Land Use Change and Suitability Analysis in Coastal Area

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Abstract. The research objective is to identify land-use change and suitability analysis of spatial use with land use policies and planning of the built-up area. The research location is in Tanjungpandan coastal area. Tanjungpandan is the capital of the Belitung Regency, which is the center of the economy of the region. The research method used was the overlay technique to determine changes in land use in coastal areas in 2010 and 2019. We conducted direct observation and interviews to analyze existing spatial use with spatial planning and policy. We found that the built-up areas had increased by 171 hectares. About 75% or 128 hectares of the built-up area was in Desa Air Saga. The suitability level of spatial use as built-up areas in the Tanjungpandan coastal area was relatively suitable with the spatial plan. There is only one village, namely Desa Tanjung Pendam that its spatial use exceeded its plan. There is compliance with spatial use in Tanjungpandan coastal area. This finding can be used as a recommendation to local governments to manage built-up coastal areas.

1. Introduction

One of the popular tourist destinations in Indonesia is Belitung. Belitung Regency is a popular tourist destination due to the famous film title of Laskar Pelangi [1]. The capital city of this regency is Tanjungpandan, which is a coastal area. The increased tourism sector has an impact on development in Tanjungpandan coastal area. The development of coastal areas with land-use change can have an impact on the environment and society. Therefore, land conversion of coastal areas and its suitability with sustainable planning are the focus of this study.

The causes and impacts of coastal land-use change are diverse. Changes in coastal land use due to human activities can result in changes in coastline [2]. Changes in tropical coastal land use from forests to agriculture and housing threaten the coastal ecosystem [3]. The coast of Bangladesh, which was initially dominated by agricultural land, turned into an aquaculture area. Changes over 36 years improve the regional economy but reduce the value of ecosystem services [4]. In South Gujarat, India, there are coastline changes that occur due to coastal erosion because of urbanization [5].

One way to preserve a coastal ecosystem is to make a spatial use plan that refers to sustainable development because there are often conflicts of interest among stakeholders. In coastal management in China’s cities, there is a conflict of interest between the expansion of the built-up area or land conservation. So in the short-term for economic development against ecosystem sustainability in the long term [6]. Sustainable coastal management depends on the state of the social system, the compromise between economic and industrial political infrastructure related to the coastal system, and its community [7].

Previous researchers studied environmental aspects in the Tanjungpandan coastal area. Wibowo [8] found out that the impact of the development of tourist areas will cause damage to the environment and waters. Meanwhile, another researcher [9] obtained the results of the coastal vulnerability index is still relatively low. The method to determine the land-use change in Tanjungpandan coastal area is an overlay
technique using Geographic Information System (GIS) software. The land use map of 2010 is overlaid with the map of 2019 to identify the changes. Therefore, the purpose of this study is to analyze the development of spatial use in the coastal area of Tanjungpandan District and to identify its suitability of existing spatial use with the Belitung Regency Spatial Planning Year 2014-2034 [10]. The coastal area, which is the research area is in five villages or sub-districts in Tanjungpandan District.

2. Method
The researchers conducted the research project from January to July 2019 and used the overlay technique to determine the land-use change from 2010 to 2019. We obtained land-use data from the Office of Spatial Planning and Human Settlement area of Tanjungpandan Regency.

The overlay technique is an approach used in regional planning. This technique is by making overlapping maps. In this research, we overlapped the 2010 and 2019 land use maps, as well as the existing maps with planned land use maps. Then, we analyzed its change and area distribution.

The authors conducted in-depth interviews with the persons in charge of land use planning in Tanjungpandan District. We conducted interviews to ask questions about the policies undertaken to control spatial use in coastal areas. The interview was conducted in June 2019. The respondents were from two offices; those were from the Office of Public Works and Spatial Planning, and the Regional Development Planning Agency of Belitung Regency.

The research location was a coastal area in Tanjungpandan District that consists of three villages (desa) and two sub-districts (kelurahan). Table 1 presents the village and sub-district area of the study sites.

| Villages or Sub-district          | Area     | %  |
|----------------------------------|----------|----|
| Desa Air Saga                    | 438      | 21 |
| Desa Juru Seberang              | 1,386    | 67 |
| Desa Tanjung Pendam             | 75       | 3  |
| Kelurahan Kota                  | 80       | 5  |
| Kelurahan Parit                 | 96       | 4  |
| Tanjungpandan Coastal Area       | 2,075    | 100|

3. Results and Discussion
3.1. Land Use Change in the Coastal Area
Overlay maps of land use in 2010 and 2019 for coastal areas found changes in almost all types of land use. Table 2 shows the land-use change in Tanjungpandan coastal area. From 2010 to 2019, there were changes in the areas of land-use types. Land-use types of forest, open land, plantation and agriculture, and livestock land-use area decreased. On the other hand, the area of the built-up area increased.

The increase in the built-up area is relatively not as extensive as in the coastal areas in other countries. Land-use changes that occurred in coastal areas due to development occurred in China with the expansion of the built area. Over the past ten years, the area developed had increased by 88% [11]. While on the coast of Nigeria, the area built for 30 years had increased to three times [12].
Table 2. Land-use change of Tanjungpandan coastal area.

| Land-use type            | Area in 2010 hectares | Area in 2019 hectares | Change 2019-2010 hectares |
|-------------------------|-----------------------|-----------------------|---------------------------|
| Water body              | 351                   | 351                   | 0                         |
| Forest                  | 141                   | 137                   | -4                        |
| Open land               | 648                   | 602                   | -46                       |
| Plantation              | 14                    | 1                     | -13                       |
| Built-up area           | 291                   | 462                   | 171                       |
| Agriculture and livestock| 449                   | 397                   | -52                       |
| Total                   | 1894                  | 1950                  | 56                        |

Table 2 shows that the area of the built-up area increased from 291 hectares in 2010 into 462 hectares in 2019. The area of built-up areas for nine years increased by 171 hectares. In Figure 1, the pink polygon represents the built-up area in 2010, which increased in 2019, as indicated by the red polygon.

We found that the built-up area had increased by 171 hectares. About 75% or 128 hectares of the built area was in Desa Air Saga, and 20% of the area was in Desa Juru Terbang, the rest was 5% in Desa Tanjung Pendam (Table 3).

Figure 1. Land-use change map (the year of 2010-2019) in Tanjungpandan coastal area.
Table 3. Change of built-up area in the Tanjungpandan coastal area.

| Village or Sub-district | Built-up area | Change of Built-up area | Percentage |
|-------------------------|---------------|-------------------------|------------|
|                         | in 2010 (hectares) | in 2019 (hectares) | (hectares) | (%) |
| Desa Air Saga           | 77            | 205                     | 128        | 75  |
| Desa Juru Seberang     | 10            | 44                      | 34         | 20  |
| Desa Tanjung Pendam    | 68            | 76                      | 8          | 5   |
| Kelurahan Kota         | 55            | 55                      | 0          | 0   |
| Kelurahan Parit        | 82            | 82                      | 0          | 0   |
| Total                   | 292           | 462                     | 165        | 100 |

3.2. Spatial use policy and suitability analysis of existing and planned land–use of Tanjung pandan Coastal Area

We overlaid existing land use and spatial pattern map (Spatial Plan of Belitung Regency 2014-2034) to analyze its suitability. Table 4 shows the results of the suitability based on each village or sub-district. Comparison of the area of the existing built area and the plan shows the Desa Tanjung Pendam has exceeded that planned while other villages are still below the planned area.

Table 4. Comparison of built-up areas in 2019 and the Belitung Regency Regional Spatial Plan for 2014-2034.

| Village or Sub-district | Area of built-up area (2019) | Area of built-up area in spatial plan (2014-2034) | Area difference of built-up area (existing-spatial plan) | Percentage area of built-up area 2019 to the spatial plan |
|-------------------------|-----------------------------|-----------------------------------------------|--------------------------------------------------------|--------------------------------------------------------|
|                         | hectares                   | hectares                                    | hectares                                              | %                                                     |
| Desa Air Saga           | 205                        | 432                                         | -227                                                  | 47                                                    |
| Desa Juru Seberang     | 44                         | 467                                         | -423                                                  | 9                                                     |
| Desa Tanjung Pendam    | 76                         | 75                                          | 1                                                     | 101                                                   |
| Kelurahan Kota         | 55                         | 58                                          | -3                                                    | 95                                                    |
| Kelurahan Parit        | 82                         | 85                                          | -3                                                    | 96                                                    |
| Coastal Area           | 462                        | 1117                                        | -655                                                  | 41                                                    |

We conducted interviews with relevant institutions to obtain information on zoning regulation and permit regulation compliance in Tanjungpandan coastal areas. Belitung Regency zoning system regulations are under provincial and national zoning system regulations. Because of in compiling the zoning system, the Regional Government of Belitung Regency has developed zoning system regulations referring to higher regulations.

The results of the study showed that there was compliance with the use of land in the area of cultivation and protected areas on the coast of Tanjungpandan District with the spatial plan. According to the Office of Spatial Planning and Built-up area of Belitung Regency, almost all buildings in built-up areas had permits.

Land-use change caused to people are losing their livelihoods and becoming vulnerable in coastal China. The recommendation policy is to involve the community in coastal development [13]. Another approach to developing resilience strategy in the coastal area is a dynamic system. The strategy is the expansion of grasslands to increase coastal biodiversity [14]. The extent of built-up areas is a factor causing flood-prone areas in the Pangkalpinang coastal area. Therefore, controlling factors for spatial use is very important to be a concern [15].

The results of the study showed that the implementation of the policy on spatial use controlling was relatively sufficient. However, we found that the built-up area in Desa Tanjungpendam exceeded the
planned area. These results need to be a concern of stakeholders so that better control over future spatial use. Coastal communities will suffer losses if land-use exceeds land capacity.

4. Conclusion
Almost all types of land use in the Tanjungpandang coastal region changed from 2010 to 2019, except for the water body. The area of land use for forests, open land, plantations, and agriculture has decreased, while the land-use area for developed areas has increased. The increased land use of the built area is 171 hectares. An area of 128 hectares or 75% is in Desa Air Saga. The results of the comparison between the existing built area with the plan show that there is one village that has exceeded that planned, namely, Desa Tanjungpendam. Overall, the suitability between the plan and existing is still sufficient and the implementation of the spatial use control policy is still relatively implemented.

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References
[1] Badan Pusat Statistik Kabupaten Belitung 2018 Kabupaten Belitung Dalam Angka 2018
[2] Lo, K. F. A., & Gunasiri, C. W. 2014. Impact of coastal land use change on shoreline dynamics in Yunlin County, Taiwan. Environments, 1(2), pp. 124-136.
[3] Ligate, E. J., Chen, C., & Wu, C. 2018. Evaluation of tropical coastal land cover and land use changes and their impacts on ecosystem service values. Ecosystem Health and Sustainability, 4(8), pp. 188-204.
[4] Akber, M. A., Khan, M. W. R., Islam, M. A., Rahman, M. M., & Rahman, M. R. 2018. Impact of land use change on ecosystem services of southwest coastal Bangladesh. Journal of land use science, 13(3), pp. 238-250.
[5] Misra, A., & Balaji, R. A. 2015. A study on the shoreline changes and Land-use/land-cover along the South Gujarat coastline. Procedia Engineering, 116(1), pp. 381-389.
[6] Xu, X., Peng, H., Xu, Q., Xiao, H., & Benoit, G. 2009. Land changes and conflicts coordination in coastal urbanization: a case study of the Shandong Peninsula in China. Coastal Management, 37(1), pp. 54-69.
[7] Nayak, S. 2017. Coastal zone management in India— present status and future needs. Geo-spatial information science, 20(2), pp. 174-183.
[8] Wibowo, M. 2018. Kajian dampak rencana pembangunan Kawasan Wisata Marina di Pesisir Kabupaten Belitung terhadap kualitas lingkungan sekitarnya. Jurnal Presipitasi: Media Komunikasi dan Pengembangan Teknik Lingkungan, 15(1), pp. 11-24.
[9] Rachmadianti, A. D., Purwanti, F., & Latifah, N. 2018. ANALISIS KERENTANAN PANTAI MENGGUNAKAN COASTAL VULNERABILITY INDEX (CVI) DI WILAYAH PESISIR TANJUNG PANDAN, KABUPATEN BELITUNG. Management of Aquatic Resources Journal, 7(4), pp. 298-306.
[10] Pemerintah Daerah Kabupaten Belitung 2014 Peraturan Daerah Kabupaten Belitung Nomor 3 2014 tentang Rencana Tata Ruang Wilayah Kabupaten Belitung Tahun 2014 - 2034
[11] Yirsaw, E., Wu, W., Temesgen, H., & Bekele, B. 2016. Effect of temporal land use/land cover changes on ecosystem services value in coastal area of China: The case of Su-Xi-Chang region. Applied Ecology and Environmental Research, 14(3), pp. 409-422.
[12] Akinluyi, F. O., Adebola, A. O., & Adeseko, A. A. 2018. Assessment of Shoreline and Associated Landuse/Land cover Changes along Part of Lagos Coastline, Nigeria. Contemporary Trends in Geoscience, 7(1), pp. 59-70.
[13] Huang, Y., Li, F., Bai, X., & Cui, S. 2012. Comparing vulnerability of coastal communities to land use change: Analytical framework and a case study in China. *Environmental Science & Policy, 23*, pp. 133-143.

[14] Kim, M., You, S., Chon, J., & Lee, J. 2017. Sustainable land-use planning to improve the coastal resilience of the social-ecological landscape. *Sustainability, 9*(7), pp. 1086.

[15] WARLINA, L., & GUINENSA, F. 2019. FLOOD SUSCEPTIBILITY AND SPATIAL ANALYSIS OF PANGKALPINANG CITY, BANGKA BELITUNG, INDONESIA. *Journal of Engineering Science and Technology, 14*(6), pp. 3481-3495.