Using Spatial Analysis with weighted overlay on selecting area for fisheries agroindustry in Southeast Maluku, Indonesia

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Abstract. As an archipelagic region with rich marine biodiversity, the abundance of raw material of fishes and other marine resources are high. This advantage should be capitalized to enhance and spread the welfare of coastal community in the region. Fisheries agroindustry is a way to boost sustainable economic of a coastal region. Although, to select the appropriate sub-district as the best suite location for either fishes-based agroindustry and marine culture-based agroindustry have to face a complicated barriers, therefore the purpose of this study is to select the suitable sub-district location as the center of fishery agro-industry in Southeast Maluku Regency based on several related factors such as resource potential, number of fishermen and farmers, number of production per year, supporting infrastructure and transportation. The method used in this study is spatial analysis with ArcGIS with utilizing weight overlay to process all the data based on experts perceptions. The results of this study are expected to be a comprehensive guidance for policy makers in this region in the context of sustainable regional development. The paper offers specific path based on empirical evidence for sustainable development in fisheries sector of Southeast Maluku District.

1. Introduction

Until now, research on the impact of agro-industry on improving the welfare of rural and coastal communities has not been too extensive and extensive. Research on agroindustry still focuses on technology, supply chains, and related government policies. Although there are also many criticisms of the impact of agro-industry on increasing value added and the lack of an economic multiplier effect when the production output is raw material [1]. Nevertheless, agroindustry can help increase the income of rural and coastal communities through improving technology, knowledge and productivity through the conversion of raw materials into intermediate and final products that are consistent and sustainable in quality and quantity. Current challenges that still become a cliché issue in rural and coastal areas are the ability related to knowledge and capabilities in entering markets and meeting global market standards, which is also a concern in Indonesia where [2] questions the ability of small-medium enterprises to serve the needs overseas market.

With high catch and cultivation fisheries resources, Southeast Maluku Regency which is part of the Kei Islands and is located in a coral triangle area with high marine biodiversity makes the availability of fishery raw materials very high [3]. On the other hand, the ability of human resources related to the
management of raw materials and businesses in obtaining fisheries resources is still inadequate. This is due to the level of formal education of most of the coastal communities that carry out fisheries activities is still very low coupled with the absence of informal education related to fisheries business [4]; [5]; [6]; [7]. The abundant of raw materials are not yet accompanied by the support of human resources coupled with the distortion of the flow of information between regions, between coastal communities inside and outside areas due to geographical conditions in the Kei Islands region [8]; [9], making the challenges of developing fisheries agroindustry become increasingly complex. For this reason, it is very important to have research that combines all-natural resources, human resources and related infrastructure in determining the location of a suitable area to be the location of fisheries agroindustry in this region. For this reason, it is very important to have research that combines natural resources, human resources and related infrastructure in determining the location of a suitable area to be the location of fisheries agroindustry in this region.

The use of spatial analysis in the study of regional development, especially in the small islands region, such as in the Kei Islands presents more advantages compared to several other approaches. Many studies have well demonstrated the ability of spatial analysis to help facilitate the determination of suitable locations for waste handling locations [10], tours [11], agriculture and plantations [12], wind farms [13]; [14], healthcare [15], to regional development planning [16]. With the characteristics of the region of Southeast Maluku Regency which has difficult terrain and not extensive access to the region, the use of spatial analysis makes it very easy to analyze and map the area based on related factors in having a suitable sub-district area location to become the location of an agroindustry development center in this region. This study aims to determine the location of agroindustry centers in Southeast Maluku Regency with spatial analysis approach using weight overlay techniques with ArcGIS 10.5.

2. Methodology
This study uses field survey data collection techniques, where the type of data used in this study is primary data in the form of in situ field survey data in all districts in Southeast Maluku Regency. For secondary data in the form of Southeast Maluku satellite imagery from USGS for digitization, other data are obtained from the Southeast Maluku Regency Fisheries and Maritime Service and Statistics. The framework of the research flow can be seen in Fig 1. Data obtained from three sources, namely the results of the field survey in the form of identification of the potential for marine resource retention, human resource potential and socio-economic conditions, data from the local government and Statistic Indonesia in the form of data on the number of fishermen and farmers cultivating fisheries, the amount of capture fisheries production and aquaculture, then satellite imagery for digitizing the location of Southeast Maluku Regency.

The data obtained is then converted into shapefile form for further processing using the weighted overlay method (WOM), where classify data on each indicator is ranked based on input from experts and empirical conditions in the field (Table 1). Data processing using ArcGIS 10.5, the study location of the study is conducted in Southeast Maluku District located in Kei Islands, on Maluku province Indonesia. We use a rating scale of 1-5 with 1 being the best value and 5 representing the opposite. Furthermore, for the weight of each indicator, divided as follows, infrastructure and transportation have a weight of 25%; marine resource potential and HR 25%; the number of cultivated farmers and fishermen both have a weight of 10%; the amount of capture fisheries production is 20% and the amount of aquaculture production is 10%.
Table 1. Classification weighted factors for selecting center of agro-industry region

| Indicator                          | Actual Value | Ranking | Weightage |
|------------------------------------|--------------|---------|-----------|
| Infrastructure and Transportation  |              |         |           |
| Potency of each sub district       |              |         |           |
| Number of fishers                  |              |         |           |
| Number of marine farmers           |              |         |           |
| Production of fishing sub sector   |              |         |           |
| Production of marine culture sub sector |         |         |           |

**Figure 1.** Research flowchart
3. Result and Discussion

3.1. Indicators per sub-district in Southeast Maluku District

Based on the data obtained, it can be seen that, Kei Kecil and Kei Besar Utara Timur Sub Districts are the districts with the highest number of fishermen in Southeast Maluku regency. For marine farmers, Kei Kecil sub-district, Hoat Sorbay Subdistrict and Kei Besar Selatan Sub-district have the highest number of farmers for marine cultivation in this region. For fisheries potential, only Kei Kecil Timur Selatan sub-district is not suitable as an agroindustry location because it is more suitable for the development of marine tourism. For transportation and infrastructure indicators, all subdistricts on the island of Kei Kecil meet the conditions and only the kei besar sub-district meets the criteria for sub-districts located on the island of Kei Besar. For indicators of capture fisheries production, it can be seen that the Kei Kecil sub-district is the highest producer and followed by the big south-west kei sub-district, while for the fisheries production of Heat Sorbayt sub-district is the biggest producer and the Kei Besar Selatan Barat sub-district is the highest on the large Kei island (Fig 2).

![Figure 2. Indicators per sub-districts: (a) number of fishers; (b) number of marine farmers; (c) fisheries potential of each sub-district; (d) transportation and infrastructure; (e) marine catch production; (f) marine culture production](image)

3.2. Suitable location for center of agroindustry fisheries in Southeast Maluku District

The weighted overlay method (WOM) processing with ArcGIS showed that the most suitable location for the center of fisheries agro-industry development in Southeast Maluku Regency is Kei Kecil sub-district. With the potential of catch fisheries and aquaculture supported by infrastructure and transportation support either between regions and outside areas, makes the Kei Kecil sub-district is an obvious choice. However, by considering equitable development, location that also meets the criteria is Kei Besar Selatan Barat sub-district. This is because only the infrastructure and transportation are very...
limited in that sub-district but other indicators are very supportive. Thus, the local government's role is important in this regard in enhancing infrastructure and transportation development so that the acceleration of equitable development and improvement of the welfare of coastal communities on the island of Kei Besar in particular (Fig 3).

The combination of locations that tend to be isolated but which have very abundant marine resources makes it necessary to have a trigger which is not only increase the level of welfare of the people in Southeast Maluku Regency but also equitable development. With the existence of fisheries agro-industry, the unemployment rate can be reduced, such as research conducted by [17] in Brazil. In addition, increasing the level of income of coastal communities due to consistent production so the demand for fishery raw materials become stable so income of coastal communities can become consistent and increase. The existence of agro-industry also increases the competitiveness of fishery products from Southeast Maluku Regency which tends to be low in quality and less consistent in quantity. However, there is a need for heavy investment from the local government, investment is also expected to be right on target so that it helps accelerate the regional equitable development in Southeast Maluku Regency.

![Figure 3. Final suitable location for center agroindustry fisheries in Southeast Maluku District](image)

4. Conclusion
Southeast Maluku Regency has the characteristics of an archipelago that does not yet have easy access between regions coupled with a considerable distance from major cities in Indonesia, making Maluku Maluku Regency obliged to develop and develop fisheries agroindustry areas to improve equitable development. The use of spatial analysis can help solve complex problems by giving results that are easy to use. From the use of the weighted overlay method (WOM) with ArcGIS based on 6 existing indicators, obtained two sub-district locations that are suitable as fisheries agroindustry development sites in Southeast Maluku Regency, first Kei Kecil subdistrict and, the second, Kei Besar Selatan Barat subdistrict. Therefore, it is hoped that the welfare of coastal communities can improve. Fishery processing industry is of the choice along with processing of semi-finished materials industry such as carrageenan, so that the added value of fishery products can increase in accordance with the selling price offered to the market.
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References
[1] Ginting, G 2015 Open innovation model: empowering entrepreneurial orientation and utilizing network resources as determinant for internationalization performance of small medium agroindustry. *Agriculture and Agricultural Science Procedia*, 3, 56-61.
[2] Tambunan, T 2007 Entrepreneurship development: SMES in Indonesia. *Journal of Developmental Entrepreneurship*, 12(01), 95-118.
[3] Teniwut, W. A 2016 For sustainable revenue of fisheries sector in small islands: evidence of Maluku, Indonesia. *Aquaculture, Aquarium, Conservation & Legislation*, 9(3), 722-732.
[4] Teniwut, W. A., Teniwut, Y. K., Teniwut, R. M., and Hasyim, C. L 2017 Family vs Village-Based: Intangible View on the Sustainable of Seaweed Farming. In *IOP Conference Series: Earth and Environmental Science* (Vol. 89, No. 1, p. 012021). IOP Publishing.
[5] Picaulima, S., Teniwut, W. A., Kahfi, S., Teniwut, R. M., Susanti, I. I. D. A. R., Hungan, M., ... and Ngabalin, A. M 2017 Mapping marine resources utilization based on seascapes area: a study on gender comparison. In *IOP Conference Series: Earth and Environmental Science* (Vol. 89, No. 1, p. 012027). IOP Publishing.
[6] Teniwut, R. M., Hasyim, C. L., and Teniwut, W. A 2017 Resource-Based Capability on Development Knowledge Management Capabilities of Coastal Community. In *IOP Conference Series: Earth and Environmental Science* (Vol. 89, No. 1, p. 012017). IOP Publishing.
[7] Teniwut, W. A., and Teniwut, R. M 2018) Minimizing the instability of seaweed cultivation productivity on rural coastal area: a case study from Indonesia. *Aquaculture, Aquarium, Conservation & Legislation*, 11(1), 259-271.
[8] Teniwut, W. A., Betaubun, K. D., and Djoanja, T 2017 A conceptual mitigation model for asymmetric information of supply chain in seaweed cultivation. In *IOP Conference Series: Earth and Environmental Science* (Vol. 89, No. 1, p. 012022). IOP Publishing.
[9] Teniwut, W., Marimin, M., and Djoanja, T 2019 GIS-Based multi-criteria decision making model for site selection of seaweed farming information centre: A lesson from small islands, Indonesia. *Decision Science Letters*, 8(2), 137-150.
[10] Shi, Q., Ren, H., Ma, X., and Xiao, Y 2019 Site selection of construction waste recycling plant. *Journal of Cleaner Production*, 227, 532-542.
[11] Ayhan, Ç. K., Taşlı, T. C., Özkök, F., and Tatlı, H 2020 Land use suitability analysis of rural tourism activities: Yenice, Turkey. *Tourism Management*, 76, 103949.
[12] Bodaghbadi, M. B., Faskhodi, A. A., Salehi, M. H., Hosseinifard, S. J., and Heydari, M 2019 Soil suitability analysis and evaluation of pistachio orchard farming, using canonical multivariate analysis. *Scientia horticulturae*, 246, 528-534.
[13] Baseer, M. A., Rehman, S., Meyer, J. P., and Alam, M. M 2017 GIS-based site suitability analysis for wind farm development in Saudi Arabia. *Energy*, 141, 1166-1176.
[14] Ostovari, Y., Honarbaksh, A., Sangoony, H., Zolfaghari, F., Maleki, K., and Ingram, B 2019 GIS and multi-criteria decision-making analysis assessment of land suitability for rapeseed farming in calcareous soils of semi-arid regions. *Ecological Indicators*, 103, 479-487.
[15] Mishra, S., Sahu, P. K., Sarkar, A. K., Mehran, B., and Sharma, S 2019 Geo-spatial site suitability analysis for development of health care units in rural India: Effects on habitation accessibility, facility utilization and zonal equity in facility distribution. *Journal of Transport Geography*, 78, 135-149.
[16] Qiu, L., Zhu, J., Pan, Y., Hu, W., and Amable, G. S 2017 Multi-criteria land use suitability analysis for livestock development planning in Hangzhou metropolitan area, China. *Journal of Cleaner Production, 161*, 1011-1019.

[17] Ometto, A. R., Ramos, P. A. R., and Lombardi, G 2007 The benefits of a Brazilian agro-industrial symbiosis system and the strategies to make it happen. *Journal of Cleaner Production, 15*(13-14), 1253-1258.