ECSOFiM: Journal of Economic and Social of Fisheries and Marine. 2023. 11(01): 102-116 e-ISSN: 2528-5939
Permalink/DOI: http://dx.doi.org/10.21776/ub.ecsofim.2023.011.01.09

INTERPLAY OF PHYSICAL AND SOCIAL VULNERABILITIES IN LUMAJANG COASTAL AREAS: A MULTIDIMENSIONAL ANALYSIS WITH A FOCUS ON WOMEN'S EDUCATION

KETERKAITAN KERENTANAN FISIK DAN SOSIAL DI WILAYAH PESISIR LUMAJANG: ANALISIS MULTIDIMENSI DENGAN FOKUS PADA PENDIDIKAN PEREMPUAN

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Received: August 24, 2023 / Accepted: October 24, 2023

ABSTRACT

Coastal areas are a key element in maintaining global ecosystems and supporting economic and social activities. This research explores the role of women's education in reducing the vulnerability of the Lumajang coastal area through method analysis that includes field surveys, spatial analysis, and SWOT. The results of a spatial analysis combining physical and social data identify coastal areas as vulnerable zones. Furthermore, the SWOT analysis reveals opportunities for improving coastal women's education. The implication is that governments can allocate resources and implement more inclusive policies to improve women's education in the region, strengthening the resilience of coastal regions as a whole.

Keywords: social, education, coastal women, regional vulnerability.

ABSTRAK

Wilayah pesisir adalah elemen kunci dalam menjaga ekosistem global dan menopang kegiatan ekonomi serta sosial. Penelitian ini mengeksplorasi peran pendidikan perempuan dalam mengurangi kerentanan wilayah pesisir Lumajang melalui analisis metode yang mencakup survei lapangan, analisis spasial, dan SWOT. Hasil analisis spasial yang menggabungkan data fisik dan sosial mengidentifikasi wilayah pesisir sebagai zona kerentanan. Selanjutnya, analisis SWOT mengungkapkan peluang peningkatan pendidikan perempuan pesisir. Implikasinya adalah bahwa pemerintah dapat mengalokasikan sumber daya dan kebijakan yang lebih inklusif untuk memperbaiki pendidikan perempuan di wilayah ini, memperkuat ketahanan wilayah pesisir secara keseluruhan.

Kata kunci: sosial, pendidikan, perempuan pesisir, kerentanan wilayah.

INTRODUCTION

Coastal areas have a central role in the sustainability of global ecosystems, providing vital natural resources and being centers of economic and social activity. However, the dynamics of coastal areas are also increasingly complicated by challenges such as climate change, urban growth, and resource exploitation. Global climate change due to human activities such as energy production, industry, and vehicle emissions has led to a significant increase in greenhouse gas emissions since the Industrial Revolution. This climate change causes unusual weather, such as heavy rains, droughts, and desert expansion, which can harm ecosystems, water resources, biodiversity, and ecosystem stability (Wang & Gu, 2021). It is not only physical aspects that affect the vulnerability of coastal areas but also social factors that play a significant role and require serious attention.

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The social role of women's education appears to be an important element that has a broad impact on the sustainability of ecosystems and the resilience of coastal areas. The role of women here is included in the direction of policies for sustainability. In the context of global policy analysis on peace and security, the role of women is becoming increasingly important, and it is recognized that there is a relationship between gender and the environment (Kirby & Shepherd, 2021). Women's education not only empowers individual women, but also has a positive impact on families, communities and ecosystems as a whole. Quality education provides knowledge, skills, and awareness that strengthen the ability to deal with social and environmental changes (Tasia & Nurhasanah, 2019).

Multidimensional analysis of physical and social aspects of coastal area vulnerability The important role of women's education in the context of ecosystem sustainability and the vulnerability of coastal areas highlights several important dimensions. First, education promotes understanding of sustainable practices in natural resource management. It includes an understanding of the balance of ecosystems and the impact of human activities on the environment. Second, education increases women's participation in decision-making, both at the family and community scales. This has the potential to lead to more inclusive and sustainable policies in the management of coastal areas. Many coastal areas in the world face disparities in access to and quality of education for women. Diverse educational outcomes, including knowledge, attitudes, and behaviors related to green buildings, In addition, education in ecosystem sustainability also needs to encourage a deeper conceptual understanding of green buildings and the ability to take sustainable actions (Cole, 2019). Geographical, economic, and social constraints complicate this situation, especially in coastal areas. Therefore, a comprehensive analysis of how women's education contributes to the vulnerability of coastal areas, including physical and social aspects, is essential.

This study aims to analyze the vulnerability of the Lumajang coastal area with a multidimensional approach. The main focus is on the social role of women's education in responding to environmental and social challenges. Equality does not mean that women and men must be the same; it means taking into account differences while ensuring fair rights and opportunities (Aprianti et al., 2022). This analysis assesses the physical aspects of the coast, women's participation in decision-making, and their contribution to ecosystem maintenance. Through a deeper understanding of how women's education contributes to ecosystem sustainability and reducing the vulnerability of coastal areas, it is hoped that this research can provide a policy overview for all stakeholders in coastal areas, especially in gender equality in the field of education. This study integrates physical and social aspects in the analysis of the vulnerability of the coastal region of Lumajang, emphasizing the key role played by women's education in this context.

RESEARCH METHODS

This research uses a spatial analysis approach to analyze the level of vulnerability of coastal areas in Lumajang and applies SWOT analysis to understand the crucial factors that influence this

vulnerability. The spatial analysis approach allows for the identification of spatial patterns of various risks and exposures in coastal areas. This analysis includes the use of geographic data and GIS (Geographic Information System) analysis tools to produce a visual map of vulnerability levels. Spatial analysis plays an important role in identifying and understanding an area's vulnerability to disaster risks, such as floods. By utilizing geographic data and spatial analysis tools, we can identify spatial patterns of factors such as topography, land use, and distance from water sources that contribute to vulnerability (Ali et al., 2019). On the other hand, SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) helps identify strengths, weaknesses, opportunities, and threats that influence regional vulnerability. SWOT analysis is used to identify strengths, weaknesses, opportunities, and threats in the context of urban regeneration in vulnerable areas. SWOT analysis helps in making a structured diagnosis and mapping specific challenges to develop appropriate guidelines and corrective actions (Ruá et al., 2021). These two methods complement each other, resulting in comprehensive insight into the factors that contribute to vulnerability and mitigation potential in the Lumajang coastal area.

Data for this research was collected through various approaches, including surveys, field observations, interviews, and secondary data collection (Natow, 2019). The survey was conducted to collect primary data regarding local community perceptions and knowledge about the risks and vulnerabilities of coastal areas. Field observations were carried out to observe physical and environmental conditions in the area as well as identify local practices in managing natural resources (Sholihah et al. 2015). Interviews were conducted to find out the developing mindset of society regarding education, especially women's education. Secondary data collection includes historical, statistical, and mapping data relevant to the vulnerability of the Lumajang coastal area. The integration of data from various sources provides a comprehensive picture of the dynamics of regional vulnerability, both from a physical and social perspective.

The physical and social vulnerability data used in this research cover a variety of sources. Physical vulnerability data includes the Digital Elevation Model (DEM) to analyze slope and height, data on the largest earthquake points in the last three years, coastline data, as well as lava path data analyzed through river channels originating from the peak of Mount Semeru. Meanwhile, social vulnerability data was obtained through sources such as the Education Service, the Central Statistics Agency (BPS), and education branch offices in Lumajang Regency. SWOT analysis is used to identify opportunities that can be used to improve women's education in Lumajang Regency. The following are the respondents interviewed in this research (Table 1).

Table 1. Research Respondents

No	Respondent
1	Head of the DKP Fisheries and Equipment Service
2	Representatives of sub-district heads and sub-district apparatus
3	Head of Education/Equipment Service
4	Representative of the Village Head/Village Head/Coastal Village Officials
5	PKK/Coastal PKK Device
6	Community Learning Group
7	Principal and teacher representatives

The research analysis plan is a step-by-step guide to research, including problem formulation, data collection, analysis, findings, and conclusions, as shown in Figure 1.

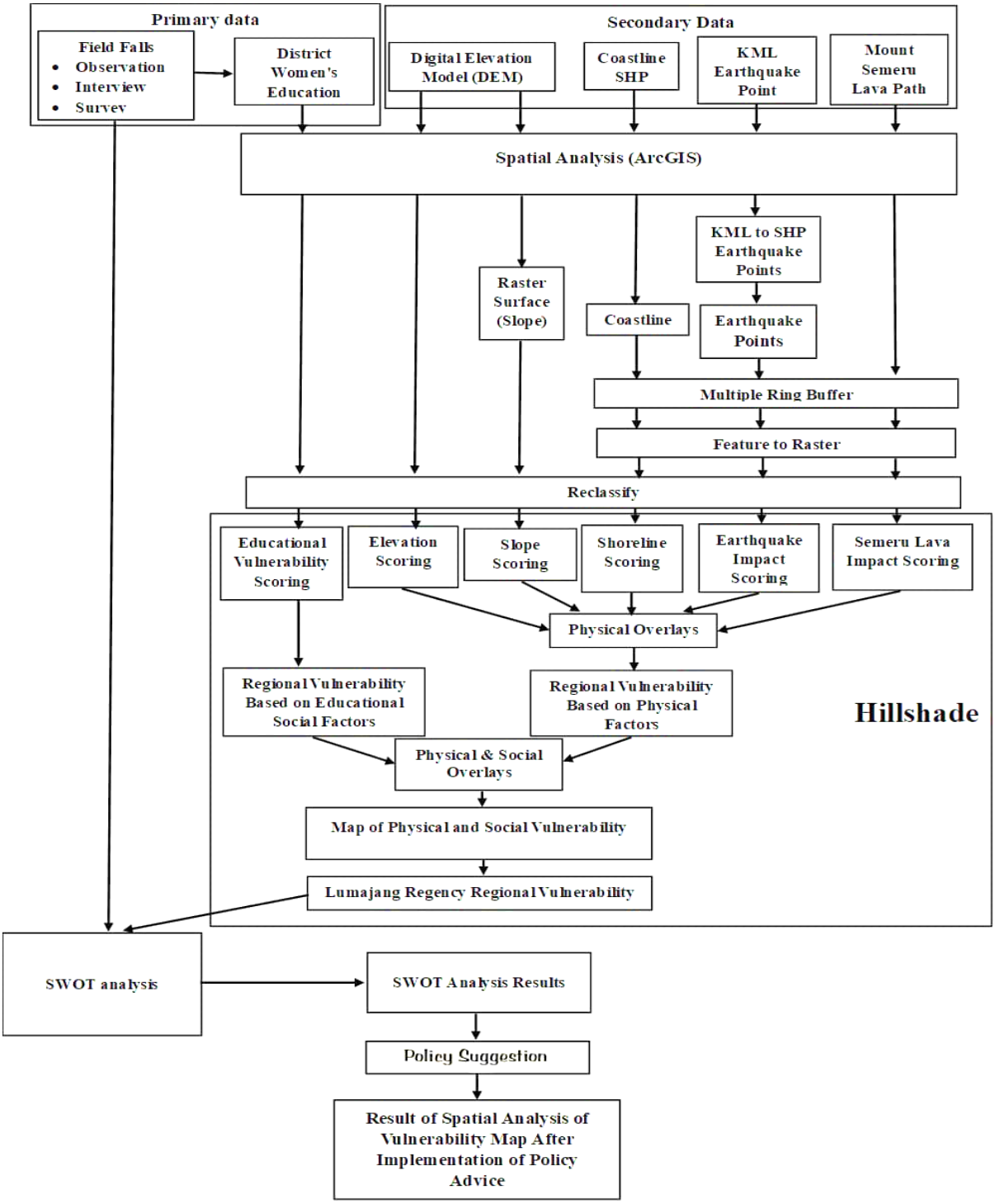


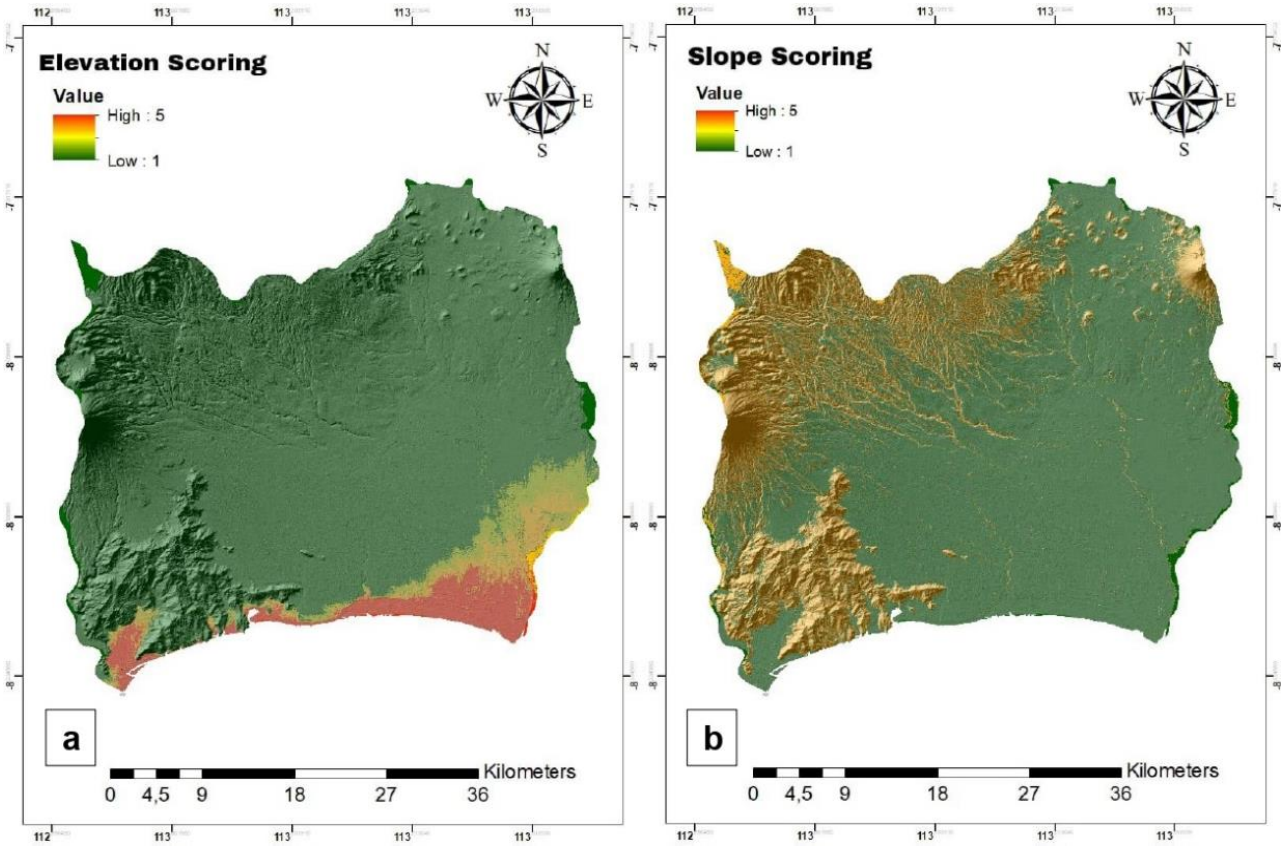
Figure 1. Analysis Flow Framework

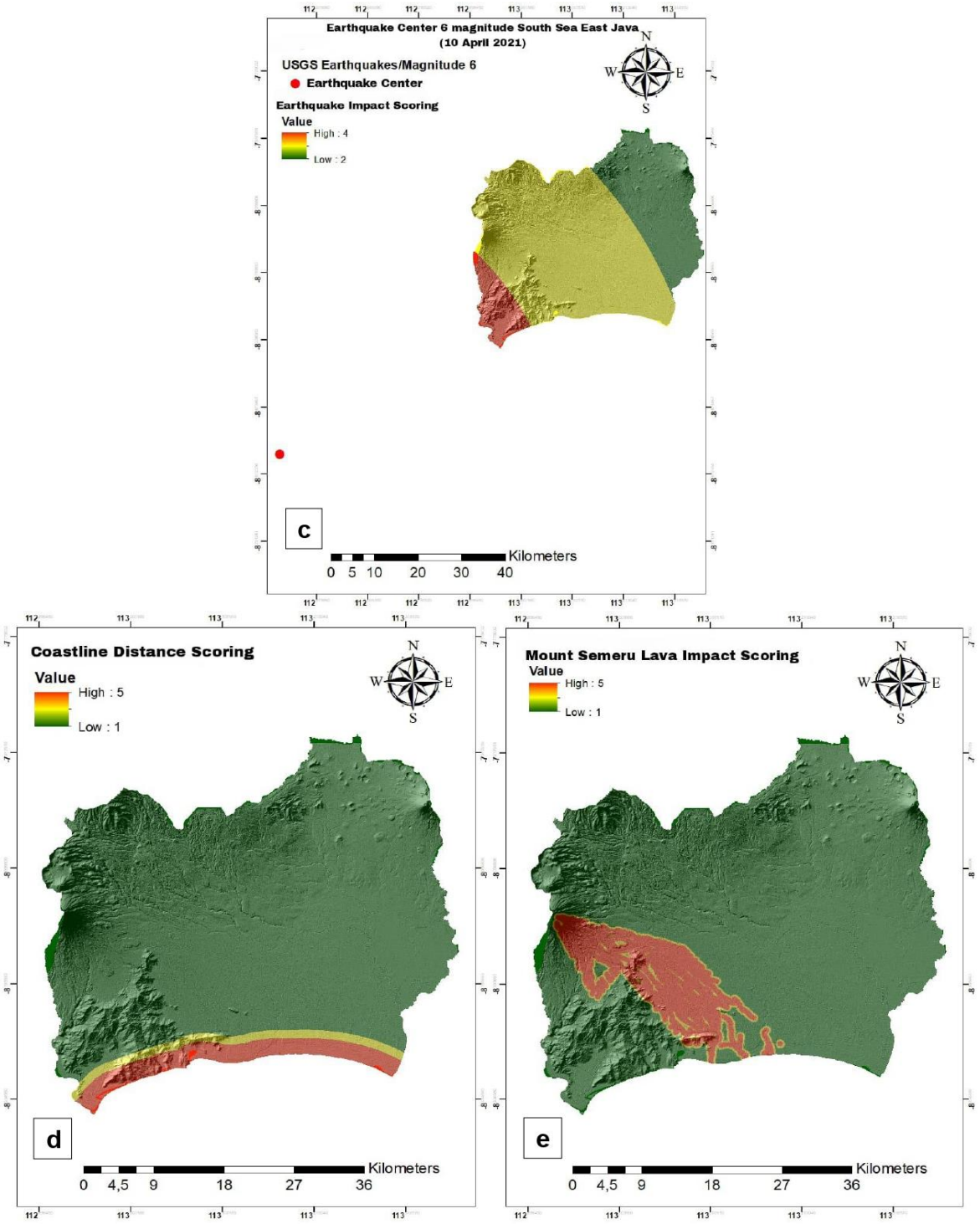
RESULTS AND DISCUSSION

Physical Vulnerability Factor

Physical vulnerability factors are one aspect that plays an important role in determining the level of vulnerability of a coastal area. From the results of field observations, five main factors were identified that contributed to the physical vulnerability of the Lumajang coastal area (Figure 2). First,

height is an important factor in assessing the risk of flooding and seawater intrusion. Second, the slope of the land has a significant impact on the potential for soil erosion and landslides, thereby increasing vulnerability to natural disasters. Third, Mount Semeru's lava path is an ongoing threat that requires special attention in understanding the potential for volcanic disasters from cold lava (Hariyanto et al., 2019). Fourth, the highest earthquake point is an important marker for understanding the potential for earthquakes and their impact on regional vulnerability (Yariyan et al., 2020). Finally, monitoring changes in coastlines over the past year is very important in measuring the level of change in coastal areas that can influence the level of vulnerability to sea level rise. The integration of these factors is a physical factor that influences the vulnerability of an area in environmental and social aspects. The higher the physical vulnerability, the higher the vulnerability of the area (Aristo & Hizbaron, 2023). The following are the scoring results of the physical vulnerability factors of coastal areas in Lumajang Regency (Figure 2).



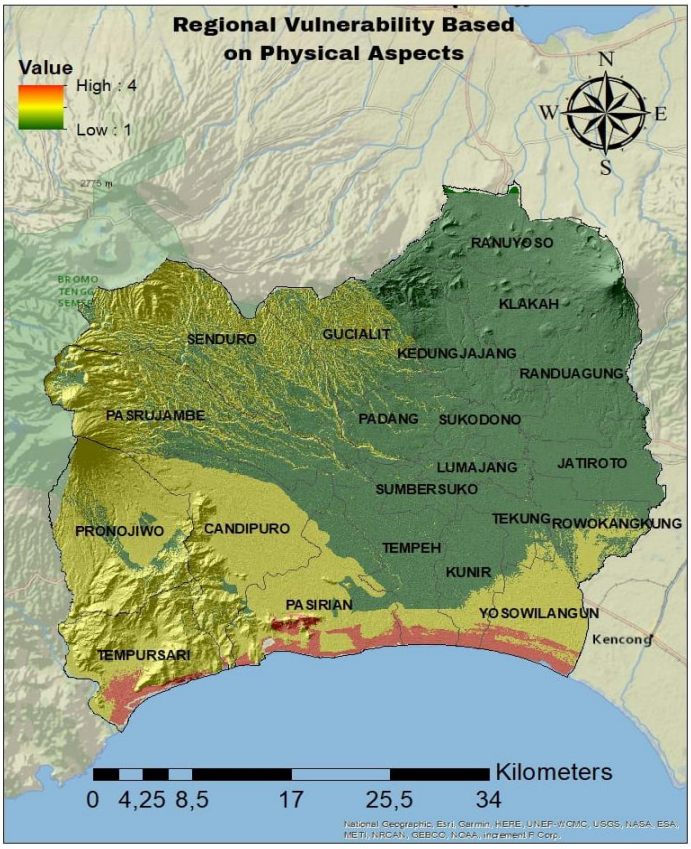


Source: Spatial Analysis Results (2023)

Figure 2. Scoring of Physical Vulnerability Factors in Lumajang District : (a) Elevation Scoring; (b) Slope Scoring; (c) Earthquake Impact Scoring; (d) Coastline Distance Scoring; (e) Mount Semeru Lava Impact Scoring

The results of the analysis of the physical vulnerability of the Lumajang coastal area show that the coastline aspect plays a central role. Changes in coastlines can have a direct impact on a region's vulnerability to disasters such as tidal floods, erosion, and seawater intrusion (Filipino et al., 2023). In this evaluation, supporting factors such as height, slope, Semeru lava path, and earthquake potential also play an important role in understanding the complexity of physical vulnerability.

The results of the 5-factor mapping scoring show that red indicates a high level of vulnerability, yellow indicates medium, and green indicates a high level of vulnerability. The combination of all these factors provides a more holistic view of how the Lumajang coastal area can respond to risks and disasters related to its physical aspects. These five factors are then overlayed to produce an assessment map like Figure 3.



Source: Spatial Analysis Results (2023)

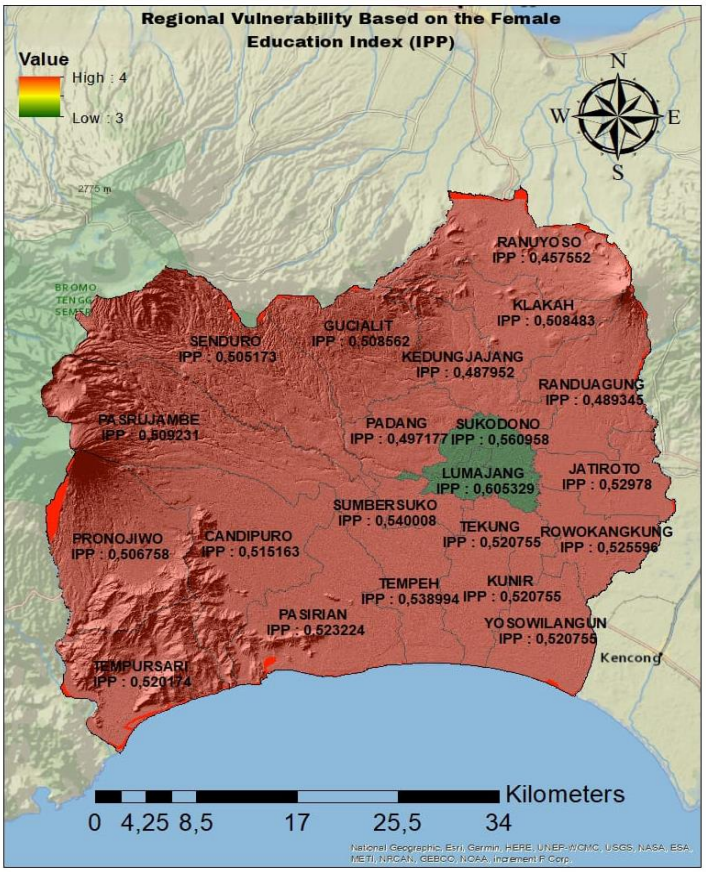
Figure 3. Overlay of Physical Vulnerability Factors in Lumajang District

The results of overlaying relevant physical factors identified three coastal districts in Lumajang with a high level of physical vulnerability. First, Tempursari District stands out for its combination of low altitude, significant land slope, and potential exposure to the Mount Semeru lava pathway. These factors together increase the potential for flooding, landslides, and volcanic threats. Second, the Pasirian Sub-District experiences similar vulnerability, with significant exposure to lahar paths and slopes that increase the risk of erosion and landslides. Third, Yosowilangun District also has a high level of physical vulnerability, especially because of its location, which is prone to earthquakes and coastal erosion due to changes in the coastline.

The identification of these three coastal sub-districts as areas with high physical vulnerability has important implications for the management of the Lumajang coastal area. The focus of handling needs to be given to disaster mitigation efforts that are specifically adapted to the unique characteristics of each sub-district. Actions to strengthen infrastructure, promote more sustainable land management, and increase public awareness of disaster risk are essential. In addition, this analysis provides a basis for developing adaptation plans that can increase the resilience of coastal

areas to inevitable environmental changes. By integrating the results of this analysis into policymaking, it is hoped that a more sustainable management of coastal areas and responsiveness to disaster risk can be achieved.

Educational Social Vulnerability Factors



Source: Spatial Analysis Results (2023)

Figure 4. Scoring of Vulnerability to Women's Education in Lumajang District

The results of the analysis of the gender-based Human Development Index (HDI), especially the women's education index for 2022 in Lumajang Regency, have been integrated into the mapping, which shows significant trends (Figure 4). Based on the search, only two sub-districts, namely Lumajang District and Sukodono District, show an education level in the medium category. In contrast, five coastal sub-districts have a fairly high level of vulnerability. The spatial vulnerability score here refers to the International Human Development Index score (Hickel, 2020). This is done because the reference for the human development index in Indonesia includes 3 indicators, namely health indicators, education indicators, and economic indicators, referring to the international HDI according to SDG 30 (Leon-Castro et al., 2021). The following is the HDI scoring table (Table 2).

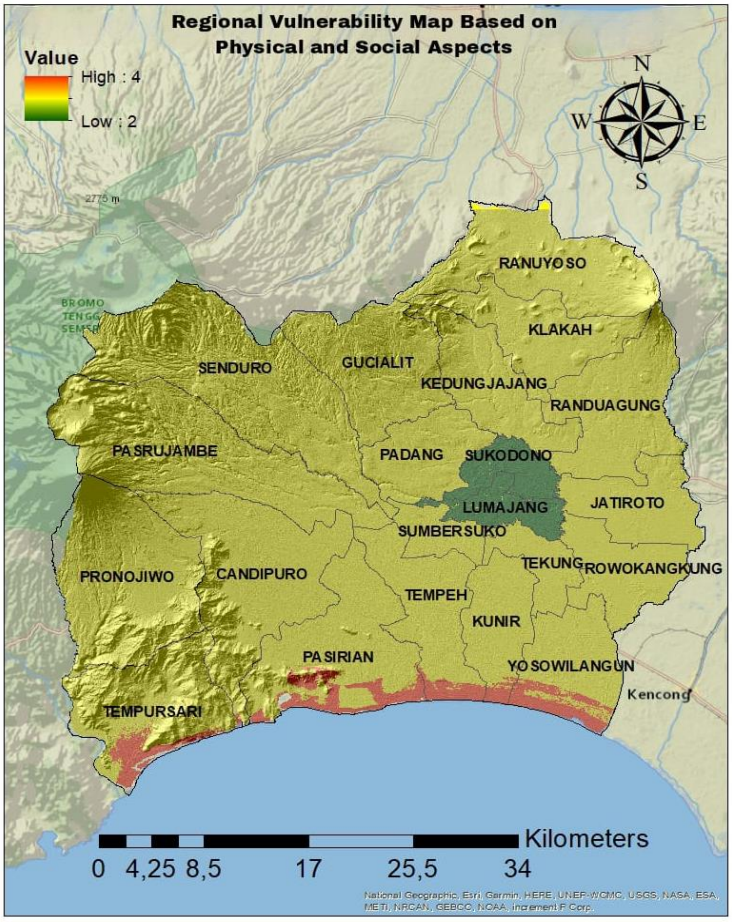
Table 2. Human Development Index Vulnerability Scoring

Scoring	Category
0,800-1,000	Very high
0,700-0,799	Height
0,550-0,699	Currently
0,350-0,549	Low
0,000-0,349	Very low

Source: Human Development Index (2023)

The use of spatial analysis to analyze the relationship between the Women's Education Index and regional vulnerability has an important impact. With this mapping, the pattern of vulnerability in coastal areas becomes clearer. Strengths and challenges in the education aspect are increasingly visible in Lumajang District and Sukodono District, while the vulnerability of coastal areas is reflected in the high vulnerability in five sub-districts. These findings underscore the need for a region-based approach to policy development that is able to address women's education gaps in each sub-district and regional vulnerabilities simultaneously. By applying the results of this analysis to decision-making and regional management, it is hoped that inclusive and sustainable regional development efforts can be directed according to the unique characteristics of each sub-district. such as providing outreach on the importance of formal education for women to better understand the environment because, in coastal areas, there are more women on land than men who work at sea (Rozi, 2023).

Integration of Physical and Social Factors: High Vulnerability in Lumajang Coastal District



Source: Spatial Analysis Results (2023)

Figure 5. Overlay of Physical and Social Factors

Through the overlay of the results in Figure 5, an analysis of the physical and social factors of women's education, it is clear that the five coastal sub-districts in Lumajang Regency, namely Tempursari, Pasirian, Tempeh, Kunir, and Yosowilangun Districts, show higher vulnerability compared to other sub-districts. The integration between physical vulnerability and the social impact of women's educational attainment has drawn a comprehensive picture of the complexity of the

challenges faced by this coastal region. These results provide important reflections for sustainable planning and action (Delgado *et al*., 2019). The trend of higher vulnerability in coastal areas emphasizes the need for specific interventions that focus on disaster risk management and women's education. Efforts to protect the coastal environment and empower women are becoming more important in these areas. It is hoped that the integration of the results of this analysis into regional development planning will result in more effective strategies for addressing vulnerabilities and promoting sustainability throughout Lumajang District.

SWOT Analysis for Increasing Women's Education in the Lumajang Coast

The SWOT analysis regarding women's education in coastal areas was generated through a combination of interviews and field observations. This approach allows the identification of strengths, weaknesses, opportunities, and threats that are relevant to the condition of women's education in coastal areas. By conducting interviews, we can get direct views from stakeholders and key actors in education (Marsh et al., 2023). Meanwhile, field observations provide an in-depth understanding of the realities of the physical and social environment in which education takes place. These two sources of information are reinforced by several works of literature, thus strengthening the argument about the potential faced by coastal women's education (Table 3).

Table 3. Analysis SWOT for Increasing the Education of Coastal Women in Lumajang Regency

Strengths	**Weaknesses**
• The spirit of the local community • Commitment as a driver of change • Involvement of NGOs and educational communities (Riniwati et al., 2021)	• Lack of educational facilities and infrastructure • Limited access to transportation and basic infrastructure • Cultural challenges in women's education (Utaminingsih et al., 2020)
Opportunities	**Threats**
• Government-inclusive policies as an opportunity • Funds and support for educational infrastructure • Incentives for women's participation • Collaboration with international and non-profit organizations (Utaminingsih et al., 2020)	• Climate change and the risk of natural disasters disrupt access to education. • Coastal areas are vulnerable to natural disasters, hindering learning. • Social and economic changes influence women's participation in formal education. (Riniwati et al., 2021)

Source: SWOT Analysis Results (2023)

The results of this SWOT analysis are one of the improved strategies for the government and stakeholders to improve women's education on the Lumajang coast. A combination of community efforts, government support, and cross-sector collaboration will play a critical role in achieving this goal.

Discussion

1. Improving Coastal Women's Education to Reduce the Vulnerability of the Lumajang Region: Opportunity and Transformation

The proposed innovative approach has great potential to change the dynamics of women's education and significantly reduce the vulnerability of the Lumajang coastal region. Each policy option

has a strong focus on improving access and quality of education for women, which in turn has a positive impact on regional vulnerability (Wike et al. 2016). The importance of women's education here is because women are a child's first madrasah, so when women's education is high, the regeneration of subsequent education will be better (Parhan & Kurniawan, 2020). Education greatly influences the level of regional vulnerability; with higher education, your knowledge will automatically get better. In this context, education will play an important role in regional vulnerability. The higher the level of education, the less vulnerable the area will be in physical and social aspects (Aksha et al. 2019).

a) Free and Compulsory High School Education: Changing the Education Paradigm

Introducing an obligation for all coastal communities, especially women, to complete education up to high school level free of tuition fees is a transformational step that will create a stronger foundation for equality and progress. This policy will permeate the educational culture of coastal communities and increase the role of women in the sustainability of better coastal education to help reduce the level of vulnerability in coastal areas (Žalėnienė & Pereira, 2021).

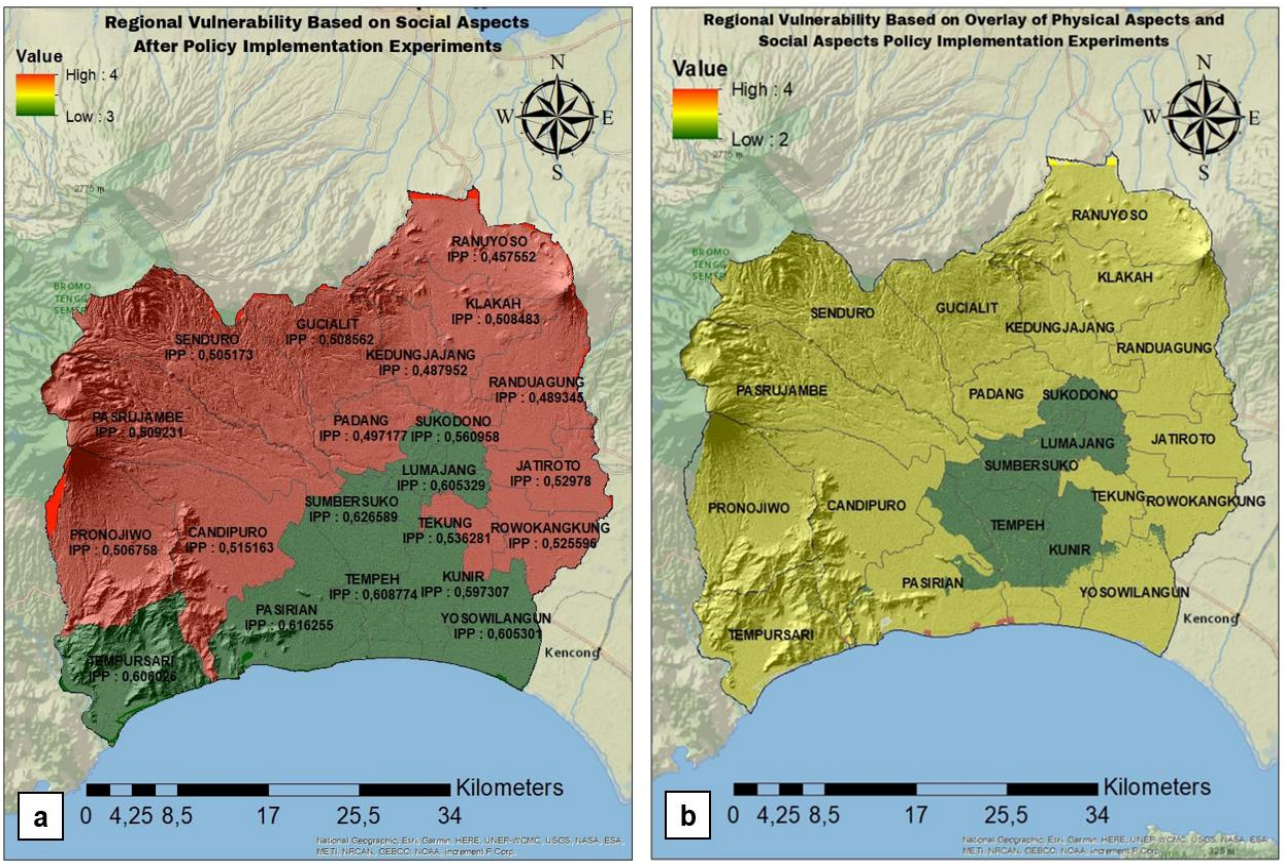
b) Scholarships and Compulsory Further Education at the Higher Level

By providing scholarships for women with the best achievements in high school to continue their education at university and prioritizing women at certain academic levels, you open the door for coastal women to enter higher education (Ismailovich, 2020). This step not only provides opportunities for individual development but also produces regeneration that is knowledgeable and ready to contribute to reducing regional vulnerability.

c) The Peak of Education: Raising Coastal Women to Advanced Levels

Designating a certain percentage to continue their studies at the masters and doctoral levels is an ambitious step that will create a group of coastal women with deep expertise (Saraini & Kholifah, 2018). Through their contributions to research, development, and policy, these women can help formulate concrete solutions to overcome the vulnerability of coastal areas and encourage sustainable improvements for future generations, especially in education (Olalekan et al., 2019).

The following is a pattern of coastal area vulnerability that will occur when the policy is implemented (Figure 6).



Source: Spatial Analysis Results (2023)

Figure 6. Changes in Vulnerability Map After Policy Implementation

Figure 6a shows changes in the social vulnerability map of women's education after testing the implementation of policy suggestions resulting from SWOT in spatial analysis in Lumajang Regency. Meanwhile, Figure 6b shows changes in the regional vulnerability map as a result of overlaying physical data and data on changes in women's education after testing the implementation of policy suggestions resulting from SWOT in spatial analysis in Lumajang Regency.

2. Coastal Women's Education: The Key to Transforming the Vulnerability of the Lumajang Region

This very interesting observation shows the positive impact that arises when coastal women's education policies are strictly implemented (Figure 6). The alignment between women's education and the reduction in regional vulnerability in Lumajang is clearly seen in the significant changes in the vulnerability map. This phenomenon highlights the important role played by women's education in reducing regional vulnerability and directing sustainability (Amalia et al., 2022).

3. Social Vulnerability Map: Distributed Transformation

Looking at the map of social vulnerability in the 5 sub-districts of the Lumajang coastal area, which are able to match those of Lumajang and Sukodono sub-districts, shows that there have been good changes. This shows that the involvement of coastal women in education has an impact on reducing the level of vulnerability in coastal areas. Increasing women's access to education has resulted in a better understanding of disaster risks, which in turn strengthens community cooperation in overcoming challenges. Educated women have an important role in raising awareness, mobilizing resources, and shaping more adaptive and sustainable policies (Nadeem et al., 2020).

4. Physical and Social Vulnerability: The New Balance

In the context of a physical and social vulnerability map, the transformation of the coastal sub-district is extraordinary (Tate et al., 2021). When women's education is empowered, they are not only able to overcome cultural barriers but can also encourage changes in community behavior patterns towards the environment. This results in a reduction in physical and social vulnerability, consistent with areas that previously had lower levels of vulnerability. The integration of knowledge gained through education with local practices and policies creates a new balance between facing risks and responding to environmental changes.

Investment in coastal women's education is not only about imparting knowledge but is also an important instrument in changing community perceptions, behaviors, and interactions with the environment and risks. Women's education emerges as a key foundation in the struggle against regional vulnerability, paving the way for sustainable growth and resilience in the Lumajang coastal communities.

CONCLUSIONS AND SUGGESTION

Conclusions

The conclusions of this research reveal that women's education plays a central role in reducing the vulnerability of coastal areas, especially in Lumajang. Physical challenges, infrastructure, and cultural aspects are the main obstacles that need to be overcome. However, opportunities from inclusive government policies and international cooperation offer significant solutions. Improving educational infrastructure, incentives for women's participation, and a better understanding of climate change and disaster risk are important steps in building resilient and sustainable coastal communities. The role of women's education is not only to support individuals but also to support the resilience of coastal areas as a whole.

Suggestion

The suggestion from this research is to improve educational infrastructure in coastal areas. It is also necessary to provide strong incentives to increase women's participation in formal education. In addition, a culturally sensitive approach is needed in designing educational programs that enable women to overcome existing traditional barriers.

ACKNOWLEDGEMENT

We deeply appreciate Universitas Brawijaya and Lumajang stakeholders for crucial support in our research. Your contributions ensured its success. Grateful for ongoing collaboration.

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