

Assessing the Sustainable Development of Coastal Reclamation: A Case of Makassar Using GIS Application

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Abstract. Reclamation has been made in many areas in Indonesia including Makassar, as a response to the present needs of land as the impact of human activity in urban area. This research aims to assess the sustainable development of coastal reclamation and focus on environmental dimension of sustainable urban development. Assessment will be done by reclamation sustainability index (RSI) and analysis by GIS as the tools. RSI was built from previous research that has simplified from many researches and analysis by Structure of Analytic Hierarchy Process (AHP) and expert choice. RSI uses 9 indices from three indicators of environment factor which are coastal resources, building and infrastructure.

1. Introduction

The paper explores the latest urban dynamics across Java, the most developed and most densely populated island in Indonesia. Given the rapid development and growing population in the city of Makassar, the housing needs are also getting higher. The coastal zone in Makassar shows a rapid change during the past few decades, including large-scale reclamation projects which have been carried out along the coastal line [1]. However, these large-scale reclamation projects have already caused a series of negative effects to the marine ecological environment [2].

By definition, sustainable development of coastal zone does not only meet the increasing demand, but also protects ecology and environment, without prejudice to the future generations access to adequate food security [3]. In order to provide a scientific basis for decision-makers, therefore, it is necessary to assess the status of coastal reclamation development [3].

Reclamation Sustainability Index (RSI) is a tool of assessing the process of coastal reclamation areas in terms of their sustainability development. RSI can assist in assigning coastal reclamation development to sustainable environment and help to shape (or reshape) coastal development plans to create a well laid-out coastal environment. The planners need the process of appraising and grouping specific coastal areas in terms of their sustainability for defined uses [4]. The process is using geographic information system (GIS) as a tool for data input, storage, retrieval, manipulation, analysis and output of the spatial data [5].



However, because of the different research purposes, time and condition, no further study related to assessment of sustainability of the reclamation project on the coastal environment using RSI has been carried out yet. This paper aims to assess the sustainability of coastal reclamation area in Makassar city using RSI and analysis by GIS.

2. Theoretical Transition to Asian Background

2.1 Study Area

Geographically, Makassar city is located on the West coast of the southern part of South Sulawesi, at coordinates between 119 ° 18' 27.97" "up to 119 ° 32' 31.03" East longitude and 5 ° 30' 18" "- 5 ° 14' 49" South latitude." [6] The city is the capital of Makassar of South Sulawesi Province and is the fourth largest city in Indonesia whose area is 175.79 km² with coastal line 52.8 km consisting of main land coastline 36.1 Km, and along small island 16.7 km. This research was conducted in south coastal zone of Makassar, South Sulawesi Province [7] based on South Sulawesi Governor Regulation number 17 of 2008 concerning Detail Spatial Planning of Global Integrated Business Area.

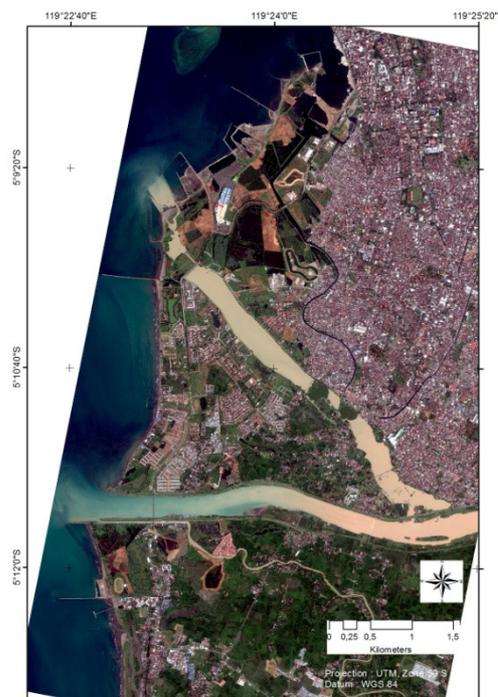


Figure 1. Location of the Study
Source: Satellite Image, 2014

2.2 Developing Assessment for Sustainability Index

The AHP-Expert Choice evaluation method has been refined into four steps [8]; Determination of Evaluation Index System, Weighting of Indices, Arranging Matrix, Testing Consistency, and Determination of Priority. The AHP structure of the indices can be seen in next figure.

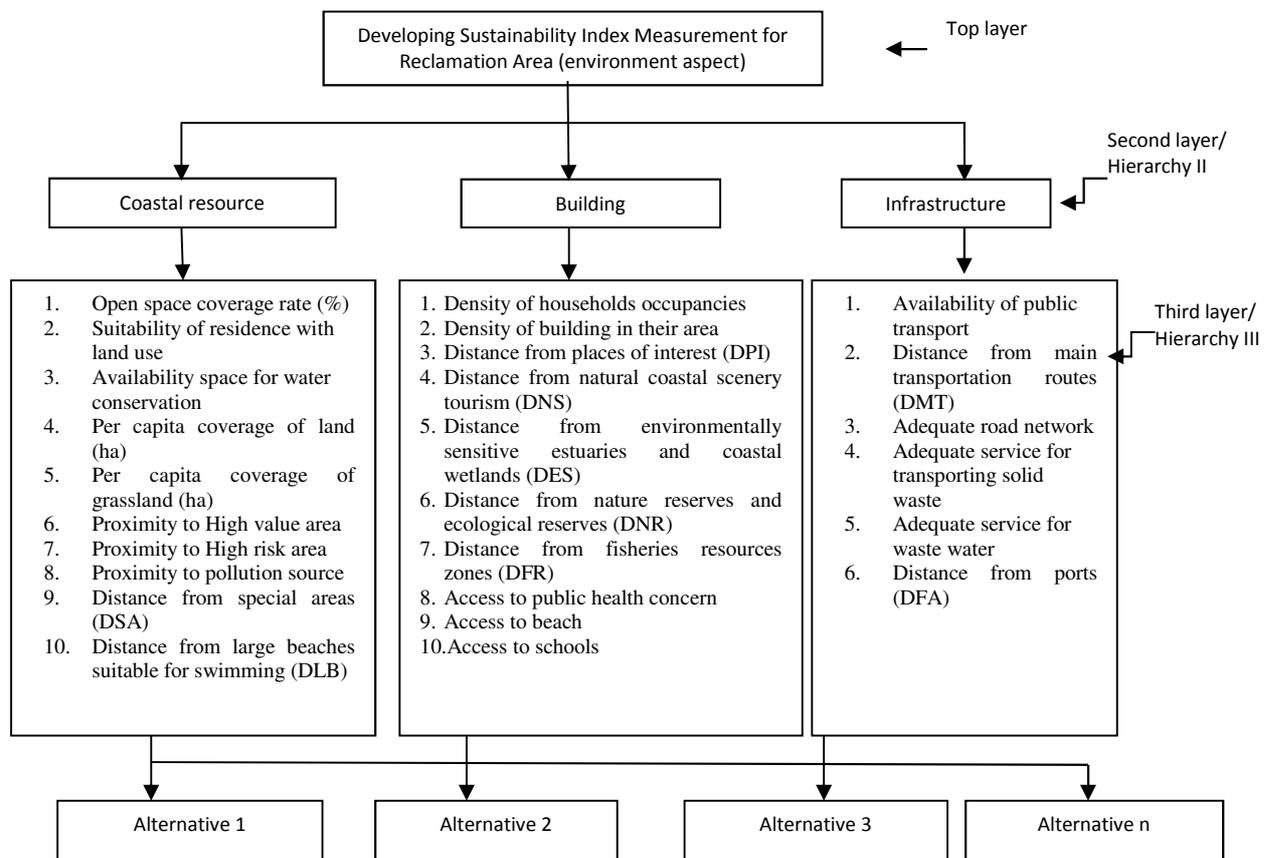


Figure 2. Structure of Analytic Hierarchy Process (AHP)
Source: Yurnita, 2016

To simplify the indices, this research is analysed through AHP and Expert choice. There were three types of experts who served as respondents whose opinions are considered and included in the matrix. They were from professional fields, government staffs and academics. They chose the most important indicators by pair wise system, using expert choice [9].

The summarized criteria obtained from experts' opinion from 72 criteria disclosed 26 applicable indicators, and from AHP, it listed 9 indicators which were most important according to the experts' choice. The experts assessed whether an indicator has more important influence than other indicators with a range of assessment 1 – 9, then ranked and graded. Top rank is environment effort rather than manmade, consistent across all interviewees, as shown in table 2.

2.3 Digital image processing

The study area was represented by Geo eye satellite images as of June 2014. The images were geometrically corrected. Rectification method (image for map) was followed. A mosaic process was elaborated to overlay the images.

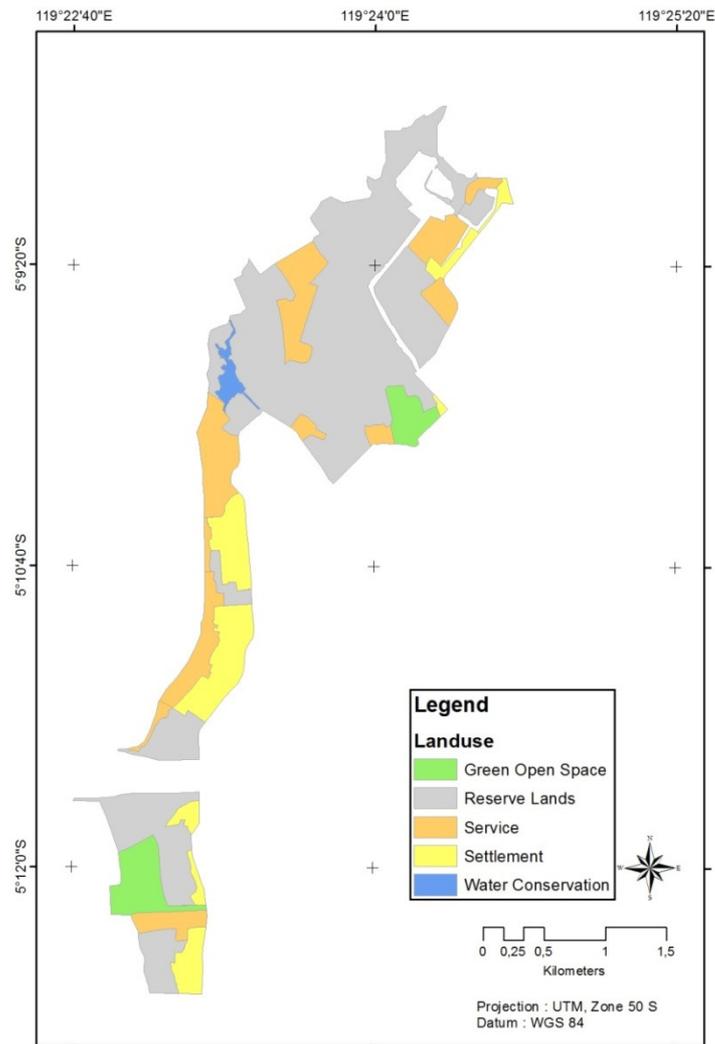


Figure 3. Land Use of Study Area.
Source: Result of GIS

2.4 Sustainability Index

Three factors which were selected for monitoring and assessing [10] the sustainability of reclamation in the study area which could be categorized as coastal resources, building and infrastructure. This factor consisted of 9 indices, that were found from previous research simplified from many indicators from many researches by Analytic Hierarchy Process (AHP) and Expert Choice.

Table 1. The Criteria of Reclamation Sustainability Index (RSI).

Category	Sub Category	Indices of sustainability
Coastal resource	Open space coverage rate (%)	3. >30 % of the area: good 2. 10–30 % of the area: poor 1. 0–10% of the area: bad
	Availability Space for water conservation	3 available: good 2. less available: poor 1. no available: bad
	Per capita coverage of land (ha)	Ha
Building	Distance from environmentally sensitive estuaries and coastal wetlands (DES)	3. >500m away from DES :good 2. 1–500m away from DES: poor 1. Within DES: bad
	Distance from nature reserves and ecological reserves (DNR)	3. >500m away from DNR: good 2. 1–500m away from DNR :poor 1. Within DNR: bad
	The Density of building in their area	3. Suitable: good 2. less Suitable: poor 1. not Suitable: bad
Infrastructure	Adequate road network	3. available: good 2. less available: poor 1. no available : bad
	Availability of public transport with weights	3. available: good 2. less available: poor 1. no available : bad
	Distance from main transportation routes (DMT)	3. 100-200 away from DMT : good 2. 200–500m away from DMT : poor 1. >500m away from DMT: bad

Source : Yurnita, 2016, (9)

2.4.1 Coastal Resources Indicator

The coastal resources indicator was calculated by three indices, open space coverage rate (%), availability space for water conservation and per capita coverage of land (ha) factor.

2.4.2 Building Indicator

Building indicator was assessed based on survey work, which identified the existence of the building in reclamation or nearby reclamation area. The building indicator considered three determining indices: distance from environmentally sensitive estuaries and coastal wetlands (DES), distance from nature reserves and ecological reserves (DNR), The density of building in their area.

2.4.3 Infrastructure Indicator

The infrastructure index was calculated using three factors: adequate road network, availability of public transport with weights, and Distance from main transportation routes (DMT).

Determination of the sustainability status was expressed by index and status of sustainability. Scale of index system of city sustainability examined in this study had three (3) categories of status of the sustainability of the city. The value of the index and status of sustainability can be shown in Table 2 [11]

Table 2. The Criteria for the Sustainability Index

Index value	Sustainability Status
3	Good (very sustainable)
2	Poor (sufficient sustainability)
1	Bad (not sustainable)

Source: Renald, 2015 and modified by author

3. Result and Discussion

Reclamation Sustainability Index (RSI) in the current study was focused on three factors: coastal resources, building and infrastructure and the was done by making use of geographic information system.

3.1 Sustainability indicators

This paper made use of geographic information system. The sustainability of the reclamation area was identified based on the Land sat ETM+ images, that has been derived from ASTER images as in Figure 2. The results obtained as shown in Figure 2, revealed that sustainability indicators in the current study were focused on nine factors; open space coverage rate (%), the availability Space for water conservation, per capita coverage of land (ha), distance from environmentally sensitive estuaries and coastal wetlands (DES), distance from nature reserves and ecological reserves (DNR), The density of building in their area, adequate road network, availability of public transport with weights and distance from main transportation routes (DMT).

3.1.1 Coastal resource index

The results showed that an area about 15% of the total investigated area is open space. From the RSI, it means that the area is classified as less sustainable, because less than 30% and the water conservation area is about 16 % it means it is available. If so, it is classified as good or sustainable. Then the last index from the coastal resource is per capita coverage of land (Ha). In Makassar, there is no certain amount to measure this indicator, because it has to count the land that people need to live, not only the house but also the land of school, work, recreation which all of them must be countable. This condition of the index is as shown in Fig. 4.

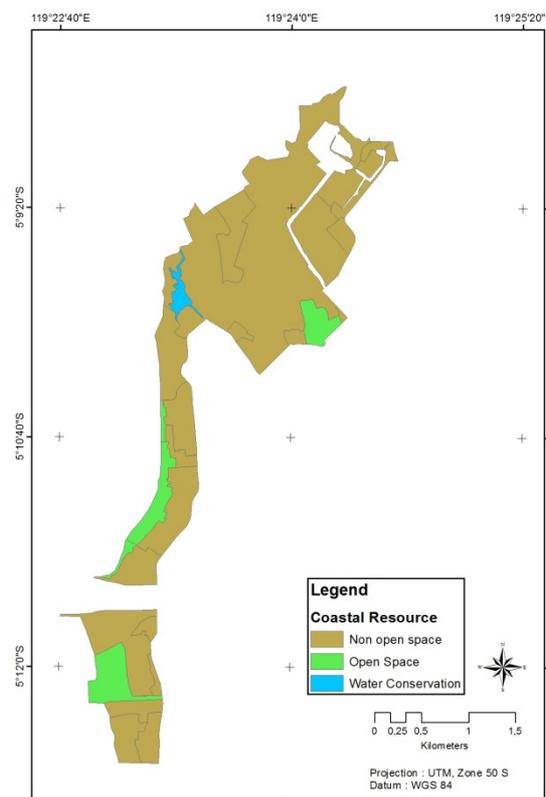


Figure 4. Coastal resource in the study area.

3.1.2 Building index

The results of the building index which consist of three indices show that the distance from environmentally sensitive estuaries and coastal wetlands is bad or not sustainable, because some part of the reclamation area is within the sensitive estuaries and coastal wetlands. The second indices show that the distance from nature reserve and ecological reserves is far from the reclamation area, which is more than 500m away. The next index is the density of building in their area which is suitable with Makassar Spatial Planning [6] it means it is sustainable as shown at figure 5(a).

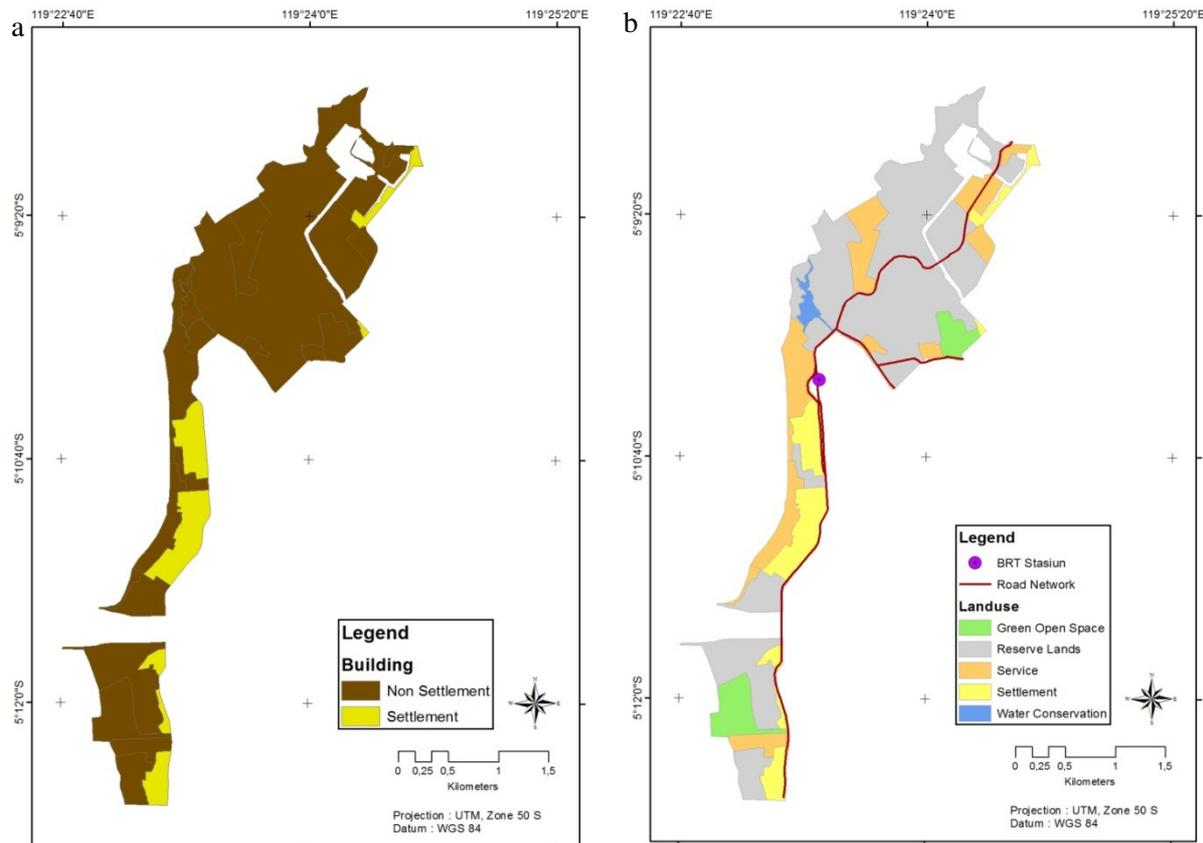


Figure 5. a) Building index in the study area; (b) Infrastructure in the study area
Source: Result of GIS

3.1.3 Infrastructure index

The infrastructure index obtained was classified into three indices, as shown in the Fig 5(b). First of these three indices is adequate road network. From the map, it can be seen that the reclamation area has adequate road network, meaning to say it is sustainable. The availability of public transport in the reclamation area is available, so it is sustainable. The last is the distance from main transportation routes is about 420M, it means poor sustainable.

4. Conclusion

The current work assessed reclamation in terms of sustainable development in the Makassar coastal area. It depended on three factors (coastal resource, building and infrastructure) by Reclamation Sustainability Index (RSI) that was built in previous research. At coastal resource index, it can be said that the open space was classified as less sustainable, because it accounted for less than 30% and the water conservation area was about 16 % which means it is available, so it can be said it is sustainable, for index per capita coverage of land (Ha) in this paper is not counted because in Makassar, there is no certain amount to measure this indicator.

The building index from three indices show that there is one factor classified as not sustainable that is the distance from environmentally sensitive estuaries and coastal wetlands which is bad or not sustainable. Another index is classified as sustainable status.

The infrastructure index in this paper is sustainable because the from analysis found that reclamation area in Makassar has adequate infrastructure. This paper concludes that land reclamation in Makassar city is sustainable. Finally, unused index was found for research in Makassar that is index per capita coverage of land (Ha) because in Makassar, there is no certain data to measure this indicator.

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References

- [1] Azwar SA, Suganda E, Tjiptoherijanto P, Rahmayanti H 2013 Model of Sustainable Urban Infrastructure at Coastal Reclamation of North Jakarta *Procedia Environmental Sciences* **17** 452-461
- [2] Li K, Liu X, Zhao X, Guo W 2010 Effects of Reclamation Projects on Marine Ecological Environment in Tianjin Harbor Industrial Zone *Procedia Environmental Sciences* **2010(2)**
- [3] Yua L, Xiyong Houa, Meng Gaoa PS 2010 Assessment of coastal zone sustainable development: A case study of Yantai, China *Ecological Indicators* **10(25)**.
- [4] Feng L, Zhu X, Sun X. 2014 Assessing coastal reclamation suitability based on a fuzzy-AHP comprehensive evaluation framework: A case study of Lianyungang, China *Marine Pollution Bulletin* **89**
- [5] Ismail M, Abdel Ghaffar MK, Azzam MA 2012 GIS application to identify the potential for certain irrigated agriculture uses on some soils in Western Desert, Egypt. *The Egyptian Journal of Remote Sensing and Space Science* **15** 39-51.
- [6] Makassar PDK. Rencana Tata Ruang Wilayah (RTRW) Kota Makassar Tahun 2015 – 2035 In: Makassar BK, editor. Makassar: Pemerintah Daerah Kota Makassar; 2015.
- [7] Suhayati, Bachri S, Patittingi F 2013 Aspek Hukum Kebijakan Pemanfaatan Tanah Hasil Reklamasi Pantai Losari di Kota Makassar.
- [8] Yurnita A, Trisutomo S, Ali M 2016 Developing Sustainability Index Measurement for Reclamation Area *Fourth International Conference on Sustainable Built Environment*
- [9] Mohamed ES, Schütt B, Belal A 2013 Assessment of environmental hazards in the north-western coast - Egypt using RS and GIS. *The Egyptian Journal of Remote Sensing and Space Science* **16(2)**
- [10] Renald A 2015 Model Adaptasi Ketahanan Kota Rawan Bencana Banjir untuk Keberlanjutan Kota Studi Kasus: DKI Jakarta (Jakarta: Universitas Indonesia)