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SPATIAL ANALYSIS OF THE POTENTIAL CROPS FOR THE PRODUCTION OF BIOFUELS IN ARGENTINA

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ABSTRACT: The increase in biofuels production has been rising in the last ten years at a high rate. Argentina as one of the main crop producers in the world has a great potential to contribute with high volumes of biofuels. At present time common crops are used for large scale production but new alternatives are under study in different regions of the country. The increase in pressure for expansion also raises concerns on the impact on ecology issues such as soil erosion and biodiversity.
Looking at a national level INTA has been working on the construction of a GIS were different crops were placed.
The purpose is to identify critical information, to raise a methodology to obtain accurate and up-to-date thematic maps using satellite images , to feed a GIS and to integrate the different layers to estimate biomass potentials for energy supply in our country, assessing potential land availability for biofuel crops or plantations to be made with ecological, economic and social sustainability bases.
KEYWORDS: bioenergy, remote sensing, biofuels,

INTRODUCTION: Argentina has a framework that regulates and promotes the production and use of biofuels since 2007. The law mandates the use of biofuels by 2010, with an obligatory mix of 5 percent of ethanol in gasoline and 5 percent of biodiesel in diesel. To comply with the Biofuels Law, it is estimated that a volume of about 700 million litres of biodiesel and 250 million litres of ethanol will be needed (Hoff 2007). Similar increases are mentioned by indicating a demand of 717000 m^3 for internal consumption which leads to an increasing soy production area of 1.288.651 hectares. This is around 10% of the seeded soy area in the country in the year 2006/2007 (J. Adámoli 2007).

Companies which produce biofuels will have three alternatives (Hoff 2007):
1) To produce for the domestic market, taking advantage of various tax incentives;
2) To produce for self-consumption, with similar advantages as in 1; and
3) To produce for the export market, subject themselves to government controls, and not be eligible to receive the tax incentives.

In the year 2007, 300.000 ton of biodiesel was exported from Argentina from which 75% to the United States and 25% directly to the European Union (S. de La Hamaide). In the beginning of 2008, there are eight companies exporting biodiesel with a production capacity of around 600.000 tons per year. In 2008, seven more plants will start operating, In Argentina, it is estimated that mid 2008, the biodiesel production capacity is around 1.1-1.2 millions of tons biodiesel
Sugar cane is currently the main feedstock for ethanol production in Argentina (Hoff 2007). Beside this, there is also an interest in the use of sorghum for ethanol production. There exist around 15-16 small scale producers of bioethanol which serve the beverage, food and pharmaceutical industry. Soybean oil is currently the main feedstock for biodiesel production in Argentina.

There are several programs in Argentina focused on developing new technologies which would rely on different feedstock as Jatropha, Castor Oil plant and algae. There is also research on feedstock which can be produced in areas not suitable for agriculture and which do not compete with food production HOFF (2007). Several feedstoks are currently being studied by INTA along its different Experimental Stations distributed all over the country, the principal are: rapeseed, carthamus, sorghum, panicum virgatum, corn, cotton, sunflower, jatropha, sugar beet, sugar cane HILBERT (2007).

Looking for technical criteria needed to study the potential of different alternatives the national project of biofuels of INTA began the construction of a national GIS gathering all the available information.

METHODOLOGY: The methodology combines the use of an economic ecological and social criteria with modern techniques used in the construction of a geographic information system (GIS). After a selection of the principal crops with potential to be grown at a high level the maximum expansion of them considering the bioclimatic requirements was constructed over the Argentine territory.

The different climatic requirements were identified including frost resistance according to the international and national literature. With this information bioclimatic index were developed for each crop considering their potential growth, development, danger of loss. In this work the assistance of the University of Buenos Aires Agronomy Faculty was crucial coordinated by Eng. G.Murphy

Using the national meteorology databases 1971-2000, the boundaries over the territory were defined classifying the regions into four categories: into four categories according crop aptitude to different weather characteristics: high, médium, low and marginal aptitude. The maps were integrated into a GIS layer. In a second stage the soil characteristics and requirements were used to generate zones with differente aptitude for each crop , using the digital soil soil map of INTA in a scale 1:500.000. Adjustments of this maps were carried over using satellite photography in each region. The final consistency was done over LANDSAT images (1986-2007). For obtaining potential of the different crops the 8 classes of soil capacity criteria of the US soil conservation system was employed. Four categories were selected as a potential criteria for the selected crops.
In order to integrate the different layers raster format was employed and the ARCGIS spatial analyst tool was used. A new layer of integration was developed and a multi criteria approach was used defining 4 levels of aptitude.

In order to prepare the socioeconomic analysis processing plants, roads, railways and hydro ways were also added to the GIS. Each layer was associated the specific databases containing the processing capacities. With ARCCATALOG tool a (GEODATABASE) was created to enable overall analysis.

In a second stage of the program the residue generation by the principal agro industries were added in order to obtain the potential use of this product in bioenergy generation.

RESULTS AND DISCUSSION: Thirteen crops have been finished at national level obtaining the final maps and databases. As an example in this presentation soybean bioclimatic output map, soil criteria map and the interaction output for bioclimatic and soil consideration layers for the same are presented. There are several areas on which several crops can be produced; the final expansion of them will be related to the economic benefit and risk in each of the regions studied.
In the most expanded crops as soybeans and corn a verification study was carried over comparing the theoretical maximum areas with high potential and the actual surface being used by farmers with a perfect correlation.

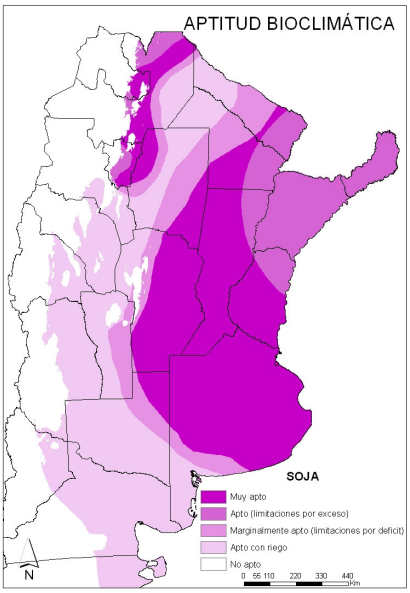

FIGURE 1. Bioclimatic map output of the GIS system with four capacities

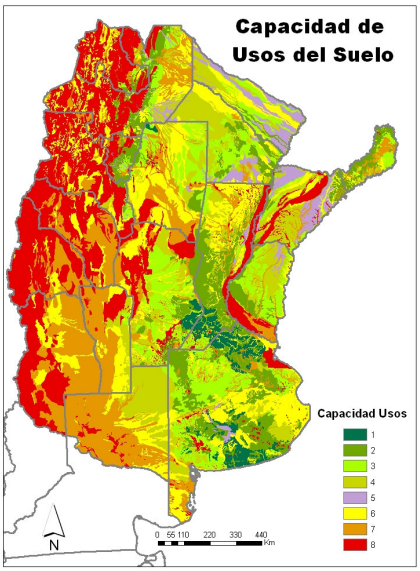

FIGURE 2. Base layer of soil capacity in Argentina use in the system

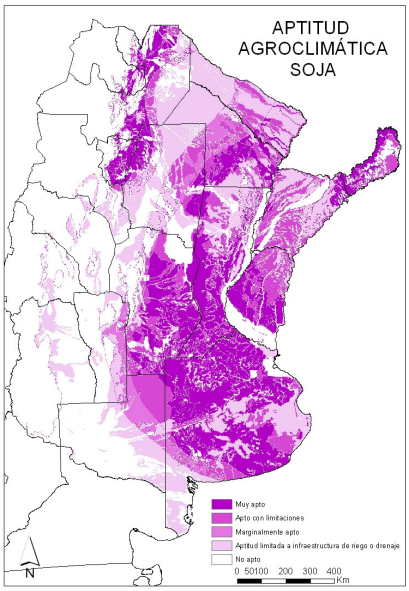

FIGURE 3 Example of final output map obtained for each crop studied with the four capacity areas

TABLE 1. Winter rapeseed potential productive area

Capacity level	Surface
No suitable	93.000.000 has
Very limited	40.200.000 has
Marginal without irrigation	2.500.000 has
Posible with limitations	28.400.000 has
Optimum	36.200.000 has

CONCLUSION: The GIS system produced has become a very important tool used by governments, research community and investors in order to study the viability of feedstock's production in the very different regions of a continental size country as Argentina. The system is in permanent growth adding new data and enlarging the database with the rapid changes.

REFERENCES:

BIRKA W **The Socio-Economic Impacts of Large-Scale Land Use Change and Export-Oriented Bio-Energy Production in Argentina**. Birka Wicke. Copernicus Institute. 2006.

HILBERT J **Programa nacional de bioenergía INTA** 2007.

INTA **Atlas de Suelos de la República Argentina**- INTA-PNUD 1990, versión digital 1995.

FALLOT A,GIRARD P. Dep- Montpellier- France- **Discussion paper for the STAP/GEF biofuel workshop**, New Delhi, 2005

SHAFIKL A MARCUS R **Biomass Energy Potential in Argentina**. Buenos Aires, 2005.

WICKE, B. (2006). **The Socio-Economic Impacts of Large-Scale Land Use Change and Export-Oriented Bio-Energy Production in Argentina; Quantifying the Direct, Indirect and Induced Impacts of Agricultural Intensification and Bio-energy Production with Input-Output Analysis**. Department of Science, Technology and Society. Utrecht, Copernicus Institute, University Utrecht**:** 106.