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Land suitability for maize at different land use types and spatial planning zones: an analysis using GIS

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Abstract

This study examines land suitability for maize at different land use types and spatial planning zones in Mamminasata region, and identifying spatial matching between present land uses and their changes and spatial planning zones in the study area. A preliminary stage of the study has been undertaken to produce land suitability map for maize and present land use map of the study area (2014). The former uses FAO method (FAO, 1976), and the later utilizing a combination technique of visual interpretation and image analysis. Land suitability map and its statistics shows that no land suitability class S1 exists in the study area, while S2 comprises 8.059 ha, S3 62.724 ha, and N 105.114 ha. Forest, paddy field, and dryland agriculture, cover the dominant part of the region (approximately 53.509 ha, 40.751 ha, and 3.789 ha, respectively), followed by scrubs and other types of land use. Forest is dominantly found in the upland of Gowa regency, and may become protected and conserved zones for the region. The results of this study were in form of a series of land use information (geographic and descriptive), and land suitability for maize, as well as their match to spatial planning regulation map, which are useful for spatial planning and land resource management. Such information set may give insights into the future anticipation of land use development on the region on a spatial basis, and thus useful for devising the future land resource management control.

Keywords: maize; land use; GIS; land suitability; spatial planning regulations

Introduction

Maize is one of the prime agriculture commodities in South Sulawesi Province, Indonesia. It grows along the tropical zones of Sulawesi Regions, which has long become staple food. However its development has recently limited by a rapid growth of other land use types, suppressing land for maize cultivation. In this paper we focusses our analysis on Gowa regency, i.e., one of the largest Mamminasata administrative regions, covering a total area of approximately 200 thousand ha. Mamminasata region is one of many strategic regions in Indonesia, as stated in Government Act number 26, 2008 about National Spatial Planning. Due to this status, this region has recently experienced rapid land use changes, due to intensive urban development. The Mamminasata region (as an acronym for Makassar, Maros, Sungguminasa,and Takalar) covers four districts in South Sulawesi Province, including the whole area of Makassar City, and some parts of Maros, Gowa, and Takalar regencies with a total area of approximately 240.000 ha. This study examines land suitability for maize at different land use types and spatial planning zones in Mamminasata region, and identifying spatial matching between present land uses and their changes and spatial planning zones in the study area.

Methodology

The study employed integrated techniques of ground surveys, remote sensing, and geographic information systems (GIS) technology (Aubert *et al.*, 2013; Baja *et al.*, 2002; Maxwell and Sylvester, 2012; Nurmiaty and Baja, 2014). Land suitability evaluation for maize was performed using the FAO's land suitability scheme. This study covers survey activities and laboratory analysis, guided by soil information at reconnaissance level obtained from RePPProT (1988). Classification of land suitability was made at class level (see FAO, 1976), each with a unique name in Soil Taxonomy (USDA, 1996). Class is land suitability group within the Order level. Land suitability classification is undertaken based on the level of detail of the data available. For example, in this study S order is divided into Highly Suitable (S1), Moderately Suitable (S2), and Marginally Suitable (S3). In the "Not Suitable" order no further division is made (see also Baja, 2009).

Spatial information for land use classification used in this research includes LANDSAT ETM+ images (resolution 30 meters), SPOT XS images (resolution 20 meters). Spatial planning map of the region was derived from a set of vector data bases developed by local government, i.e., Gowa Regency. Field surveys were conducted to find out actual condition on the ground that represents a wide range of physical environments within the study area. A number of site locations were visited and examined during this study, and such sets of information were used for correcting and refining classified satellite images, and for assessing the actual change in conjunction with spatial planning regulation. A spatial based procedure was developed to integrate the information obtained from field surveys, remote sensing image analysis, and local government vector-based spatial data bases. Then, an analysis is undertaken to examine the spatial matching between land use types, land suitability classes, and the land status according to the local spatial planning regulation stated by the government under the Government Act No. 26 2007 about Spatial Planning.

Result and Discussion

A preliminary stage of the study has been undertaken to produce land suitability map for maize and present land use map of the study area (2014). The former uses FAO method (FAO, 1976), and the later utilizing a combination technique of visual interpretation and image analysis. Land suitability map and its statistics can be seen in Figure 1 and Table 1. The statistics of land use analysis can be seen in Table 2.As the table shows, no land suitability class S1 exists in the study area, while S2 comprises 8.059 ha, S3 62.724 ha, and N 105.114 ha.

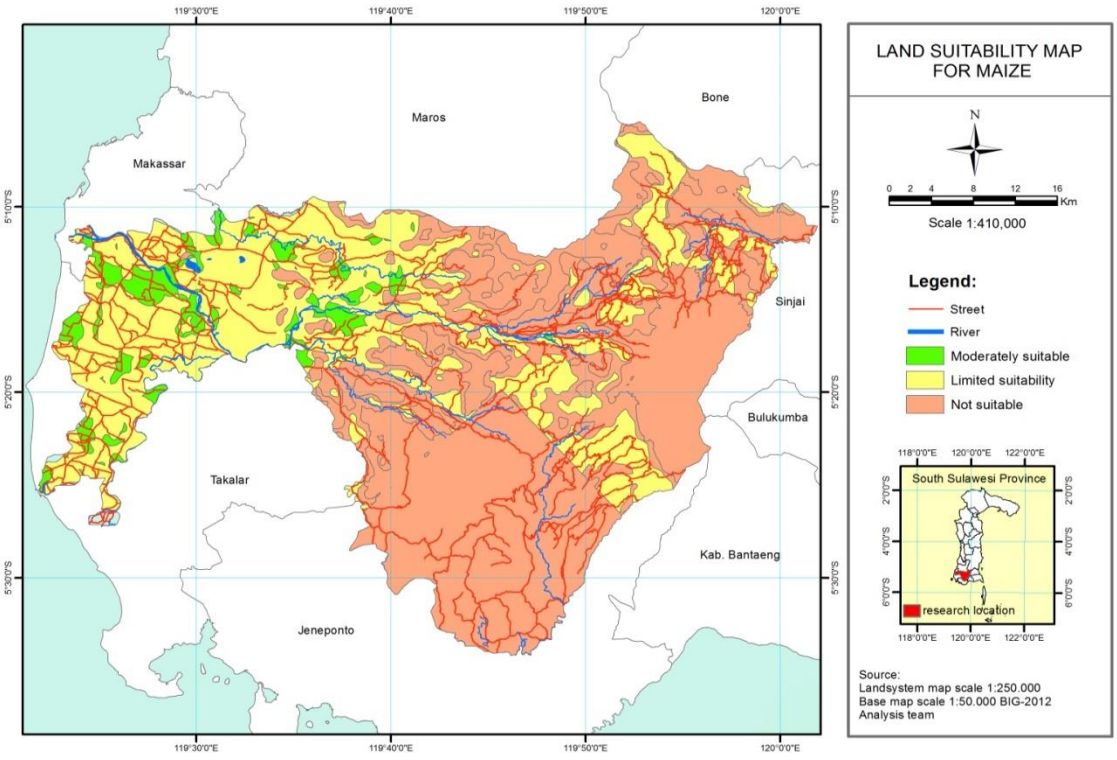

Figure 1. Land suitability for maize

Table 1. Land suitability area for maize at different class

Category	Description	Area (ha)	%
S1	Highly Suitable	-	-
S2	Moderately Suitable	8.059,6	4,6
S3	Marginally Suitable	62.724,4	35,7
N	Not Suitable	105.114,9	59,8
	Total	175.898,8	100,0

Further, as the Table 2 shows, forest, paddy field, and dryland agriculture, cover the dominant part of the region (approximately 53.509 ha, 40.751 ha, and 3.789 ha, respectively), followed by scrubs and other types of land use. Forest is dominantly found in the upland of Gowa regency, and may becomes protected and conserved zones for the region. An analysis is still underway for land use classification, back to 5 and 10 years to assess changing in land use types, both quantitatively and spatially. This analysis will show the rate of land use change that can be used to describe land conversion from forest to other uses, from agriculture to other uses, and so on.

Table 2. Land use types and their coverage area derived from classifying SPOT XS images

Land Use	Area (ha)
Reservoir	1080,3
Forest	53509,5
Grassland	41,5
Dunes	1024,8
Plantation	2790,4
Residential	4704,8
Paddy field	40751,9
Rainfed paddy field	3980,2
Shrubs	32749,7
Bare land	793,4
Dryland agriculture	37892,5

*SPOT XS images have a 20 m resolution, 2014.

Further, based on the local government vector data base an analysis was performed in GIS to calculate the distribution of land function/status that should be used by the local government in directing land use within a period of 20 years. A simple overlay was made to calculate and to map distribution of land status according to land suitability class for maize. According to the land status/function and land suitability maps, there is quite extensive land areas are suitable for development of maize (classes S2 and S3) within forested zone status. This particularly occurs at protected and production forest. Furthermore, a very consistent result is found for land suitability class S2 and S3 in the wetland agricultural zone, covering 4.240,8 ha and 21.035,4 ha, respectively (Table 3).

An analysis is still underway to examine the spatial matching between land use types and the land status according to the spatial planning regulation stated by the government under the Government Act No. 26 2007 about Spatial Planning. A preliminary results show that, present land use type of some proportions of the area do not match according to their function as stated in the spatial planning map produced by the government, particularly for those already been determined as protected and production forest. Some areas of mixed dry land agriculture, in fact are found on the protected and production forest status. A similar phenomenon also occurs for agriculture and urban areas.

Table 3. Land status/function (from spatial planning regulation) with different land suitability classes for maize

Land status/function	Land suitability class (ha)		
	S2	S3	N
Conservation forest	0,0	703,7	3.451,6
Protected forest	230,1	5.204,6	25.063,2
Limited production forest	-	3.952,3	16.322,3
Production forest	706,1	5.980,7	16.428,2
Conversable production forest	-	-	309,8
Agroforestry zone	453,5	4.281,3	4.261,7
Horticulture zone	-	3.606,7	8.466,4
Plantation zone	146,9	4.276,8	8.649,4

Wetland agricultural zone	4.240,8	21.035,4	8.449,7
Dryland agricultural zone	117,6	3.817,2	12.933,2
Industrial zone	-	44,8	-
Education zone	77,7	81,0	-
Residential zone	2.086,9	9.739,9	779,3

Conclusion

The results of this study were in form of a series of land use information (geographic and descriptive), and land suitability for maize, as well as their match to spatial planning regulation map, which are useful for spatial planning and land resource management. Such information set may give insights into the future anticipation of land use development on the region on a spatial basis, and thus useful for devising the future land resource management control.

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