SRYAHWA PUBLICATIONS

International Journal of Emerging Engineering Research and Technology
Volume 3, Issue 7, July 2015, PP 232-237
ISSN 2349-4395 (Print) & ISSN 2349-4409 (Online)

GIS Based Site Suitability and Potential Assessment of Jatropha Crop for Biofuel Production

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ABSTRACT

This paper presents some preliminary results from a research study conducted on biofuel potential assessment in T. Narasipura Taluk of Mysore District, Karnataka state, India. Due to an increase in the pressure on renewable energy sources to meet the fuel demands, there is a need to look at alternate sources of energy which can complement conventional sources of fuel. Bioenergy is such a sector which can be a major portion of the fuel energy market if it is supported properly. A biofuel crop is a plant grown as a low-cost and low-maintenance harvest used to make biofuels, or combusted for its energy content to generate electricity or heat. Recently, the Government of India has emphasized on the use of Jatropha crop as a medium term alternative to energy security in the country through biodiesel. GIS plays an important role in the site suitability of biofuel crops. In this paper an attempt has been made to identify suitable wastelands for the cultivation Jatropha plants in T.narasipura taluk of Mysore district. A specific category of wasteland such as fallow land and cultivable wasteland were chosen for the GIS analysis. Parameters such as Oil seed yield of the crop per hectare per tonne, Oil yield percent and Electricity Equivalent were used to calculate the total energy units (MW) that can be produced if Jatropha is cultivated in the taluk. The total potential was calculated to be about 11MW in the taluk

Keywords: GIS, site suitability, biofuel, Mysore, Jatropha, potential assessment

INTRODUCTION

Day by day energy demand is increasing globally. Due to this there is an ever increasing pressure on renewable energy sources to meet the requirements. It is to be noted that no single type of renewable energy source will be able to meet all of our needs. Bioenergy is an upcoming sector which is becoming a major portion of the energy market. [1] [2][3]

Energy policies around the world are progressively mandating increases in bioenergy production, and most are targeting second generation non-food biofuels that promise to be more environmentally sustainable than first generation crop-based biofuels (e.g., corn and soy) if they can be designed and managed appropriately. [4] A biofuel crop is a plant grown as a low-cost and low-maintenance harvest used to make biofuels, or combusted for its energy content to generate electricity or heat. Of late, government of India has encouraged the use of Jatropha as a medium term alternative to energy security in the country through biodiesel.

A Petrol blending program mandated 5% ethanol blending of petrol, initially for selected states and union territories, and in 2006 extended to the whole country (Ministry of Petroleum and Natural Gas 2009). Programs for stimulating complementary use of biodiesel to displace petroleum based diesel primarily focused on biodiesel production based on non-edible oil seeds produced on marginal or degraded lands. The Government of India approved the National Policy on Biofuels in year 2009 targeting a 20% blend of biofuels with gasoline and diesel by 2017.[5]

Hence numerous institutions have evinced a keen interest in the crop cultivation and popularization of the crop. Identification of promising locations suitable for Jatropha crop cultivation would yield in

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better result of such programmes. [6] The site suitability of biofuel plants depends on the location and climate therefore, location specific assessment plays an important role in the regional planning of biofuel cultivation.[7]

Geographic Information System (GIS) is an important technology which helps to identify suitable locations to harvest Jatropha plant based on certain suitability criteria. Wu WeiGuang et al discuss the Potential land for plantation of Jatropha curcas as feedstocks for biodiesel in China. As a renewable energy, biofuel has attracted great attention in China and the rest of world. Concerned with the national food security, China recently has shifted its biofuel development priority from grain-based to non-grain-based biofuels, including forest-based biodiesel, since 2007. Jatropha curcas is one of major biodiesel feedstocks. However, there is rising debate on availability of land for expanding Jatropha curcas areas. [8]

Botanical Description of Jatropha Plant

The complete scientific name of Jatropha is Jatropha curcas Linnaeus. Jatropha curcas is a large shrub, or a small tree. Its maximum height does not exceed 6 meters. Jatropha curcas' 5 to 7 lobed leaves have a length and width of 6 to 15cm.The seed contains upto 37% of valuable oil. In Asia, Jatropha curcas can only be found in the cultivated form. Jatropha crop is a highly adaptable species and it can also withstand long period of droughts. [9]

Wastelands in India

The most recent assessment by the government of India suggested that more than 50 Million hectare (ha) as wasteland in the country. This roughly accounts to about 16% of the total geographical area of the country. [10]Out of this, about 14 million ha is considered suitable for cultivating biofuel feedstocks, such as Jatropha.[11]

Study Area

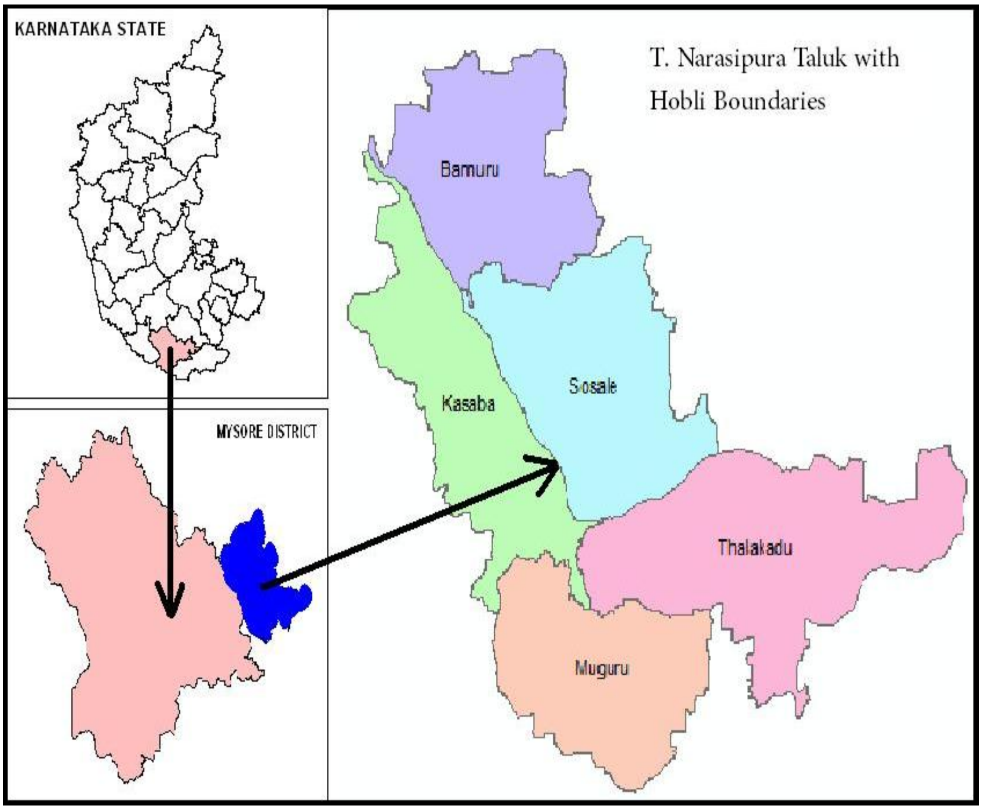

Figure 1. *Study Area*

The study area chosen is T. Narasipura Taluk which is one among the seven talukas in Mysore district, Karnataka State and incidentally my native place because of which I am very familiar with the taluk's geographical locations. I had an ambition of doing some project work which would be of some use to the people of my taluk. The study area chosen is shown in **figure 1** (above).

Profile of the Study Area

Tirumakudal Narasipura (T. Narasipura) town is the headquarters of the taluk of the same name within Mysore District of Karnataka state, India. It is 29 km South-East of Mysore, the district headquarters and 130 km from Bangalore, the State capital. Nearest airport is Mysore Airport. Mysore Junction Railway Station and Nanjungud Town Railway Station are the nearest railheads. National Highway 212 passes through the taluk.

Population

As of 2001, India census, T. Narsipur town had a population of 9,930. Males constituted 50% of the population and females 50%. T. Narsipur had an average literacy rate of 66%, higher than the national average of 59.5%: male literacy is 73%, and female literacy is 59%.

Geographic Location

T. Narasipura taluk is situated in the northeastern part of Mysore district. It is located between 12o 05' 53" to 12o 24' 36" North latitudes and 76o 47' 15" to 77o 08' 11" East longitudes covering an area of 555 sq km with an elevation of 638 Metres (2,093Ft). The taluk has 5 hoblis namely Kasaba, Bannur, Sosale, Talakadu and Muguru consisting of 120 Villages.

Climate

The climate is semiarid tropical. The mean annual rainfall is 718 mm with 45 rainy days. Area under cultivation is about 47621 ha, the forest occupies about 154 ha mainly concentrated in the western and southwestern part of the taluk. The major crops grown are paddy and mulberry.

Administrative Divisions

Figure 2.*Administrative divisions of T.Narasipura Taluk*

The administrative division of T. Narasipura taluk is as shown in **figure 2**

Data Used in the Study

Spatial data

1. LU/LC Map of T. Narasipura prepared by using QuickBird satellite imagery of 2005.

Non spatial data

1. Secondary data from Gazetteer
2. District statistics from Department of Economics and Statistics, GOK.
3. Secondary data from University of Agricultural Sciences, (GKVK), Bangalore.

Table 1. *Details of the data used and the source*

Sl No	Data Type	Source
1	Area wise wasteland spatial map	KSRSAC.
2 3 4	Oil seed yield per hectare per tonne, Oil yield percent, Electricity Equivalent.	UAS (GKVK), Blr. UAS (GKVK), Blr. UAS (GKVK), Blr.

METHODOLOGY

The software used for the analysis was ArcGIS 9.3 from Environmental Systems Research Institute (ESRI) and it was used to perform the various spatial analyses and to develop a site suitability analysis model. Microsoft Excel was used to create the tables and spreadsheet data used for analysis the starting point of the analysis was to define the characteristics that make the land suitable for Jatropha cultivation. Based on the literature survey in [9]Jatropha curcas can be grown in degraded lands. One of the classes in the LULC map is wasteland. There are about 15 categories of wastelands (Source: Wasteland Atlas of India, 2010, NRSC).

Waste lands are wasted lands and therefore if development is required, most of the waste lands can be put to one or the other use like agriculture, horticulture, silviculture, afforestation etc. One of the classes of waste land namely fallow land, cultivable wasteland, stony/sheet rock area and also the non cultivable wastelands are not reclaimable unless huge investments are made. Therefore, these categories of wasteland can be used for the cultivation of biofuel crops. The parcels and the spatial extent of wastelands, particularly, the wasteland categories such as fallow land and cultivable wasteland were extracted from the wasteland classes of the LRIS Map.

The harvestable area available under each wasteland category for Jatropha crop cultivation was calculated using the GIS software. Based on the secondary data collected from the University of Agricultural Sciences (GKVK), Bangalore, the oil seed yield per hectare was found out to be 1.25 tonnes. The oil yield was calculated to be about 30% of the oil seed yield. The electricity equivalent was noted to be about 4.58 kWh. The total energy units were calculated as shown in the equation,

Total Potential (MW) = Electricity equivalent (KWH) * Oil seed yield per hectare * oil yield * total wasteland area

RESULTS AND DISCUSSION

The results obtained from the GIS analysis are discussed in this section. For the purpose of demonstration, T.Narasipura taluk in Mysore district was chosen for the analysis.

Table2.*Categories of wasteland and harvestable area*

No	Category of wasteland	Harvestable area available for Jatropha Cultivation (in hectares)	% of Total Geographical extent of type of land to the total geographical extent of the taluk
1	Fallow Land	3784.08	6.81
2	Cultivable wasteland	1638.07	2.95

Table 2 shows that 3784 hectares of fallow land can be used for harvesting the jatropha crop and cultivable wasteland amounts to 1638 hectares.

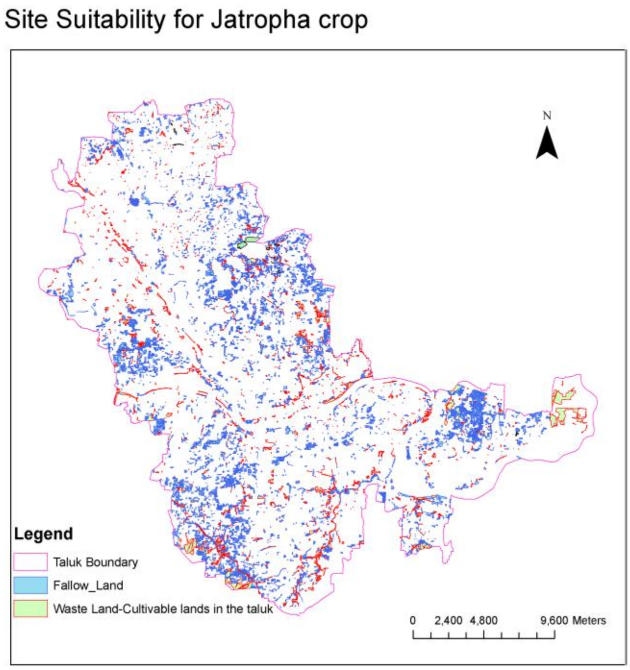

Figure3. *Map showing suitable locations for jatropha crop*

Table 3. *Table showing suitable area and potential of Jatropha Crop*

Type of crop	Total area of suitable wasteland categories[1] in the taluk	Total Potential (MW)
Jatropha	5422.15	11.64

From table 3, we can see that approximately 11M can be produced if Jatropha crop can be cultivated in the entire area of the suitable wastelands.

CONCLUSION

This study shows that a spatial technique is highly useful for assessing the potential of Biofuel crops in the area of interest. Though, field study has to be conducted to access the accuracy of the results. This kind of exercise will help planners and policy makers to create a road map to close the gap on supply and demand of electricity and also to achieve long term sustainable growth.

ACKNOWLEDGEMENT

The authors would like to express their profound gratitude and indebtedness to Dr. D.K Prabhuraj, Director, KSRSAC, Bangalore, for his valuable encouragement, support and for provision of all departmental facilities and the spatial data. The authors would also like to express their gratitude to University of Agricultural Sciences (GKVK), Bangalore for sharing their invaluable data with us.

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AUTHORS' BIOGRAPHY

Abhijith Sastry N S has received his Bachelor of Engineering degree in Computer Science and Master of Engineering degree in Geoinformatics in 2008 and 2011 respectively. He has around 3 years of experience in the field of geospatial analysis and development. He has worked on numerous projects on GIS applications in renewable energy and watershed management

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