/ Pokdarwis)**

The presence of Pokdarwis has made crucial development towards Bugel and Bidara Beach which actually be the potential tourism spots within Bugel Village. Even though they were established since 2015, but they already planned such tourism development program either for Bugel or Bidara Beach.

- ***Existing mitigation by local transmigrants***

Blarak is arranged to be a natural fence that covers local transmigrant's farm from high waves. But some of the cavities that exist between the rows of *blarak* are unable to withstand the penetration of sea water. So that *blarak* is considered less effective, then the community takes the initiative to plant vegetation such as *cemara udang* which is considered suitable to be planted in Bugel Village.

3.2.2 Weakness

- ***Unavailability of abrasion risk map***

The impact of local transmigrants is rarely part of the KSB or FPRB, one of which is that there is no map related to abrasion. According to the local government, abrasion itself is not yet included as a hazard that must be assessed as a disaster that has occurred in Bugel Village. Thus, none of the respondents had specific information about the dynamics of coastal erosion in Bugel Village.

- ***None of the building which use adaptive structure to respond the occurring disaster***

All of the dwellings which close to the shoreline are basically couple house design. Each of the house is built with type 21 and established on 600 m^2 land, owned by *Kraton Ngayogyakarta Hadiningrat* [16]. Therefore, the type and structure of the building was designed by the government and each of the houses is having uniform style. However, the government who built the houses did not support every house with stilt design though it stands merely 200 metres from the shoreline since the very first time it was established [16].

3.2.3 Opportunity

- ***Developing integrated tourism at Bugel and Bidara Beach***

Bugel and Bidara Beach are close to each other, and solely separated by 200 metres walking track. Bidara Beach is also getting prioritized by the local government for tourism development since it makes a straight line with Menoreh's Hills and *Nyi Ageng Serang's S*tatue, both of which are landmarks of Kulon Progo Regency.

- ***Getting helped by many academists to develop its agricultural sector***

Agricultural sector in Bugel Village which dominated by coastal agriculture, has attracted academists to make it as a research topic, for instance [12]. As such, the implementation of the sprinkle water system as modern modified mechanism for irrigation in local transmigrants' farms area. The featured agricultural product by local transmigrant is melon, watermelon, kale, and chili.

3.2.4 Threat

- ***Intensed abrasion causes agricurtural land to be reduced***

As time goes by, abrasion has reached out backside of the farm until it merely left 6 meters away from the shoreline. The head of the local transmigrant farming community said that this made farmers often suffer losses because the waves that came damaged the crops on their farms.

- ***Coastal vegetation keep washed away***

Each household in fact got 600 metres of land, including house within it. Nevertheless, some of the household changed the area of land which is used as farm, by expanding it to the south, getting closer to the shoreline. The expansion itself used up greenbelt area of the coast. This surely affected the existence of coastal vegetation, and gradually most of the *cemara udang* easily washed away by the waves due to its exiguous in number and lack of maintenance by local community. Based on internal and external factors, several mitigation strategies that need to be developed can be determined as follows:

1. ***Weakness-Threat/WT Strategies:***

Adjustment to building shape is needed in disaster-prone areas. In terms of abrasion and coastal flooding, it is necessary to build houses on stilts. The importance of adaptation to disasters could be implemented by taking measures to prevent water from entering the house that can be installed or stored, flood insurance, and storing household appliances during an emergency [8].

2. ***Strength-Opportunity/SO Strategies*:**

Agricultural products can be used as agriculture-based coastal tourism. Thus, integrating creativity and innovation for tourism development plan by Pokdarwis and local government is paramount.

3. ***Strength-Threat/ST Strategies:***

Communities play a main role in building capacity to face disasters. There are several communities such as Farmers Community, KSB, FPRB, and Pokdarwis, though majority of local transmigrants did not take part within it. In fact, it is very important to involve local transmigrants in the community. This allows them to raise the urgency of crisis in the coastal environment, such as increasing public knowledge and awareness of disasters.

4. ***Weakness-Opportunity/WO Strategies:***
It is also necessary to have data and maps regarding abrasion disasters. By collaborating with academists, it would be a good start to upgrade local government and communities' skills in Bugel Village. It is expected to focus on this issue and together with the community, to periodically improve mitigation strategies and discuss impacts on agriculture as part of local transmigrant livelihoods.

3.3. Multi-Level Mitigation

Based on the analysis, it is necessary to have a mitigation plan to protect the community, agricultural assets and increase the community's capacity.

3.3.1 Household Mitigation

Household mitigation can be one of the solutions to reduce the long-term impact. According to [8] and SWOT study, mitigation can be carried out in Bugel Village by (1) store valuable things in a high section of house, (2) keeping the electricity supply secured from water, (3) saving important numbers for safety whether by phone or paper, (4) at the rainy season, each person knows what to do for the neighbor's house if their neighbor was not at home, (5) gaining non-agricultural skills, (6) create savings, as well as (7) taking part in local communities.

3.3.2 Community Mitigation

The coastal area of Bugel is managed by the village government and community groups (Pokdarwis, the farmers' community, as well as KSB and FPRB), hence mitigation should also be planned together by these stakeholders.

1) Structural mitigation planning through potential mining materials

Based on the 2009 Environmental Status Report of Kulon Progo Regency, the Panjatan area has potential for excavation, one of which is limestone. It is located less than 10 km from Bugel Village, thus mitigation can be carried out by harnessing those limestone. [6] stated that the potential mining can be utilized in solving problems, especially for the urgency of mitigation.

2) Green zone plan

Moreover, a vegetation plan can be carried out with characteristic layer of beach sand [9], This is in accordance with the Cultivation Area (the 2012-2032 RTRW of Kulon Progo Regency) as part of the designation of agricultural land. Circulated Letter Number 08/SE/M/2010, is included in the priority level of coastal development in 2021, this is coherent with types that are in accordance with the typology of sandy beaches [15]. The plantation for *Cemara Udang* can be adjusted to the level of vulnerability to residential areas, there are very close to the coastline and the houses. Based on Fig. 2, Area with higher level of vulnerability is a priority for planting more *Cemara Udang*, alongside with its supervision during plant's growth. The strong roots are able to grip the unstable sand substrate and the leaves are able to break up the coastal wind [13].

Fig.2 Green zone map of local transmigrant area in Bugel Village

3) Periodization of nurseries, planting and maintenance

In order to rehabilitate, it is necessary to have a team from the local transmigrants along with FPRB & KSB, and also supervised by the Village Government. Thus, the periodization in each stage, can be done.

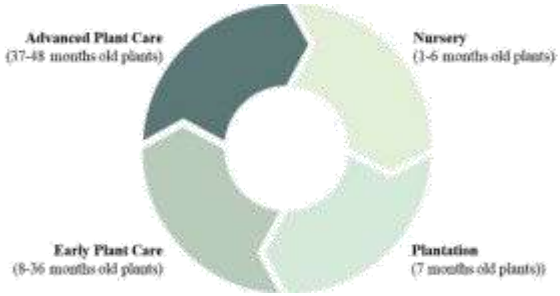

Fig.3. Maintenance cycle of planting

According to Fig.3, Management maintenance cycle as follows (1) nursery periodization, (2) planting periodization, and (3) follow up treatment. The distance between the trees is 4x4 metres [17], thus for the study area which has 2.9 hectares in size, it needs 1,875 trees.

3.3.3 Collective Mitigation (Community and Government)

Joint mitigation and preparation is needed to deal with abrasion. According to [4] study, collective mitigation could use the 6M policy period concepts. If 6M implemented in abrasion context, then 6M policies might be (1) measurement of coastal abrasion, (2) mechanism of coastal abrasion understanding, (3) modelling for predictions, (4) monetary aspects (Cost Benefit Analysis/CBA), (5) measures' implementation, as well as (6) monitor and evaluate the progress of abrasion.

4. CONCLUSION

Vulnerability data analysis showed that majority of this location is highly vulnerable towards abrasion with a percentage of 29%. Thus, SWOT analysis results indicated that abrasion mitigation shall be done by household, community, and collectively. Household mitigation could be considered as non-structural mitigation by developing non-agricultural skills, earn savings, harnessing the tourism potential on the coast, and exercise more on adaptation skills amid rainy season. Within community level, it is highly recommended for local transmigrants to do the structural mitigation by planting more *cemara udang* and protect them with limestones, and also make engagement with other local communities. At last, collectively, it is utterly paramount to cooperate with local government and academists to ensure that 6M is implemented systematically, thus it may be sustainable way to protect Local Transmigrant Area of Bugel Village from the danger of abrasion.

All in all, this study was situated in a considerably detailed scale hence this probably won't have the same situation as any other locations. Even though, future research may focus on evaluating integrated mitigation and household readiness to adapt with abrasion by comparing currently and upcoming situations.

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