

Using Geospatial Information Technology for Regional Assessment of Food Crop Land in South Sulawesi

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Abstract. Recently, geospatial information on land suitability and land availability for specific purposes has become a prerequisite for strategic planning in regional development. Although geospatial data on land resources and their uses have become more available and detailed, in some circumstances, their geographical representations for spatial decision making are often considerably intricate. Accordingly, it requires advanced geospatial methods and approaches that could deal with those complex phenomena in an effective manner. The principal aim of this paper is to utilize Geographic Information Systems (GIS) and Remote Sensing (RS) to assess food crop land suitability at a regional scale. We fully utilize integrated techniques of GIS and RS in mapping land areas of three regencies, namely Takalar and Jeneponto, where such regencies have to date become strategic areas for food crop development, especially maize. Our preliminary finding as show that although Jeneponto district has long been recognized as a very dry area (where some parts of the region have less than 1,000 mm annual rainfall), this area has a very large potential suitability for maize cultivation, followed by Takalar. Such analysis has also been confirmed by the results of our geospatial data analysis following ground visits and local government statistical data. The results of this study not only present the suitability of future development of food crop especially maize, but also depict spatially the distribution of land class fitness for a given crop in such three regions; and thus provide the basis for decision making in future land use management.

Keywords: geospatial information, land suitability, food crop, South Sulawesi.

1. Introduction

The maize productivity was still classified as low, was only 4.20 ton/ha, this productivity is lower than Vietnam's which reaches 4.60 ton/ha and even Uni Europe has reached 6.80 ton/ha. As a result, Indonesia should import maize as much 800.000 ton on 2010, dan proximately 900.000 ton on 2013 for fulfill domestic needed that has average about 5 million per year [1]. The southeast of South Sulawesi region has big potential for food crop development, especially for maize, both for agroecology and culture of society in maize cultivation. Nevertheless, this potential has been not explored and has not used yet. Specifically, in South Sulawesi, the average of productivity was about 4.70 ton/ha, only a few on the above national average.



Available land was wide enough, and the farmers still have hereditary of maize cultivation. According to [2], maize was a flexible plant and has great tolerance with its environment, in require that growing period should be ice-free. Maize could growth on temperature 12-24°C, minimum temperature was 26-29 °C. rainfall for maize is about 500-5.000 mm. The optimal amount of water for maize was about 500-1.200 mm/growing period [3]. Maize could be possible growth on variety kind of soils. Maize was suitable with soil which has good drainage, good aeration, has loam and silt loam texture, and enough percentage of organic matter [3]. The land has bad drainage have to be avoided, groundwater level should be below 0,75 m from the surface. Maize could not be resistant if there is flooding on 5 weeks after planting [4]. In order dry region, poor capability of water retention and slight rainfall have to do cultivate in low density. The optimal acidity soil for maize growth was about 5.8-7.8.

Identification of potential, constraints, and land suitability for specific commodity development were done by survey and land evaluation. In a fact that various land use needed different requirements, thus it was used information about properties of land from various appropriate aspect with land use planning [5]. Land characteristics could be gained by land survey and other analysis. Different areas might have different soils type based on the affected condition. Different soils also have different properties. Difference of soil characteristics might cause different potential, constraints, and land suitability for certain commodity development.

Land suitability evaluation was to determine potential of land in order to certain purpose [6]. Basically, it was to evaluate land for certain land use, such as paddy field, maize, and others. Actual land suitability was assessment of land suitability before land improvement. Potential land suitability is assessment of land suitability after land improvement. For example there was land as actual was classified as marginally suitable (S3) due to nutrient deficiency could be change as moderetely suitable (S2) or even suitable (S1), after it has done by fertilization [7]. The aim of this study was to elevate effectivity of management system for Maize in Sulawesi region by spatial-based integrated model applying for biophysics, social-economy, and wisdom of cultivation at maize central area.

2. Methodology

The study was done in 3 (three) stages continually, consists of: (i) **stage I**: food crop's biophysics analyze (suitability and productivity of land); (ii) **stage II**: Social-economy analyze and management system of maize; and (iii) **stage III**: wisdom analyze and spatial integration between biophysics factor, social-economy, and wisdom factor to take decision for maize management. This study will be held over South Sulawesi to turn out indication of land suitability maps and to analyze 6 regencies by spatial integrated to get wisdom of maize management in South Sulawesi. Biophysics factor was also needed, consists of climate, topography, geology, and soil type.

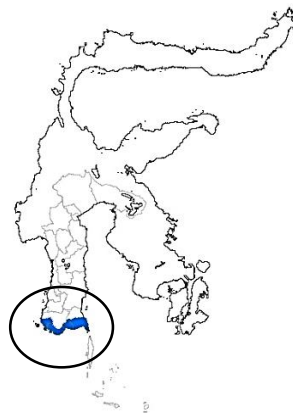


Figure 1. Study area

3. Results

3.1 Jeneponto regency

Jeneponto's rainfall was slightly if it was compared with other regency in South Sulawesi. Rainfall of Jeneponto have been noted on 2001-2010 were about 1.278 mm until 1.986 mm per year, mean of temperature is 24.01°C, mean of maximum and minimum temperature were 27.12°C and 22.71°C. The rainfall was often erratic and it was begun to pour regularly at the end of October. Dry season starts in the middle of June until October. Rain season starts on November and it was getting down on the beginning of March until the end of May. Instead, temperature was more regularly and deviation between temperatures of different months was relative narrow both minimum or maximum temperature even for mean of temperature. The most maximum temperature was on October (33.5°C) and the most minimum was on February (26.13°C). Mean of relative humidity was 85.32% with length of radiation (n/N) was 0.63 and the highest was measured on September was 0.78.

Topography of Jeneponto could be classified as flat (0-3%) percentage as 5%, wavy (8-15%) as 31%, hilly (15-25%) as 32% and mountainous (>45%) as 31%. Tamalatea district was classified as flat (0-3%) percentage as 16.2%, undulating (3-8%) as much as 38.3%, rolling (8-15%) as 6.1%, hilly (8-15%) as much as 7.1%, and mountainous (>45%) with percentage as 32.3%.

As lithography, Jeneponto was formed from 4 rock types, those were: 1. Qac formation (Quarter alluvium coastal). This formation was arranged by alluvial deposit and coast (gravel, sand, clay, mud, corl and limestone); 2. Qlvb formation (Quarter breccia volcanic Lompobattang) which was consists of breccia, lava, and volcanic ash; 3. Tmc formation (Tersier miosen Camba) which was formed as marine sedimentary rock interbedded volcanic; 4. Temt formation (Tersier eosin miosen Tonasa) that was arranged from limestone [8]. The dominant formation that found in Jeneponto was Qlvb and following to Temt, Qac, and Tmc. Based on soil map of South Sulawesi scale 1:500.000 [9] that was overlaying with soil map based on soil taxonomy [10], there were 3 types of soils in Jeneponto regency, those were Alfisols (45%), Inceptisols (24,8%), dan Vertisols (29,8%).

Based on criteria of land suitability classification for maize that has been determined by [11] generally on study area in jeneponto classified as S2 as much as 7.067 Ha (8,9%) and S3 as much as 33.292 Ha (41,8%) with various limiting factors. The main limiting factor was climate specifically for rainfall on vegetative stage of maize, relative humidity on generative stage, length of radiation, soil fertility for base saturation and soil pH and other soil physics, those were course fragments and soil depth.

The results showed that variety of maize yield at area study was wide enough as 3.0– 5.2 ton/ha. Generally, average of hybrid maize yield that was gained is on dry area, in this case Jeneponto, which was represented by Tamalatea district, Kelara district, and West Bangkala district. The maize yield that are showed on attachment is result of maize yield average on study area for twice planting that measured using square area method 2.5 m x 2.5 m. If it adjusts with growing period in Jeneponto with assumption that using hybrid seed could be harvested 110 days after planting, so planting time that is proposed for Jeneponto regency if does in twice are first week of November until second week of February (MT1) and first week of March until second week of June (MT2). Determination of planting time in growing period was important in maize cultivation, in line with research of [12] and [13] who has results that appropriate planting time could be improve crop yield as long as growing period was long enough and relative humidity was in controlled. According to [14] appropriate planting time might avoid maize yield loss due to climate change. Furthermore, Nafziger [14] explained that in Illinois state which is the largest maize produced in USA, has been determined that planting time starts in the middle of April, if it does backwards will be cause yield loss, thus if its back out at the beginning of June will be cause yield loss up to 50% due to frost problem on generative stage. Thus, determination of planting time was urgent for maize cultivation which is adjusted with growing period. As for the proposed growing period has been showed on Table 1.

Table 1. The proposed planting time according to growing period on study area (Jeneponto)

	Location	Planting time*
Jeneponto	Kelara	1.November-February (MT1) 2.February – May (MT2)
	Tamalatea	1.December – March (MT1)
	West Bangkala	1.November-February (MT1) 2.February-May (MT2)

3.2 Takalar regency

According to Oldeman climate classification, Takalar classified in climate types of D3, C3 and D4. On a year, mostly amount of wet season only 3 until 4 months, instead dry season was 3 until 5 months for D3, 4 until 6 months on wet season and 3 months for dry season for C3, and more than 5 months on dry season for D4. Even though the amount of dry season is more than wet season, rainfall of Takalar was still classified as high, is about 1.905 mm for Sanrobone station, 2.217 mm for Galesong station, and 1.979 mm for Biringkassi station.

The result showed that various of maize yield per ha on study area was wide enough, it was 4.0– 5.5 ton/ha. Average of hybrid maize yield on dry areas that were represented by 7 districts in Takalar, those were Polongbengkeng Utara, Polongbengkeng Selatan, Mangarabombang, Pattalassang, Galesong Utara, Galesong Selatan and Mappakasunggu. The maize yield that shown on Attachment 2 was results of mean maize yield on study area for twice planting which was measured using square area method 2.5 m x 2.5 m. If it adjusts with growing period in Takalar with assumption that using hybrid seed could be harvested 110 days after planting, so planting time that was proposed for Takalar regency if does in twice were first week of November until week 2 of February (MT1) and first week of February until fourth week of May (MT2). Determination of planting time in growing period was important in maize cultivation, in line with reseach of [12] and [13] who has results that appropriate planting time could be improve crop yield as long as growing period was long enough and relative humidity was in controlled. According to [14], appropriate planting time might avoid maize yield loss due to climate change. Furthermore, Nafziger [14]) explained that in Illinois state which is the largest maize produced in USA, has been determined that planting time starts in the middle of April, if it does backwards will be cause yield loss, thus if its back out at the beginning of June will be cause yield loss up to 50% due to frost problem on generative stage. Thus, determination of planting time was urgent for maize cultivation which was adjusted with growing period. As for the proposed growing period has been showed on Table 2.

Table 2. The proposed planting time in line with growing period on study area (Takalar)

	Location	Planting time*
	Takalar	1.November-February (MT1) 2.February-May (MT2)

4. Conclusion

The study results on the first year showed that:

- 1) Potential of biophysics consists of climate (rainfall, temperature, humidity, n/N), physical properties of soil (texture, drainage, soil depth, coarse fragments), and chemical properties soil (pH, amount of N, P, and K, Organic C, salinity, CEC) on South Sulawesi might support food crop development for maize.

- 2) Study areas was classified as S1 (very suitable); S2 (moderately suitable) and S3 (marginally suitable) with limiting factors, such as topography, soil depth, and soil fertility, climate (rainfall on growing period).
- 3) Maize development potency on South Sulawesi was high that was supported by heredity society policy and suitability of biophysics factor.
- 4) Measured of farmers production on study area showed that maize yield was about 3.0 until 5.5 ton/ha which was dominated by maize farmers who have been used hybrid and composite seeds.

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