

APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM IN ASSESSING THE SUITABILITY OF THE CLIMATIC VARIABLES OF ADAMAWA STATE FOR THE PRODUCTION OF IRISH POTATOES

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ABSTRACT

The application of Geographic Information System (GIS) in assessing the suitability of climatic variables for Irish potatoes production in Adamawa State north-eastern Nigeria was carried out. This involved the use of rainfall length, mean annual rainfall and temperature maps of Adamawa State. The assessment was based on Boolean logic and suitability classification described by FAO guidelines of 2008, where most suitable, suitable and unsuitable classes were used. The thematic land qualities with their associated attribute data were encoded in GIS database of IDRISI Taiga and overlay operations of the variable maps were carried out. Results showed that most suitable, suitable and unsuitable areas for Irish Potatoes production cover 43.82% (18,566.83 sq km), 37.28% (15,795.79 sq km) and 18.90% (8,008.06 sq km) of the state's total land area respectively Irish Potatoes on the most suitable and suitable lands is recommended towards tackling the problems of food shortage in Adamawa State

KEYWORDS: Irish Potatoes, Suitability classification, Climatic variables, Geographic Information System, Boolean logic

INTRODUCTION

Geographic information systems have been widely used to support real world decision-making processes that involve finding regions capable of supporting certain land uses. For example, identifying an area capable of supporting a certain agricultural crop or locating a site 'suitable for a landfill are tasks often tackled with the assistance of GIS tools. Spatial decision-making processes like these require the assessment of alternative sites based on criteria that are defined by a variety of environmental and/or

socioeconomic factors. The process of assessing these factors involves comparing the actual conditions of the alternative sites with desirable characteristics, and is usually referred to as capability/suitability evaluation (Stoms *et al.* 2002).

Irish potato (*Solanum tuberosum L.*) is the world's fourth largest food crop after wheat, rice and maize (Raemaekers, 2001). World production reached a record of 320 million tons in 2007 and production in the developing countries has almost doubled since 1991, with a corresponding increase in

consumption (Sofyan R.W. *et al*, 2007). Potato is an important source of food, employment and income in developing countries (FAO, 2008). The potato's high energy content and ease of production have also made it an important component of urban agriculture which provides jobs and food security to some 800 million people globally (Sofyan *et al*, 2007). Hundreds of millions of people in the developing countries including Nigeria is facing food crisis as the cost of their staple foods continues to rise. Rice prices have almost doubled during the year 2008, as wheat prices are climbing rapidly while maize prices are skyrocketing. But On the contrary, the price of potato has remained stable. The potential of the potatoes is yet to be fully realized and has never been more evident until the recent rising prices of rice, wheat and maize (FAO, 2008). Potatoes have the potential to relieve the pressure of increasing cereal prices on the poorest people and contribute significantly to food security. Potatoes are grown and eaten locally, with little significant international trade compared to cereals, so they are particularly valuable as food in the developing countries. Potatoes mature in 3-4 months and can yield about 40 tons/ha and hence ideally suited to places where land is limited and labour is abundant (FAO, 2008).

Irish potato is not a common tuber crop cultivated in Adamawa State. It is produced only in few areas

of the State namely; Ganbe Village in Mayo-Bellwa and Kwaja village in Mubi South Local Government Areas. A good numbers of areas in Adamawa State could be found suitable for production of this important crop based on the soil requirement as pointed by Madefa, (2012). However soil and altitudinal characteristics alone cannot serve as adequate suitability determinants for the crop's production without considering climatic variables. It is against this background that the current research examines the suitability of Irish potatoes production in Adamawa State base on mainly climatic variables.

Cultivation of the crop requires an Annual rainfall of equal or greater than 1000mm, Rainfall length of 90-170 days and Temperatures of equal or less than 27°C (CIP, 1982).

Adamawa state is located in the North – Eastern part of Nigeria. It lies between latitudes 7°N and 11°N and between longitudes 11°E and 14°E, with a total land area of 39,742.13 sq. Km (Adebayo, 1999).

MATERIAL AND METHODS

Software packages (Idrisi Taiga and ArcGIS 10.3) and hardware materials (Computer system and conventional thematic maps of climatic variables) for GIS techniques were used to generate precise and reliable results. The acquisition of the relevant data, identification and definition of sites

as well as the digital mapping and analysis of the data were carried out.

determine the production of a crop (Irish Potatoes) Raemaeker (2001).

Factors and Constraints used in Site Suitability

The variables used for this study were; annual rainfall, length of rainfall, and temperature of Adamawa State. These factors were chosen because they are the major environmental factors that affect or

Data Analysis.

ArcGIS 9.3 was used for georeferencing, and digitizing of the thematic conventional maps, while IDRISI Taiga was used for image processing and analyses, where Map Algebra (Overlay) Method of Analysis was employed. Other supporting non – GIS packages used included Microsoft word 2007 and Corel draw I2.

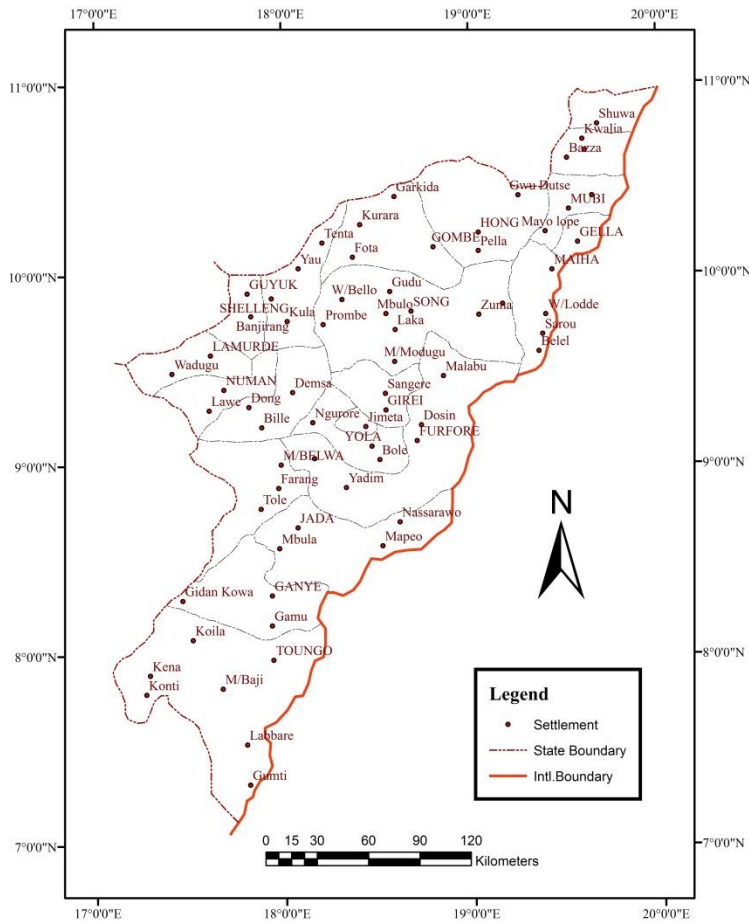


Figure 1: The Study Area

Map Algebra.

Definition of Suitability and Unsuitability Criteria

The research defined criteria for the Land Suitability Analysis based on

the FAO (1976) Mukhtar (2012) and Boolean Logic Theory of suitability guidelines and modified criteria (Table 1.)

Table 1: Criteria definition

	Criteria	Constrai	
		Suitable	unsuitable
Rainfall length	≥ 90 Days	1	0
Annual rainfall	1000-2500	1	0
Temperature	≤ 27°C	1	0

According to these criteria, values for layers were quantitatively scored according to suitability condition where 1, and 0 were assigned to suitable and unsuitable classes, respectively (Table 1). An

overlaid subroutine of IDRIS 32 was used for map algebra (Figure 2).

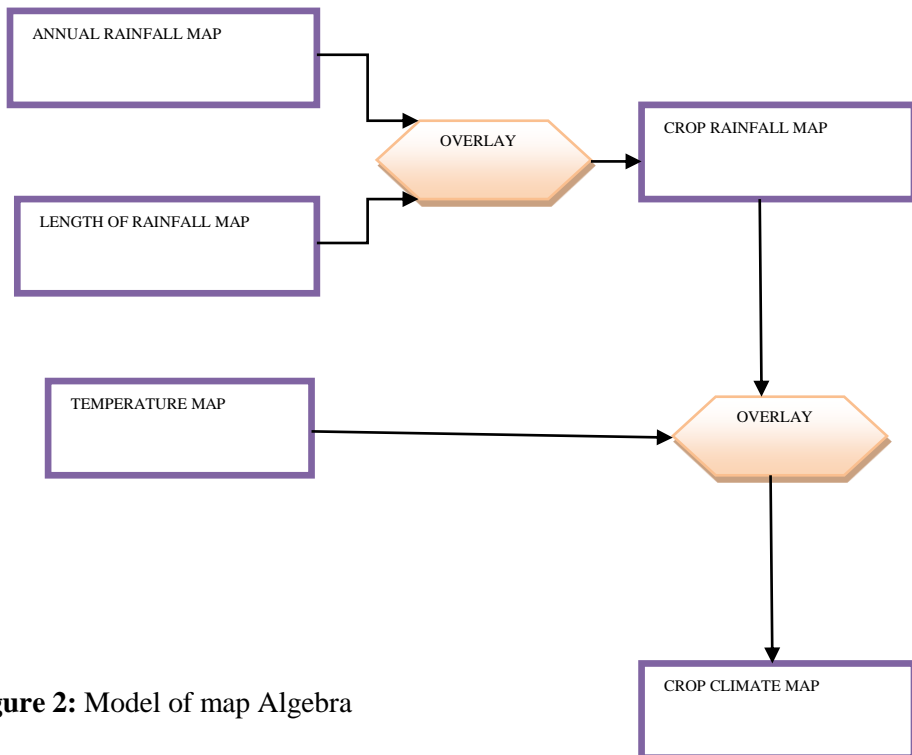


Figure 2: Model of map Algebra

RESULTS AND FINDINGS

An assessment of the climatic variables as obtained from the thematic maps is presented on Table 2.

Table 2: Suitability of the Climatic variable of Adamawa State

s/n	Requirement	Suitability Condition	Adamawa Condition	Remark
1	Rainfall Length	Equal or greater than 90days	110-210days	Suitability (100%) Figure 7
2	Annual rainfall	1000-2500mm	600-1600mm	Suitability (71.3%) Figure 6
3	Temperature	Equal or less than 27°c	Zone1 24-27°c Zone2 greater than 27°c Zone3 less than 24°c	Suitability (54.19%) Figure 8

Adebayo 1999, Raemaeker 2001, FAO 2008

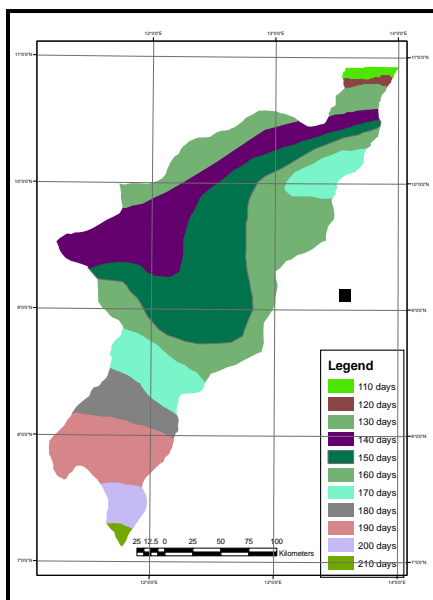


Figure 3: Rainfall Length of Adamawa State

Source: Modified from Adebayo 1999

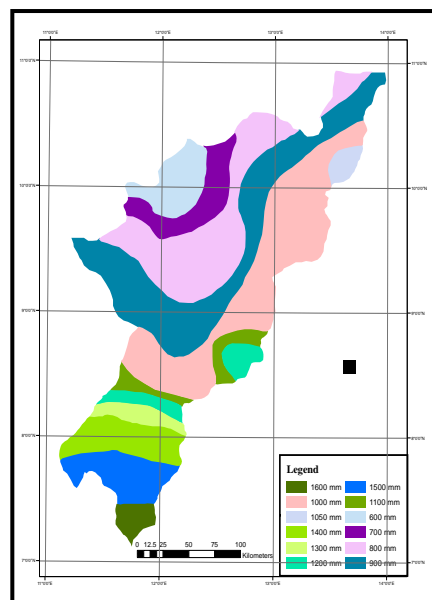


Figure 4: Mean Annual Rainfall of Adamawa State

Source: Modified from Adebayo

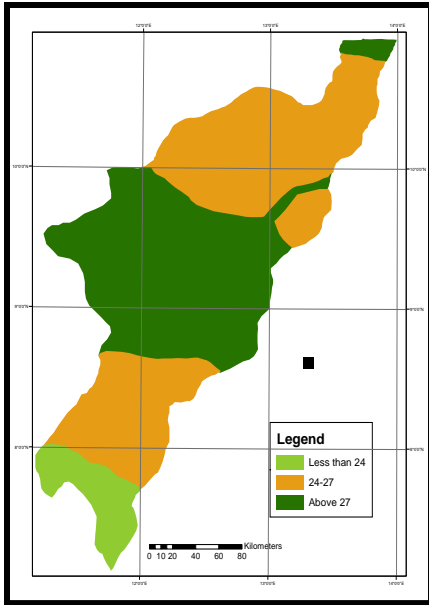


Figure 5: Mean annual temperature of Adamawa State
Source: Modified from Adebayo 1999

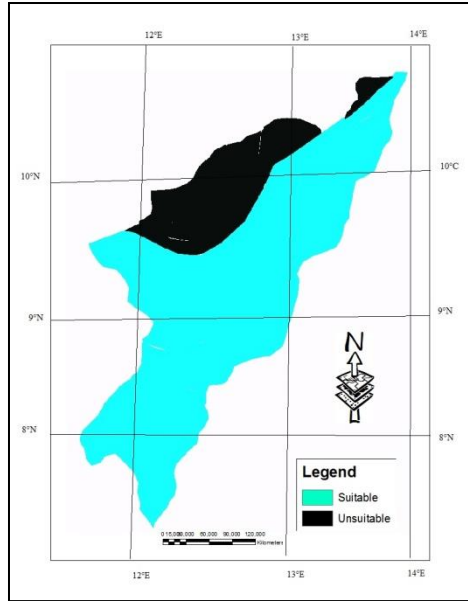


Figure 6: Constraint of annual rainfall length

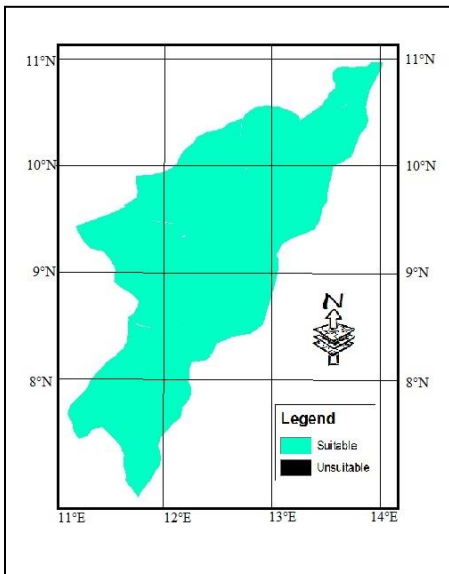


Figure 7: Constrain of Mean annual rainfalls for Irish Potatoes

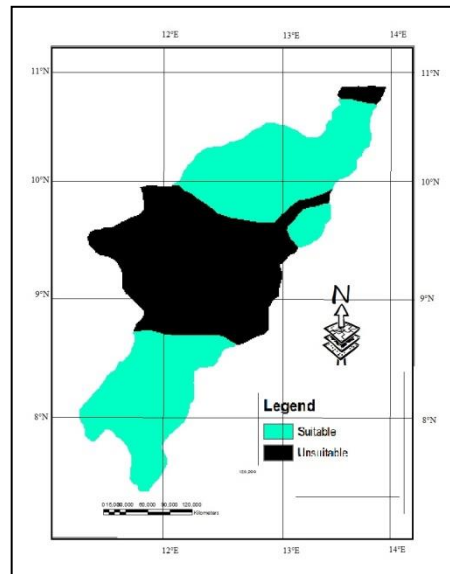


Figure 8: Constrain of mean annual temperature of Irish Potato

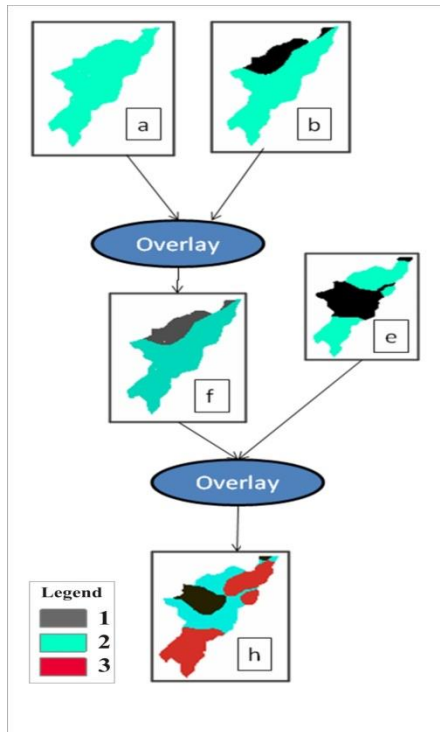


Figure 9: Model of Map Algebra

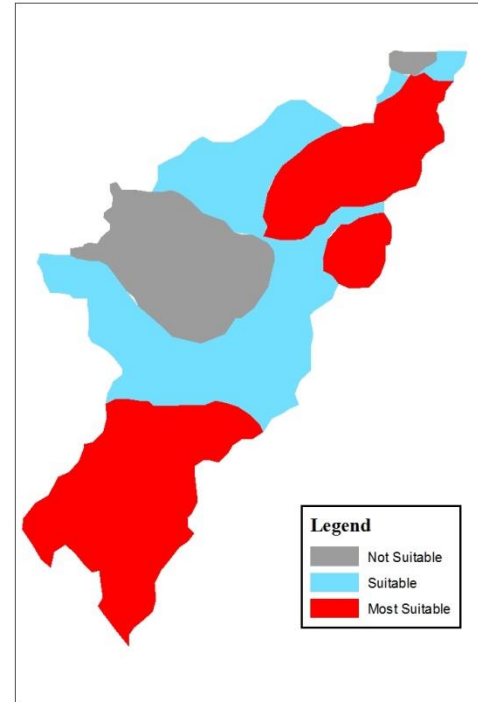


Figure 10: Suitability map

Assessment of the prepared suitability map (Figure 10) showed that the suitable area (base on the three climatic factors) for Irish Potato production covers nearly all the state with a total area of 37,217.75 km² (95.7%) and 1,672.27 km² (4.3%) as Unsuitable area. Base on the FAO guideline of Suitability classification, suitable area is further been sub-classify in to three (2) with the most suitable area mostly in the northern and southern part of the state which covers a total area of 3,480.66 km² (8.95%). The suitable area covers the largest part of the state with the total area of 17,757.18 km² (45.66%)

CONCLUSION

Based on the findings of this research work, it is concluded that Adamawa State would be suitable for investment in the cultivation of Irish Potatoes on basis of climatic variables. Suitable areas in the state are underutilized probably due to lack of awareness. Therefore, cultivation of the crop is recommended towards tackling the problem of food shortage in Adamawa State.

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