DonnishJournals 2041-3104

Donnish Journal of Agricultural Research
Vol 2(5) pp. 037-047 July, 2015.
http://www.donnishjournals.org/djar

Original Research Paper

The Potential of Land Suitability for Growth And Production of Soybean Crops Particularly in Kediri

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Accepted 10th March, 2015.

Spatial Analysis is a process of modeling, testing and interpretation of the model results, may be extracting or creating new information from a collection of elements of geography. Spatial analysis is integrated in a GIS system (Geographic Information System). Spatial analysis is a system to locate and understand the spatial relationships of spatial data, the process of searching and this understanding can be done with the show and performance of system commands (queries) roomates are integrated in the data. Land suitability is essentially the suitability of a particular type of land for a particular kind of use. Suitability of land is a specific land capability. The rate of land suitability, land use rate means the balance with the carrying capacity of the land, being the size of the feasibility of land use. Land is appropriately used in terms of carrying capacity being fully utilized. The spatial land meets the criteria of suitability and environmental economics knowledge and insights are applied simultaneously. The purpose of this study was to determine the suitability of potential agricultural land suitable for the growth and production of soybean in Kediri region with spatial analysis. The results of the study are; in the first growing season (March to May), there were 1,457 ha Including Appropriate classes (S1), 8,400 ha Including Moderate classes, class (S2), 2,457 ha Including Marginal Appropriate classes (S3) and 2,386 ha which belongs to the class Not Available (N) while the second growing season (June to August), can only be grouped into two classes of land suitability items, namely: 10.874 ha including Marginal Appropriate classes (S3) and 216 699 ha including class Not Available (N). The main limiting factor is the texture of the soil in the first season, while limiting factor in the second season is the texture of the soil and availability of water. The growing season to two soybean production ranged between 64.74 kw/ha - 106.6 kw/ha or 0.6474 tons/ha - 1,066 tons/ha with the addition of water of 6.46 mm/day - 9.45 mm/day.

Keywords: Land suitability, Growth, Production, Soyabean, Kediri.

INTRODUCTION

Indonesia is a country which has a tropical climate with an average temperature of 27 ° C-30 ° C, a potential temperature in agriculture so that many Indonesian citizens who have livelihoods as farmers, even attracts foreign tourists to want a lot of Indonesian agricultural prospects for their own countries. Any plant can be easily grown on Indonesian land due to temperature and climate which are varied, such as agricultural crops, namely soybeans.

Soybean is an important crop because of its role as a source of vegetable protein and can also be used as an industrial raw material. The low amount of production of soy as a source of vegetable protein in Indonesia impacts the need to import some in large amount enough each year to meet the needs of national consumption (Karamoy, 2009), up until the year 2006, imports of soybean in Indonesia each year was around 1.1 million ton/ha. Seeing these conditions is believed to be the fulfillment of soybean agricultural problems are serious enough, given the increasing demand (Perdinan and Santikayasa 2006).

Along with population growth and industrial development of soybean processed foods, the domestic soybean demand continues to rise. Statistics from FAO and BPS showed that soybean demand on average in 2001-2005 amounted to 1.84 to 2.04 million tons, while domestic production is still very low,

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between 0.67 to 0.81 million tons. The drawback had to be imported at 1.12 to 1.36 million tons. When viewed from the soybean plant productivity, Indonesia has yet to deliver the results that have been achieved by other countries such as America, Brazil, Taiwan and Japan, which had the results up to 1.5 tons per hectare, while Indonesia reached 0.9 tons per hectare. The decline in soybean production in Indonesia is not solely determined by the different level of production technology, but also due to the climate in the humid tropics that are not favorable for the growth of soybean (Karamoy 2009).

Environmental components which had become critical success factors in soybean production business are; climate (temperature, sunlight, rainfall and rainfall distribution), fertility physico-chemical and biological properties of soil (solum, texture, pH, nutrient availability, soil moisture, organic matter in soil, drainage and soil aeration, and soil microbes). The interaction between temperature-intensity solar radiation-soil moisture is crucial to the growth rate of soybean plants. High temperatures are associated with high transpiration, water vapor deficit of high voltage, and drought stress in plants.

The temperature in the soil and atmospheric temperature affect the growth *Rhyzobium,* roots and soybean crops. Suitable temperature for the growth of soybean plants ranges between 22° C-27° C (Sumarno and Mansuri, 2007). Based on the condition of the soil and climatic conditions are going to use to find out how potential land suitable for the growth and production of soybean plants in an area, including Kediri. The potential land area that corresponds to the growth of soybean plants in the Kediri area is required for efforts to increase soybean production and decrease dependence soybean demand from outside Kediri.

Results of previous studies show that soybeans grown in the dry season with irrigation are sufficient to provide a higher yield than soybeans planted during the rainy season in the same location. This difference is caused by different climate elements, especially the sun's radiation. Soybeans were planted in the dry season with sufficient irrigation could produce an average of 1.97 tons / ha, while in the same location during the rainy season only produce 0.61 tons / ha (Karamoy 2009).

Based on the issues above, it needs to be studied between climate relationships and soy-growing farmland (land suitability) in order to obtain production to meet national consumption of soy consumers in addition to reducing dependence Kediri region with other regions or import from other countries.

METHODS

The equipment and materials used in this study were Arc View 3.3, Map as research material, Cropwatt 8.0 for ETO (evapotranspiration) analysis, Paint to assist in the editing of the map or generated jpeg file, secondary data include rainfall data of year 2002 - 2012, the climate data of the year 2002-2012.

Preparation Stage

Preparation in this study is covering preparation materials, data collection, which includes primary data, secondary data, and the determination of land use requirements.

Data Analysis Stage

Data analysis in this study is the grouping of field and map data with land suitability classes for soybean crop, the grouping will obtained classes, namely S1 (which is very suitable), S2 (which is quite appropriate), S3 (which is marginally suitable), and N (which is not appropriate). Having obtained the classes according to the characteristics of land in terms of land use for soybean crops, then they would do the scrolling to get the value. Scoring is converted into value serves to facilitate the calculation, the analysis using the *map calculator*. Having obtained the Land Suitability Evaluation in the form of the value will be propagated and classified to obtain the map based on the parameters or characteristics that exist on land suitability classes.

This deployment got 11 maps in accordance with the parameters or characteristics that exist on land suitability classes. The maps that will be generated are map of rainfall, temperature maps, soil texture map, soil pH maps, CEC-clay map, organic-C maps, drainage maps, maps of erosion, effective rooting depth maps, slope maps and height maps. Having obtained 11 maps, the next step is to transform all the eleven maps in the form of a grid. Map modified in grids aims to divide the map into cells, according to our wishes to be adjusted for analysis. These cells contain the values that have been included in the previous map-making, and changing into the form of the grid serves to facilitate the calculation of the map calculator analysis.

To change the map in the form of a grid is using Arc View program, where each map of the eleven maps converted one by one into a grid form. The first step is the desired map activated first, then select *a theme convert to the grid* after the entry into the file saving stage. The saving phase results will certainly be asked where these grids will be saved, then it asked again which files will be on the grid, and how many times grid will be the grid in the map. Having answered all the questions the results to be obtained in the form of a grid. These steps are also done to the other maps, thus we'll obtain eleven maps in the form of a grid. After we got the maps in the form of a grid map, the next step is to analyze them. The analysis is used to analyze the results in the form of a grid map using the Arc View's Map Calculator. This is a menu of Arc View program that only use to analyze the ways to add, subtract, multiply, or divide the values of the cells in the map that have been modified in the form of a grid. The first step in the analysis is to enable the 11 maps in the form of the grid, after that select menu Analysis choose Map Calculator then perform the summation of all the maps.

Then, the generated grid maps summed. The maps are a temperature grid map, drainage grid map, soil texture grid map, erosion grid map, soil pH grid map, slope grid map, clay CEC grid map, height grid map, C-organic grid map, rainfall gird map, effective depth grid map. The results of the analysis calculator 1 is *Map Cal* 1, after the results obtained, the next step is to select the menu *analysis,* then select *Map Calculator* and the formula of the second analysis is *((mapcal* 1)) * 1000. The second analysis is multiplied by 1000 because the result of *map calculator* cannot be in decimal form so it should be multiplied by 1000 and the resulting value in units of thousands. The result of this second analysis is *Map Cal* 2, the results obtained after re-select menu *Analysis* and select *Map Calculator* and enter the formula. The formula used in the third analysis is *((MapCal*2)) / 11, result *Cal Map* 2 divided by 11 means there are 11 characteristics that are summed up in the first formula. The final step after the obtained results *Cal Map 3* is to *reclassify. Reclassify* is a menu in *Arc View* program that serves to re-classify, meaning that when analyzed with *Map Calculator* the value obtained was reclassified into a class or group. The grouping results Land Suitability Map for Soybean Crop especially in Kediri.

RESULTS AND DISCUSSION

Research Location

The location of the research is at the former residency of Kediri region, particularly in *Nganjuk* District, District / City of *Kediri* and District / City of *Blitar*. These areas are located in the central-western part of East Java Province with the position of the Zone 49 between 9070^{000}mU and 9170^{000} mU and 580^{000}mT and 664^{000} mT. Typographically located in the vast plain surrounded by mountains in the west (Mount *Wilis*) and eastern (*Kelud* and *Anjasmara*) and the hills in the north (*Kendeng* Hills) and southern (South Mountain).

Soybean Crop Land Suitability Evaluation

Temperature (tc)

The average temperature (°C) in the study area is only supported by 3 stations that spreading is not possible to make fine interpolation, the average air temperature obtained from the results of spatial analysis using Break Formula. Interpolation results indicate that the study area has temperatures varying from 15° C to 28° C. Thus, according to the criteria of the temperature for soybean crops, the study area can be grouped into land suitability classes S1 = 130 357 ha (28%), S2 = 318 858 ha (68%), S3 = 8723 ha (2%), and N = 8,616 ha (2%). The majority of wetland in *Nganjuk* and Kediri is in a somewhat appropriate class (S2), while existing in Blitar almost half including Appropriate class (S1).

Analysis Of Evapotranspiration

Evapotranspiration values of the results of calculations using software CropWat, in 1998-2002 the average evapotranspiration obtained 3.95 mm/day, in 2003-2007 the average evapotranspiration of 4.15 mm / day, and the 2008-2012 average evapotranspiration 4.10 mm / day. Increasing the value of evapotranspiration caused by several factors such as the location of the latitude, the maximum temperature, minimum temperature, humidity, wind speed and sun irradiation. Graph changes in evapotranspiration values can be seen in Figure 1.

Soybean Crop Water Requirement Based Cropping Month

Soybean Crop Evapotranspiration

Soybean crop evapotranspiration obtained from the coefficient multiplied crop evapotranspiration values. Soybean planting season in *Blitar*, *Kediri* and *Nganjuk* began in July after the rice harvest to two and generally September has begun to enter for the harvest of soybeans. The values of soybean evapotranspiration (1998-2012) can be seen in Table 1.

The value of crop evapotranspiration (ETc) of soy per 5 year (Table 1) in planting July to September 1998-2002 ETc values obtained 3.21 mm / day, in 2003-2007 was obtained value ETc 3.29 mm / day, and years 2008-2012 ETc value of 3.35 mm / day. Graphs ETc soy value changes can be seen in Figure 2. Changes graphs crop evapotranspiration (ETc) soybeans (Figure 2) per year 5. ETc value most and are likely to increase in August, compared to July, and the lowest value of ETc in September. Changes in the value of soybean ETc can be affected by changes in wind speed, solar radiation, and rainfall effect on soybean planting in *Blitar*, *Kediri* and *Nganjuk* i.e. July to September.

Relationship between Effective Rainfall and Soybean ETc

Crop evapotranspiration (ETc) and rainfall (CH) is closely related to effective water demand. If the number is greater than the effective CH crop evapotranspiration, the water requirement is fulfilled. Vice versa, if the amount of precipitation is lower than evapotranspiration of plants, the water requirement is not fulfilled. As in soybean, soybean planting season in *Blitar*, *Kediri* and *Nganjuk* began in July after the rice harvest to two and generally September has begun to enter the harvest, so as to know the amount of water needs by CH effective relationships with soy etc per 5 years in *Blitar*, *Kediri* and *Nganjuk* as shown in Table 2.

CH effective relationships with soy ETc (Table 2) in *Blitar*, *Kediri*, and *Nganjuk*. Of CH effective relationships and soy etc. can be seen in the water needs in the 1998-2012 growing season. Water demand is obtained by calculating the difference between CH effectively with ETc. Water demand can be seen in Table 3.

Soybean crop water requirements (Table 3) years from 1998 to 2012 in Blitar, Kediri and Nganjuk there are differences in water demand for soybean planting season is July through September, the month-on-month deficit soybean crop water requirements. This could be due to changes in climatic factors such as changes in solar radiation, wind speed, and that most affect the change in effective precipitation, and July through September effective rainfall in Blitar, Kediri and low Nganjuk.

Water Availability (wa)

The quality of water availability land can be distinguished by two land characteristics, namely: a) rainfall during the growth, and b) relative humidity (%)

a) Rainfall during the growth stage

Rainfall at growing season 1 (March-May) there is no problem for the growth of soybean plants throughout the region including the three counties because of the class S1. However, in the second growing season (June-August) of soybean plants begin to lack of water if rainfall relies solely on the needs of the plant. Most of the wetland does not include the appropriate class (n), only a small part of paddy fields and dry fields in Blitar which includes classes accordance marginal (S2).

Analysis of Changes in Rainfall

Fluctuations in rainfall per 5 years was held change that in 1998-2002 the average gained 146.06 mm rainfall, 2003-2007, dropped to 133.75 mm, and the 2008-2012 average rainfall increased to 158.7 mm. Changes in rainfall caused by several factors such as wind speed can vary according to the horizontal pressure gradient, geographical location, altitude and time. The chart rainfall per year 5 can be seen in Figure 3.

Rainfall data is used to calculate the effective rainfall. Variation changes the effective rainfall will affect the amount of crop water requirements needed for evapotranspiration.

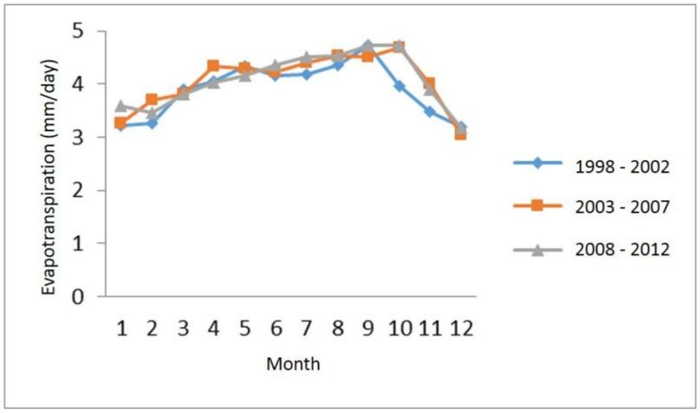

Figure 1. Graph Change Value Evapotranspiration

Table 1. Crop Evapotranspiration (ETC) Soybean per 5th Annual

	ETc (mm/day)		
Month	**1998-2002**	**2003-2007**	**2008-2012**
July	3,26	3,54	3,42
August	4,46	4,64	4,64
September	2,34	2,25	2,26
Total	10,06	10,43	10,32
Average	3,35	3,48	3,44

Source: Calculation Results

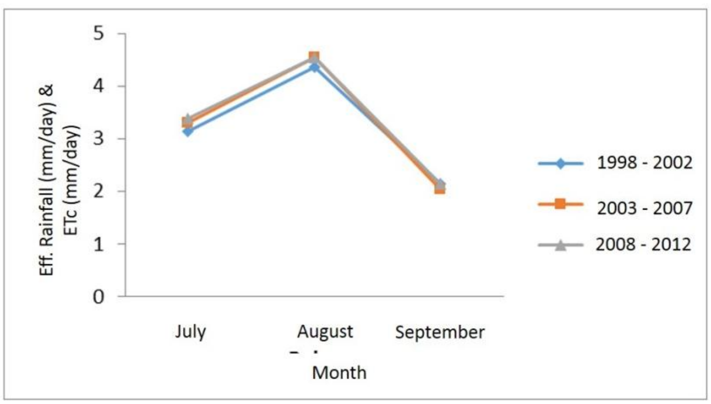

Figure 2. Changes in Soybean ETc Per 5th Annual *Blitar*, *Kediri*, *Nganjuk*

Table 2. CH Effective Rainfall Relationship With Soybean ETc in Blitar, Kediri and Nganjuk Year 1998-2012

	Year 1998-2002		**Year 2003-2007**		**Year2008-2012**	
Month	Effective CH **(mm/day)**	**Etc (mm/day)**	Effective CH **(mm/day)**	**Etc (mm/day)**	Effective CH **(mm/day)**	**Etc (mm/day)**
July	0,85	3,26	0,41	3,54	0,82	3,42
August	1,23	4,46	0,12	4,64	1,13	4,64
September	1,14	2,34	0,11	2,25	1,31	2,26

Source: Calculation Results

Table 3. Water Needs Soybean Crop Year 1998-201

Month	Year 1998-2002	Year 2003-2007	Year 2008-2012
July	-2,25	-2,93	-2,57
August	-3,13	-4,58	-3,49
September	-1,08	-1,94	-0,86
Total	-6,46	-9,45	-6,82
Everage	-2,15	-3,15	-2,37

Source: Calculation Results

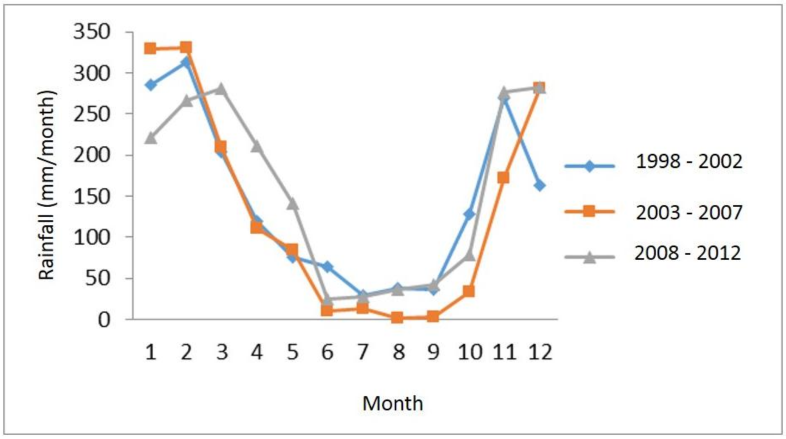

Figure 3. Graph changes in precipitation Year 1998-2012

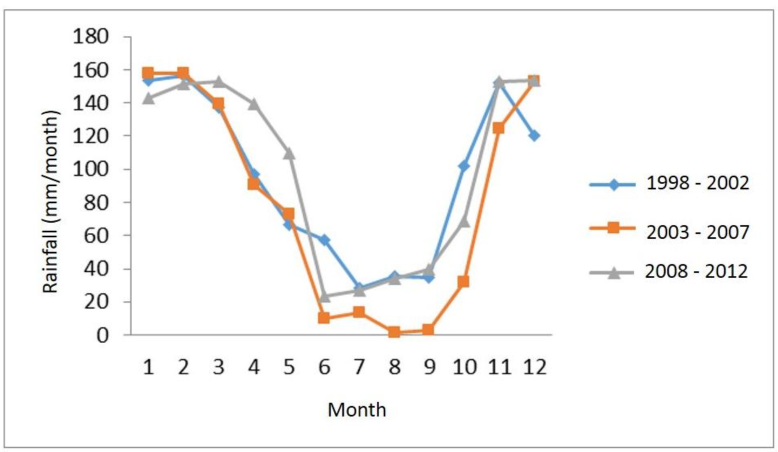

Figure 4. Graph changes effective rainfall

The results calculated by the software can be known CropWat average amount of effective rainfall, rainfall in 1998-2002 the average effective 97.3 mm, 2003-2007 effective rainfall average decreased to 81.7 mm and the year 2008- 2012 rainfall increased to 99.85 mm. The chart changes effective rainfall can be seen in Figure 4.

b) Relative humidity (%)

Information about air humidity is not enough, because of the lack of station's humidity recording data. However, from the data obtained, the air humidity does not seem to be a problem for soybean growth and go to the accordance classes (S1).

Oxygen Availability (OA)

Availability of oxygen to plant roots in the land evaluation drains measured by observing the condition of the soil. The scale of used land system map is 1:50.000. At this scale, it was not detected areas that have poor drainage. Thus, the soil drainage is not an issue for the growth of soybean plants. All regions include to the appropriate class (S1).

Rooting media (rc)

A) Texture

Soil texture is closely related to soil physical and chemical properties of others and very influenced on the growth of soybean plants. In conscious, the survey area has a texture that is quite varied. Fine texture found in paddy fields throughout Nganjuk. Rough texture found in paddy fields almost in all Kediri and Blitar. Dry land in Kediri and Nganjuk generally has a medium texture - smooth. Dry land in Blitar in the southern mountains has particularly fine texture, on the slopes of Gunung Kawi has a medium texture, and is located on the slopes of Mount Kelud has a rough texture. Under these conditions, the soil texture can be incorporated into Appropriate class (S1) to the ground with a medium texture, somewhat delicate and refined, class Not Appropriate (N) for coarse-textured soils.

B) Abrasive materials

There is no valid data which show land system that has a coarse material. In general, land is a material that has the hills and / or mountains that have shallow solum or loose rock stockpiles and transported to the slope below. Generally, these lands are not used for cultivation of seasonal crops. While plant cultivation season is not a problem, and include to the S1 class.

C) The soil depth

As the condition of rock, shallow soil with an effective depth only found on the steep slopes of the volcano in the region and / or area of limestone hills in the area of the Southern Mountains and Kendeng hills. Such lands are generally not used for soybean cultivation so not to be observed in more detail. Paddy fields and dry fields were planted with soybeans all have the potential to land suitability in Appropriate class (S1).

Nutrients Retentions (nr)

CEC-clay soil in the survey area can be grouped by >= 16 and <16. Most of the land (384 459 ha or 82.39% of the territory) has more than 16 CEC-clay that can be grouped accordance suitability classes (S1), the remaining area of 82 153 ha or 17.61% of the occupied land under the influence of the eruption of Mount Kelud can be grouped in Somewhat appropriate suitability class (S2). The data is unavailable in base saturation, so it is not discussed further.

The soil pH in the study area varies from acidic to neutral. Based on the data recording pH, most of the area (449.630 ha or 96.34% of the territory) has a pH of acidic and neutral and include appropriate Enough (S2) for the soybean crop, the remaining area of 17 064 ha (3.66% of the territory).

No data of soil organic matter content are available, so it is not discussed further. Research areas not including sea-influenced landscape so that salinity is not a problem, thus is not discussed further. Research area that has a pH high (alkaline) only on limestone hills in the Southern Alps. This land is generally not used for soybean cultivation, so it is not discussed further. Research areas not including sea-influenced landscape so that there are no layers of sulfidic, and is not discussed further.

Erosion Hazard (eh)

Most areas have a flat to slightly sloping slopes (344.841 ha or 73.91% of the territory) and includes to Appropriate class (S1). Land suitability of appropriate enough class (S2) covering an area of 63 225 ha or 13.59% of the territory. In accordance with the land suitability marginally suitable class (S3) covering 37,225 ha (7.98%). The remaining area of 21,100 ha (4.52%) including not suitable (N). Land suitability class S2, S3 and N found in volcanic slopes and hills and / or valley in the south and the lane Kendeng Mountains.

No erosion hazard data, but based on the experience of researchers, erosion distribution almost coincides with the slope, thus not studied further. Land units are made on a scale of 1:250,000 not allow delineated polygon / land system was subjected to a puddle, so it is not a valid distribution obtained on these puddles, and not considered in the evaluation of land suitability.

Suitability of Land Soybean Crop Planting season 1

Evaluation of the suitability of soybean crops in the first growing season was conducted in March, April, and May. The results of the land suitability of soybean plants during the growing season the first of these three districts showed that most areas have land suitability class S2 with an area of 8,400 ha, or approximately 40.73% of the total area of the three districts, with a broad suitability class S3 8383 ha (40 , 64%). Land suitability class S1 only occupies an area of 1,457 ha, or approximately 7.06% of the total area of the three districts. The remaining land suitability class N area of 2,386 ha, or approximately 11.57% of the total area of the three districts. Results at Plant Land Suitability Map Season 1 depicted in Figure 5.

Blitar with a total area of 6,826 ha have the potential for soybean crop planted with land suitability classes S1 area of 1,328 ha. These include the use of the land area of 33 ha of irrigated rice, rainfed area of 328 ha, and a land area of 967 ha farm. Land suitability class S2 has an area of 2,010 ha, with the use of irrigated fields (89 ha), rainfed (399 ha), and farm land (1,522 ha). Land suitability class S3 or is not appropriate for the soybean crop has an area of 1,413 ha, with the use of irrigated fields (25 ha), rainfed (810 ha), and farm land (578 ha). While the land suitability class N has an area of 2,075 ha of irrigated land include the use of an area 514 ha, rainfed area of 958 ha and 603 ha of farm land area.

District of Kediri, land use soybean plants during the growing season 1 located on land suitability classes (S1, S2, S3, and N) with a total area of 7770 ha. Land with the land suitability class N 75 ha of land, including the use of rainfed (25 ha), and farm land (50 ha). Land with the land suitability classes S1 has an area 125 ha, covering the use of irrigated fields (41 ha), rainfed (41 ha), and farm land (43 ha). Land with the land suitability class S2 area of 1,893 ha, with the use of irrigated rice (1,300 ha), rainfed (238 ha), and farm land (355 ha). Land with an area of land suitability classes S3 5,677 ha, with the use of irrigated fields (3922 ha), rainfed (322 ha), and soil fields (1,433 ha). Kediri had an 301 ha area of wetland and rice paddy. Suitability class S2 area of 102 ha, located on irrigated land (87 ha) and dry fields (15 ha). S3 suitability classes covering 199 ha, which is contained in irrigated fields (198 ha) and field (1 ha).

Blitar only found rainfed areas covering an area of 117 ha and 4 ha fields, which all belongs to the class N because of the coarse soil texture. Nganjuk, land suitability classes of soybean plants during the growing season 1 located on land suitability classes (S1, S2, S3, and N) with a total area of 5608ha. Conformity soybean crops on land suitability class N is: 115 ha, with the use of rice irrigation (7 ha), rainfed (51 ha), and farm land (57 ha). The use of soybean crops on land suitability classes S1, namely: 4 ha, with the use of rainfed rice (4 ha). Soybean crop land suitability on land suitability class S2, namely: 4395 ha, with the use of irrigated fields (3494 ha), rainfed (354 ha), and farm land (547 ha). Soybean crop land suitability classes of land suitability in S3, namely: 1 094 ha, with the use of irrigated fields (105 ha), rainfed (743 ha), and farm land (246 ha).

Land whose suitability classes S1 lies largely in the ABG land system. ABG is a land system that has a slope of volcanic plains flat to choppy and located in dry areas. Land with the land system is consistent with the soybean crop, besides formed from volcanic materials, fertile land also has a flat slope. Soybean plants grow optimally on the land with a flat slope. Soybean plants can grow in all types of soil, however, to achieve the level of optimal growth and productivity, soybeans should be planted in a sandy loam type of soil structure or sandy clay, to achieve optimal plant growth, plants grown soybeans require optimal environmental conditions as well. Soybean plants are very sensitive to changes in environmental factors to grow, especially soil and climate. Water demand is highly dependent on the rainfall pattern during the growth, crop management, and age of varieties grown.

Soybean plants can grow in a variety of temperature conditions. Optimum soil temperature in the process of germination is 30 ° C. When grown at low soil temperatures (<15 ° C), the process becomes very slow germination, could be 2 weeks. This is because the pressure on the seed germination of high soil moisture conditions. While at high temperatures (> 30 ° C), many seeds that die due to respiration of water from the beans too quickly. In addition to soil temperature, ambient temperature also affect the development of soybean plants. When the ambient temperature around 40 ° C during the flowering plants, the flowers will fall so that the number of soybean pods and seeds are formed also be reduced. Temperatures that are too low (10 ° C), as in the subtropical region, can inhibit flowering and pod formation soybeans. Ambient temperature that is optimal for flowering flowers 24 -25 ° C. The soybean plant is actually quite tolerant to drought stress because it can survive and produce when drought conditions a maximum of 50% of field capacity or soil conditions are optimal. During the period of seed ripening stadia, soybean crop requires dry environmental conditions in order to obtain good quality seeds. Environmental conditions that will encourage the process of growth dried beans faster and uniform seed form.

Suitability of Land Crop Soybean Planting season 2

Evaluation of the suitability of soybean crops in the first growing season conducted in June, July, August. The results of land suitability in the second growing season in three districts showed that soybean plants have land suitability classes S3 and N. The results of land suitability evaluation soybean cropping season 2 at the observation point (in Blitar, Kediri, Blitar, Kediri, and district Nganjuk, obtained for a total area of N land suitability 216 699ha, and land use on land suitability S3 of 10,874 ha.

Classes of land suitability N dominate in every land in the District 3 in the second growing season that is equal to 95.22% of the total area of the three districts. This may imply that the three districts can not be planted soybeans in the second growing season, the cropping season 2 Blitar suitability of soybean crops in season 2 including the land suitability classes (S3 and N) with a total area of 75 871ha. Land suitability of Soybean crop land on class N is: 68 210 ha, with the use of irrigated rice (6,435 ha), rainfed (22 235 ha), and farm land (39 540 ha). Conformity soybean crops on land suitability classes S3, namely: 7661 ha, with the use of irrigated fields (824 ha), rainfed rice (5,597 ha), and farm land (1,240 ha). The results of the Land Suitability Map Planting Season 2 are illustrated in Figure 6.

In Kediri district, only found the land suitability class (N) with a total area of 85 501ha.Land area of 85.501 ha divided in several land use: the use of irrigated rice (57 883 ha), rainfed (6861 ha), and field soil (20 757 ha). Much like Kediri, Blitar city has a land suitability classification of soybean plants in season 2 there is only on land suitability classes (N) with a total area of 1,365 ha. The use of soybean crops on land suitability class N covering 1365 ha, with the use of rainfed rice (1,324 ha), and farm land (41 ha). Kediri City, suitability land soybean planting season 2 was also found on land suitability classes (N) with a total area of 3,362ha. Use of soybean crops on land suitability class N is: 3,362 ha, with the use of irrigated rice (3,189 ha), and farm land (173 ha).

Nganjuk, land suitability soybean planting season 2 are on land suitability classes (S3 and N) with a total area of 61.474ha. Land area of 58.261 ha divided in multiple land use: the use of irrigated rice (39 681 ha), rainfed (9943 ha), and farm land (8637 ha). Conformity soybean crops on land suitability classes S3, namely: 3213 ha, with use of irrigated rice (1 ha), rainfed (2656 ha), and farm land (556 ha).

Soybean Production

Soybean planting is usually done at the end of the rainy season, after the rice harvest. Forms the basis of many soy foods from East Asia, such as soy sauce, tofu, and tempeh (Iswara, 2010). Soy is also a staple food in Indonesia, East Java itself, particularly in Blitar, Kediri and Nganjuk. In three of the many area residents who use agricultural land for planting soybeans after the rice harvest, this suggests that the soybean is very influential and important to the daily food needs in Blitar, Kediri and Nganjuk.

Kediri is one area in East Java, which became the center of soybeans, soybean produced, though not as much as the regions of East Java soybean producers such as Banyuwangi, Bondowoso, Ponorogo, Ngawi and Nganjuk. Even thought in Kediri can find new varieties of soybean that can grow and more dry resistant. Therefore, some soybean production results in Kediri according to the Central Bureau of Statistics began the year 1998 - 2012 is seen from the harvested area (ha), results / hectare (Kw), and production (Ton). Table 5 below shows the production of soybeans in Blitar, Kediri and Ngajuk years 1998-2012 per 5 years.

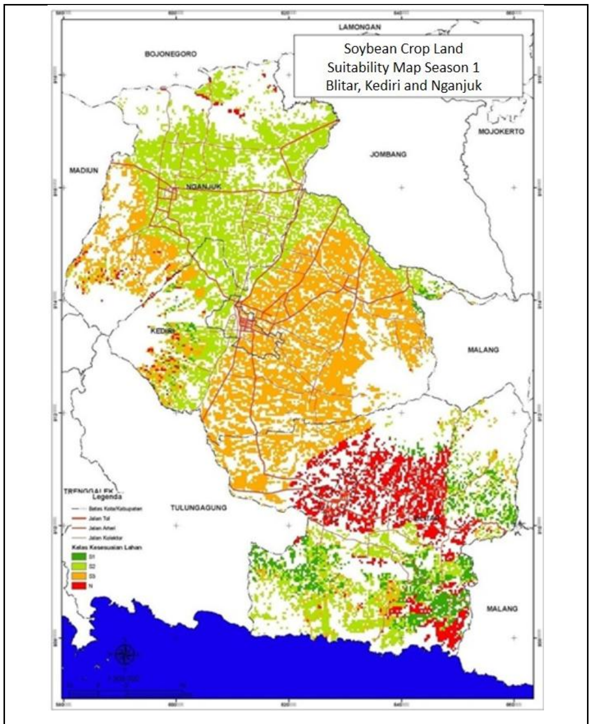

Figure 5. Soybean Crop Land Suitability Map Season 1 Blitar, Kediri and Nganjuk

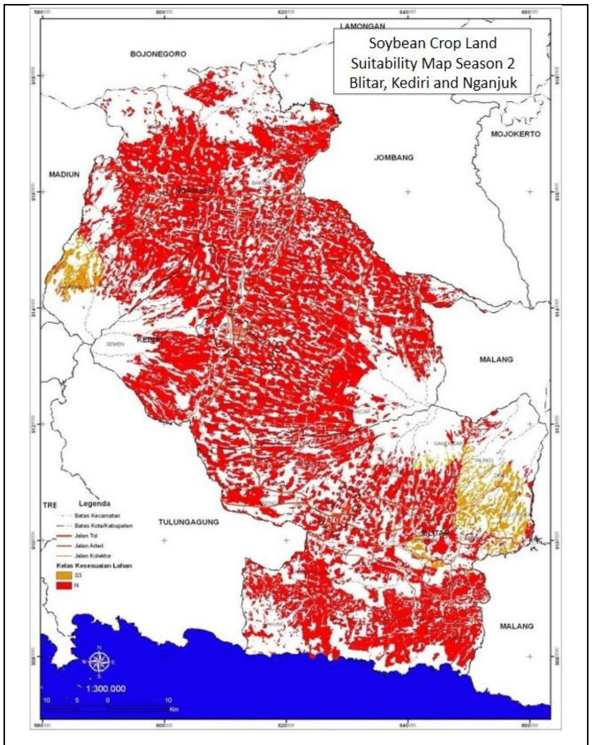

Figure 6. Soybean Crop Land Suitability Map Season 2 Blitar, Kediri and Nganjuk

Table 4. Soybean Production in Blitar, Kediri and Ngajuk Year 1998-2012

Year	Harvested Area (ha)	Results / Ha (Kw)	Production (Ton)
1998-2002	516264	71,63	369799,90
2003-2007	783145	106,6	834832,57
2008-2012	515872	64,74	333975,53
Total	1815281	242,97	153860,00

Source: Calculation Results

Table 5. Effect of changes in water demand for soybean production

Water Needs & Soybean Production Year 1998-2012			
Year	**1998-2002**	**2003-2007**	**2008-2012**
Water requirement (mm/day)	-6,46	-9,45	-6,82
Soybean Production (Ton)	369799,90	834832,57	333975,53

Source: Calculation Results

Soybean production data (Table 4) in Blitar, Kediri and Nganjuk during the last 15 years in the can from the Central Statistics Agency (BPS) Kediri and averaged per 5 years. The data shows that in 2003-2007 increased soybean production than in 1998-2002 and in 2003-2012.

Table 4 shows the total production in the year 1998 to 2012 per 5 years, from the table above shows that the area of land that used to be more and more yield and production are obtained, as in the years 2003-2007 783145 ha land area and the resulting production is 834832,57 tons, with the result / hectare 106.6 Kw. Conversely, if the area of land used is not too large, the production used will also be low.

The difference in the total amount of soy production each District in Blitar, Kediri and Nganjuk also be influenced by climatic factors and evapotranspiration.

Effects of Changes in Water Needs Against Soybean

Production Changes in water demand can affect soybean production in Kediri during the past 14 years. The Effect of changes in water demand for soybean production can be seen in Table 5. Data effect of changes in water demand for soybean production (Table 5) in the year 1998 to 2012 in Kediri per 5 years. As seen in the years 1998-2002 the need for water shortage is -6.46 mm / day with soybean production 369799,90 ton, 2003-2007 needs more water shortage is -9.45 mm / day with soybean production 834832,57 ton, and the 2008-2012 year water deficit reaches -6.82 mm / day with production 333975,53 tons.

The 2003-2007 soybean crop water needs of the most deprived higher than the 1998-2003 and 2008-2012 years, production in 2002-2007 was also the highest compared with previous years. The big difference in the soybean crop water requirements can be caused by changes in the value of evapotranspiration (Eto), evapotranspiration plants (ETC), and precipitation (CH) effectively. The high soybean production in those years as well as land that is not the same.

CONCLUSION

1. Based on the results of the evaluation of the suitability of land for soybean crops in the district of Blitar, Kediri and Nganjuk, of the 20.626 land area consisting of land irrigated rice, rainfed and dust, it can be concluded that In the first growing season (March to May), there were 1,457 ha incorporated in class Appropriate (S1), 8,400ha including class Appropriate Enough (S2), 2,457 ha in class Marginally Appropriate (S3) and 2,386 ha which includes in class Not Appropriate (N). In the second growing season (June to August), only can be grouped into two classes of land suitability, namely: 10,874 ha including class Marginally Appropriate (S3) and 216 699 ha including class Not Appropriate (N). Primary limiting factor is the texture of the soil in the first season, while limiting factor in the second season is the texture of the soil and water availability.
2. The growing season to two soybean production ranged between 64.74 kw/ ha - 106.6 kw/ha or 0.6474 tons/ha - 1,066 tons/ha with the addition of water of 6.46 mm/day - 9.45 mm/day.

ACKNOLEDGMENT

I would like to thank Prof. Ir. Wani Hadi Utomo, Ph. D in Brawijaya University, Malang Indonesia and Prof. Dr. Ir. Santoso, MP. In Andalas University, Padang, Indonesia for many useful comment and suggestion.

REFERENCES

Adham, M.I, C.S. Jahan, Q.H. Mazumder, M.M.A. Hossai and Al - Mamunu Haque,2010. Study on Groundwater Recharge Potentiality of Barind Tract,Rajshahi District, Bangladesh Using GIS and Remote Sensing Technique. Journal Geological Society of India.Vol.75, pp.432-438

Albaji,M, A. A. Naseri, P. Papan, and S. Boroomand Nasab,2009. Qualitative Evaluation of Land Suitability for Principal Crops in The

West Shoush Plain, Southwest Iran. Bulgarian Journal of Agricultural Science, 15 (No 2), 135 - 145.Agricultural Academy

Alexandridis, T., Panagopoulos, A., Galanis, G., Alexiou, I., Cherif, I., Chemin, Y., Stavrinos, E., Bilas, G., and Zalidis, G., 2014. "Combining remotely sensed surface energy fluxes and GIS analysis of groundwater parameters for irrigation system assessment." *Irrigation Science*, 32(2), 127-140.

Bruce A. DeVantier and Arlen D. Feldman, 1993. Review of GIS Applications in Hydrologic Modeling, American Society of Civil Engineers,Available: http://ascelibrary.org/doi/abs/10.1061/(ASCE)07339496(1993)119:2(246)

Christopher J Kucharik and Shawn P Serbin,2008. Impacts of recent climate change on Wisconsin corn and soybean yield trends, Environ. Res. Lett. 3(2008)034003(10pp)

Dmitry Kurtener, H. Allen Torbert, and Elena Krueger,2008. Evaluation of Agricultural Land Suitability: Application of Fuzzy Indicators

Djaenuddin. D, Marwan. H, H. Subagyo Anny Mulyani, and N. Suharta. 1997. Suitability criteria Land For Agriculture Commodities. Soil Research Centre and Agro climate. Bogor.

ESRI., 2012. GIS for water resources [Online]. Available: http://www.esri.com/industries/water_resources [Accessed 15/06/2014.].

Evan J. Fedorko, Robert Gilmore Pontius Jr., Stephen P. Aldrich, Luc Claessens, Charles Hopkinson Jr. , and Wilfred M. Wollheim ,2005. Spatial distribution of land type in regression models of pollutant loading. Journal of Spatial Hydrology Fall Vol. 5, No. 2 Processes, 15, *2013* - 2028.

Foote, K.E., Lynch, M.,2009. Geographic Information Systems as an integrating technology: context, concepts, and definitions [Online]. The Geographer's Craft Project, Department of Geography, The University of Colorado at Boulder. Available: http://www.colorado.edu/geography/gcraft/notes/intro/intro.html [Accessed 16/06/2014.]

Gupta, N., Aktaruzzaman, M., and Wang, C., 2012. "GIS-based Assessment and Management of Nitrogen and Phosphorus in Rönneå River Catchment, Sweden." *Journal of the Indian Society of Remote Sensing*, 40(3), 457-466.

Gyawali, R. and Watkins, D., 2013. "Continuous Hydrologic Modeling of Snow - Affected Watersheds in the Great Lakes Basin Using HEC-HMS." *Journal of Hydrologic Engineering*, 18(1), 29-39.

Hamid Reza Fooladmand* and Meisam Habibi, 2013. Estimating soil water characteristic curve based on soil-particle-size distribution curve and local void ratio. African Journal of Agricultural Research Vol. 7(14), pp. 2197 – 2204.

Jayasinghe, P., Adornado, H., Yoshida, M., and Leelamanie, D. 2010. "A Web-Based GIS and Remote Sensing Framework for Spatial Information System (SIS): A Case Study in Nuwaraeliya, Sri Lanka." *Agricultural Information Research*, 19(4), 106-116.

Jayeoba Olumuyiwa James, 2011. Spatial and Temporal Variability of Surface Soil Moisture Content Ofan Alfisolas Influenced by Tillage Operations in Oyo State, Southwestern. Indian J.Sci.Res.2(3) : 17-20.

Karamoy, Lientje. Th., 2009. Relationship Between Climate and Soybean (Glicine max (L) Merrill) Growth. Soil Environment 7 (1): 65-68.

Lalit M. Arya and Jack F. Paris, 1981. A Physicoempirical Model to Predict the Soil Moisture Characteristic from Particle-Size Distribution and Bulk Density Data. Crop Science society of amirica journal vol . 45 no.6 p. 1023-1030.

Mazumder , C.S., Q.H., Hossain, M.M.A., & Haque, A.M, 2010. Study on groundwater recharge potentiality of Barind Tract, Rajshahi District, Bangladesh using GIS and Remote Sensing technique . Journal of the Geological Society of India, 75, 2, 432-438, 0016-7622

Mustafa,A.A., Man Singh, R. N Sahoo, Nayan Ahmed, Manoj Khanna, A. Sarangi and A. K. Mishra,2011. Land Suitability Analysis for Different Crops: A Multi Criteria Decision Making Approach using Remote Sensing and GIS. Researcher;3(12). http://www.sciencepub.net/researcher

Narendra.K, K. Nageswara Rao and P. Swarna Latha, 2013. Integrating Remote Sensing and GIS for Identification of Groundwater Prospective Zones in the Narava Basin,Visakhapatnam Region, Andhra Pradesh. Journal Geological Society of India.Vol.81, pp.248-260

Nurlia Ayu Pratama, Bambang Rahadi, and Ruslan Wirosoedarmo, 2015. Carrying Capacity Evaluation Based Land Capability in Batu. Journal of Natural Resources and Environment. UB. Vol 2, No 1, 14-20.

Osvaldo Salazar , Søren Hansen, Per Abrahamsen, Karin Hansen, Per Gundersen, 2013. Changes in soil water balance following afforestation of former arable soils in Denmark as evaluated using the DAISY model. Journal of Hydrology volume 484,p.128-139

Perdinan, and I Putu Santikayasa., 2006. Diversity Commodities Soybean Productivity In Various Scenarios Using climate change model and Agriculture (Diversity Commodities Soybean Productivity In Various Scenarios of Climate Models Using Climate Change and Agriculture). J.11. Pert. Indonesia. 11 (2): 7-14.

Ruslan Wirosoedarmo, 2005. Effect of water content on soil friability. Journal of Engineering Sciences. Vol.17.No. 2. ISSN 1410-4121 Unibraw.

Ruslan Wirosoedarmo; Sutan Haji A. Tunggul;Kurniati, Evi;Wijayanti Rizky, 2011. Land Suitability Assessment of Corn (Zea may L) Using Spasial Analysis Methode. Agritech Journal of Agricultural Technology, UGM,Vol.31, No.01.

Ruslan Wirosoedarmo; Alexander Tunggul Sutan Haji: Erlita Maidya Pramesty, 2011. Watershed Shape Using SIMODAS: A Case Study of Sabu Island, NTT, Academic Research International , Vol 1. No. 1: 258-265.

Ruslan Wirosoedarmo; Haji, Alexander Tunggul Sutan; Kuswandi, 2012. Flood PrognosisUsing SIMODAS Konto Sub. Watershed. Agritech Journal of Agricultural Technology, UGM, Vol.32, No.02.

Ruslan Wirosoedarmo, Alexander Tunggul , S.H. and Deby Prawira N, 2015. Model of Soil Water Contents for Varius Soil Texture. Journal of Enviromental Hydrology, Vol. 23 Paper 1 Februari 2015

Satti, S. and Jacobs, J.,2004. "A GIS-based model to estimate the regionally distributed drought water demand." *Agricultural Water Management*, 66(1), 1-13.

Silvio Jorge C. Simões,2013. Interaction between GIS and hydrologic model: A preliminary approach using Arc Hydro Framework Data Model. Rev. Ambient. Água vol. 8 no. 3 . http://dx.doi.org/10.4136/ambi-agua.1251

Sina Khatami and Bahram Khazaei, 2014. Benefits of GIS Application in Hydrological Modeling:A Brief Summary. VATTEN – Journal of Water Management and Research 70:41–49.

Sudaryono, Prihastuti and Andy Wijanarko,20011. Land Suitability for Developing Soybean Crops in Bumi Nabung and Rumbia Districts, Central Lampung. *J Trop Soils, Vol. 16, No. 1: 85-92.*

Sudaryono and Andy Wijanarko,2012. Potential of land suitability in Seputih Surabaya and Bandar Surabaya Districts Central Lampung regency for developing soybean. International Journal of Agricultural Science: Vol.2(11),pp.301-310.

Sumarno, Dimiyati A, Sutarman T., 2007. Varieties description Nuts (Description of Beans Varieties). Crop Research and Development Center Food.Bogor.

Vachaud, G: A. Passerat De Silans: P. Balabanis and M. Vauclin, 1981. Temporal Stability of Spatially Measured Soil Water Probability Density Function. Crop Science Society of America Journal *Vol. 49 No. 4, p. 822-828* .

Wang, G., Jiang, H., Xu, Z., Wang, L., and Yue, W., 2012. "Evaluating the effect of land use changes on soil erosion and sediment yield using a grid-based distributed modelling approach." *Hydrological Processes*, 26(23), 3579-3592.

Xu, Z. and Li, J.,2003. "Estimating Basin Evapotranspiration Using Distributed Hydrologic Model." *Journal of Hydrologic Engineering*, 8(2), 74-80.

Xu, Z., Ito, K., Schultz, G., and Li, J., 2001. "Integrated Hydrologic Modeling and GIS in Water Resources Management." *J. Comput. Civ. Eng.*, 15(3), 217–223.

Yakirevich, A.; Weisbrod, N.; Kuznetsov, M.; Rivera Villarreyes, C. A.; Benavent, I.; Chavez, A. M.; Ferrando, D. 2013. Modeling the impact of solute recycling on groundwater salinization under irrigated lands: A study of the Alto Piura aquifer, Peru. Journal of Hydrology, Volume 482, p. 25-39.

Yu Zhang and William Shuster, 2014. Impacts of Spatial Distribution of Impervious Areas on Runoff Response of Hillslope Catchments: Simulation Study. J. Hydrol. Eng. 19(6), 1089-1100.

Yue-Ping Xu, Xujie Zhang, Qihua Ran, Ye Tian, 2013. Impact of climate change on hydrology of upper reaches of Qiantang River Basin, East China. Journal of Hydrology volume 483,p 51-60.