Settlement development based on land suitability

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Abstract. The needs of settlements land are higher due to the increasing population, but the lands-availability in urban areas is getting narrower. Land use continues to grow as the initial process for the expansion of the city, its movement will out from the city centre to the periphery. Therefore, it is necessary to study the suitability land and develop the principles of the location planning of housing development. The research method using analytical hierarchy process (AHP) to calculate the weights, Geographical Information System (GIS) was used to create land suitability map, and overlay analysis result used to describe the principle of settlement location based on land suitability. The results show that 1) most suitable land for housing development is 637.75 hectares, low suitable land is 952.75 hectares and unsuitable areas of 781.5 hectares 2)The principles of settlement location based on land suitability are a)Clean water, available piped water network with adequate water quality terms smells, taste and colour, b)Flood prone, integrated drainage system development, optimization of reservoir performance and lake as water absorption, c)Accessibility, have road infrastructure and easy access to public transportation, d) Availability of land, not located in protected areas or technical irrigation, e) Availability of basic public service.

1. Introduction

Human cannot be separated from the use of land. Both land and the solid ground itself are such an important aspects of resources for human lives. The increase of population will encourage the increase of the land necessity. Some areas that can be used to support life had been settled and quite limited meanwhile, the demands for land to those residents' dwellings increases. Often the demand for land is not comparable to the existing land that holds the capacity due to population growth in a straight line with the increase of activity that can be decreases due to building development activities [1].

The City of Makassar has a fast pace of urban development. The rapid pace of the development of the city is due to the growth of Makassar's population in 2015-2016 approximately to 1.39% which is higher than the population growth of South Sulawesi province (1.12%) which can lead to various unfavorable consequences [2]. For the development of the city due to the increasing demand the use of land while the tamping power of the land is persistent. The development of its society will bring changes to various things such as compaction of buildings in the center of the city [3]. The use of Land that continues to grow would have been a process of urban expansion, its movement will might have been came out of the centre of the city to its periphery area. The increase of its them in Makassar
would give an impact on the wider range need of land for settlements, so that the needs of a great deal of competition to get land for its settlements is getting higher.

Such conditions result in higher land prices, especially in urban areas, from few decades. The high price of land will have an impact on the urban community, result shows that for low-income people they will not be able to reach the price of existing land, and they will tend to look for suburban areas as their alternative. Suburban area of Makassar in the southern region consists of Rappocini and Manggala districts. Manggala sub-district is one of the suburban areas in the city where in the City of Makassar Regulation No. 4 of 2015 concerning the Makassar City Spatial Plan for 2015-2034, Manggala District which is directed as a medium density housing activity centre, and a high density housing activity centre, as well as industrial activities.

The use of land for settlements needs to be regulated properly, so that it is in accordance with the spatial plan of the city that get involved with, taking it as a reconsideration aspects of ecological balance with the result that there is no decline in land quality. The shift in functions that occur in the suburbs that land was previously designated as a water catchment area and agriculture, has changed its function to a residential, industrial and other non-agricultural business area. Therefore, there needs to be a study of land suitability and formulate the principles of planning the location of housing and also its settlement construction in the suburban area of The City of Makassar specifically in the Manggala district.

2. Research method

2.1 Data collection and preparation
The primary data collection technique was obtained directly from interviews, observation, and questionnaire. In addition, secondary data were obtained from literature studies or surveys of agencies related to the compiling material. By giving close attention to the absence factor or the lack of field data, the aspects or parameters of the research are:

1. Aspect of regional function, consisting of protected areas and cultivation areas
   Calculation of regional function analysis according to the Decree of the Ministry of Agriculture No.837 / KPTS / Um / 11/1981 which requires the score given for each protected area function is > 175, the score of buffer area is 125-174, and the score of cultivation area is <125.

2. Aspect of accessibility
   Accessibility variables are viewed from the distance of land to the main road [4]. The distance of the road network considered suitable related to the location of the land being reviewed is less than 2 km [5].

3. Aspect of clean water networks.
   The criteria determination is viewed from the distance of piped water to the housing development location.

4. Aspect of flood-prone area
   Consideration in giving value is when the designation area of settlements not located in disaster-prone areas. It is ruled in the decree of Ministry of works and public housing No. 41 of 2007.

5. Aspect of land use
   The analysis of land use aimed to determine which lands that is appropriate to be developed as housing locations.

6. Aspect of distance of service facilities: education and health
   Distance analysis of service center is the proximity of the location to the service center. The six aspects above are analyzed in order to get the suitability of land, which is classified as appropriate areas, quite appropriate, and not suitable for settlement development locations.
2.2 Area of study
The research located in Manggala District, Makassar City, South Sulawesi Province. Geographically, the study area is at 5°10’03” south latitude 119°29’29” east longitude [2]. The research location can be viewed in figure 1.

![Map of Sulawesi, Indonesia](image1.png)

![Map of Manggala District (Study Area)](image2.png)

Figure 1. Location map of study area.

Manggala is a sub-district located out of Makassar City (rural area) which is a flood-prone location. The area of Manggala sub-district is 24.14 km² or 13.73 percent of the area of Makassar City [2].

2.3 Research analysis
The analysis technique used was overlay technique by involving several variables determined by using Geographic Information System (GIS) technology. The GIS method uses quantitative approach by giving score and weighting to each parameter. The determination of variable weighting criteria used the Analytical Hierarchy Process (AHP) method. The AHP method was used to evaluate the priority weight of each factor and sub-criteria (parameters) [5]. AHP method processing uses Expert Choice software. This software was developed by Thomas L. Saaty. Experts will determine an assessment based on the scale of 1 to 9 in pairwise comparisons [6].

| Value | Definition                          | Description                                                                 |
|-------|-------------------------------------|-----------------------------------------------------------------------------|
| 1     | Equally important                   | Both elements have the same effect.                                        |
| 3     | A little more important             | Experience and assessment strongly favor one element compared to its partner.|
| 5     | More important                      | One element is very well liked and practically its dominance is very real, compared to its partner elements. |
| 7     | Very important                      | One element is proven to be very well liked and practically its dominance is very, compared to its partner element. |
| 9     | Absolute more important             | One absolute element is preferred compared to its partner, at the highest level of confidence |
| 2, 4, 6, 8 | Middle values between two adjoining opinions | These values are needed a compromise |

Table 1. Assessment criteria in AHP.
3. Results and discussion

3.1 Identification of land function

Identification of suitability of land use in the study area used three basic parameters in the form of slope, soil type, and rainfall intensity. The processing of the three parameters used ArcGIS software using an analysis tool in the form of overlay and scoring according to the Decree of the Minister of Agriculture No. 837 / KPTS / Um / 11/1980. The results of data processing obtained from the results of the land score were 90 and 105 which showed that the land in Manggala Subdistrict was a cultivation area and able to be used as residential area (figure 2).

Furthermore, identification of the function of protected areas had also been determined in Makassar City RTRW 2015-2034, they are; river border, lake border, green open space and irrigated rice fields which are then overlaid with the results of identification of land functions based on the slope, soil type and rainfall intensity. Free analysis of protected areas was conducted by using simple overlay analysis where protected areas is considered not suitable for housing.

3.2 Determination of weight

Expert assessment results by using AHP for determining the weight of land suitability for residential areas (figure 3) shows that the five most influential criteria are the availability of clean water with a percentage value of 37.5%, flood prone 26%, land use 19.2%, accessibility 9.8%, and service center 7.5%. The research value of the inconsistency ratio that can be accepted is less than 0.1, in this study, expert valuation has an inconsistency of 0.07, meaning that the expert is quite consistent in assessing [7].

![Figure 2. Land suitability map based on physical aspects and based on the 2015-2035 Makassar City spatial plan.](image)

![Figure 3. Results of expert evaluation of the land suitability in residential areas.](image)
3.3 Suitability of land settlement viewed from the research variables

This study consists of five variables, they are; availability of clean water, accessibility, use of flood-prone land, and distance of service centers. Variable analysis of the availability of clean water was conducted by using tool analysis in the form of buffering of the pipeline of clean water in accordance with the specified suitability class (figure 4).

Figure 4. Map of clean water pipeline buffer.

Accessibility variable analysis was carried out by using tool analysis in the form of buffering the collector road network map as a form of accessibility. The conclusion is drawn that the closer the settlement area to the road, the higher the quality of accessibility. Results of analysis of figure 5.

Figure 5. Map of the main road network buffer.

Variable analysis of flood-prone areas (figure 6) is divided into two classification based on its role: flood-prone area and non-flood-prone area. The consideration to determine the mark is that the
residence designation area is not on the flood-prone area according to ministerial regulation PU No 41 2007.

Figure 6. Map of flood-prones area.

Figure 7. Map of land use in Manggala District.
Analysis of land availability is important to determine the suitable residential area development. The priority is the land that is available to develop. Quantitatively on the map of land use in Manggala District, about 14% of the land is protected land and about 86% is cultivation area, which it designated as residential area and rice field (figure 7).

Analysis of service center distance is the proximity of location to service centre. Service centre in this analysis is service regarding education and health. Analysis of education and health facilities’ proximity is an analysis to find out the accessibility of a location to education and health facilities. In this analysis, it is assumed that accessible location means a good location as residential area, meanwhile inaccessible location cannot be a residential area.

Figure 8. Map of affordability of primary school services.

Figure 9. Map of affordability of junior high school services.

Figure 10. Affordability map of senior high school services

Figure 11. Affordability map of Healthy services.
Analysis result is map of land suitability which considered from all aspects in figure 12. From the analysis result, it is found out that the appropriate category is 1294.25 ha for non-flood-prone area, clean water pipe available, not a protected area, and close to main road and primary service facilities. Quite appropriate category is 812.75 ha which most of the area is built area. Meanwhile inappropriate category is 265 ha which is protected area/irrigated rice field, flood-prone, far from main road and primary service facilities, and clean water pipe unavailable.

Table 2. Parking change rates.

| No | Land Suitability Classes | Area (Ha) | Percentage (%) |
|----|--------------------------|-----------|----------------|
| 1  | High suitability         | 637.75    | 40             |
| 2  | Low suitability          | 952.75    | 27             |
| 3  | Not suitability          | 781.5     | 33             |
|    | Total                    | 2372      | 100            |

3.4 Principle for developing residential housing locations based on land suitability

1. Clean Water. Based on land suitability result for clean water, principles for developing residential location is formulated as follows: source of clean water processed by organizers in a sufficient amount, supply of PDAM water is 60-100 liter per person per day, and water infrastructure meets the proper requirement of smell, taste, and colour.

2. Flood-Prone. The construction of rainwater drainage system with sufficient capacity. The drainage can be an open drainage or closed drainage, the fulfilment of drainage system with integrated network between recharge area and other water system areas in handling floods, and the optimization of lake and reservoir manufacture in Manggala district.

3. Accessibility. Based on the land suitability result in suburban for accessibility indicator, the principle for developing residential land is that residential designation area should have road infrastructure and is accessible by public transportation.

4. Land Availability. In developing residential designation area, land capability factor or capability of a land to support a residential construction should be paid attention to which they are based on potential value, future obstacles, and imitation land establishment or land which cannot be developed at all. As for the principles of land use for residence, it is that residence location should be based on applicable regulation and does not disturb the existing protective function (not in the region of river border/lake/fountain/irrigation channel).

5. Service Facilities. Utilization and management of land must be supported by the availability of public service facilities, such as education and health service at the least. Affordability of education access must be paid attention to in developing residential land, ideally elementary school can be reached on foot from residential location.

4. Conclusion

Based on previous discussion, the final conclusion is that by considering clean water availability, land availability, flood-prone area, and proximity from service centre, the result of the level of residential land suitability is as follows: appropriate category is 637.75 hectare, quite appropriate category is 952.75 hectare, and inappropriate category is 781.5 hectares from the overall area in Manggala District. The principles of residential area development based on land suitability in suburban are 1) clean water, availability of clean water pipe and the water meets the proper requirement of smell, taste, and colour, 2) flood-prone, the construction of integrated drainage system, optimization of lake and reservoir manufacture as water infiltration, 3) accessibility, an adequate road infrastructure and accessible for public transportation, 4) land availability, not in the region of protected land/technical irrigation, 5) availability of public service facilities and its accessibility.
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