EFFECTIVE AGRICULTURAL DECISION MAKING THROUGH COMPUTER SPATIAL MODELLING

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1.1 INTRODUCTION

Batticaloa District lies in Eastern part of Sri Lanka. This is a predominantly agricultural economy that is blessed with natural resources for the agriculture and animal husbandry industries. The coastal area of the Batticaloa district is dominated by sandy soil, and the western part of the region (majority of the areas) is inherited by soils like reddish brown earth and alluvial. Farmers in this region produce vast amount of paddy and OFC (Other Field Crops) for domestic consumption and export.

Inadequate water availability[1] I has been the major constraint for increasing the cultivated area in Batticaloa even if it is potential area in terms of land productivity (Jeyakumar, 2001). Even in the present cultivable area, demand for water is becoming more distinct as the intensive use and scarcity issues are more acute. In order to achieve food security, to meet the growing water demand by other sectors and under limited resource availability, the district is now left with the option of meeting productivity through identifying high potential areas[2] (of agricultural productivity) and utilizing those identified areas for cultivation in order to increase yield per unit land area.

Therefore, the district needs to utilize the areas with high agricultural potential that have not been identified yet/or not been used traditionally. If these areas are not identified or used, the district may be losing some (or much) productivity in terms of agricultural produce output (in terms of agricultural food production). Hence, the need for identifying agricultural potential areas in this district is paramount. In this respect, the traditional methods of agricultural field trials and field surveys are not feasible as well as not economical, for these are expensive-time consuming processes. A cost effective and efficient solution to this problem could be through the development of an electronic (digital) Geographical Information System (GIS)/Decision Support System (DSS), which will aid in agricultural decision-making and resource management in the Batticaloa district. This target (development of Geographical Information System) can be achieved by using commercially available computer software packages such as Arc View and Arc Explorer. But these are very costly packages and they needs costly data of high quality (i.e.remotely sensed data). This project concentrates on the Development of a cost effective geographical Information System by using Microsoft Excel software package. This can arguabley be called as the unique aspect of this research project.

1.2 GOAL OF THIS PROJECT

The overall goal of this project focuses on facilitating use and integration of cost effective computer-based simulation models and applications and spatial technologies for agricultural decision making. Toward this goal, a computer-based methodology was developed. The spatial model was developed using Microsoft Excel package.

2.1 MODEL DEVELOPMENT

"BATTI-LAND" was the name given to the model, this means 'potential agricultural lands in Batticaloa district'. Electronic spreadsheets[3] were used to develop this GIS model. The steps involved in the development of model were logical formulation, collection of secondary data (maps of Batticaloa), storing and developing of spatial maps in spreadsheet and overlaying the maps. Buffering concept was also used (to view an area which is located a particular distance from the main road).

2.2 FEATURES OF MICROSOFT EXCEL 2000 FOR GIS DEVELOPMENT

There are lot of features are available in Microsoft Excel 2000 for spatial modeling, especially for raster overlaying[4]. Most useful functions are IF and SUM for overlaying. Furthermore the rearrangement of the dimensions of a cell is suitable feature for handling in parallel cell value. Unlimited workspaces facilitate for spatial drawing. Copying and co-coordinating capability from one sheet to another sheet leads to reducing spatial overlaying error. There are facilities to distinguish a particular cell of a group of cells by providing cell values, colour and shading.

2.3 LOGIC FORMULATION

Initially the criteria for agricultural potentialities were considered for formulation of logic; which are land availability, soil types, water availability, infrastructure facilities, marketing facilities, land covering and population density. Some of these are basic requirements and others are additional requirements. Basic requirement for agriculture are suitable land and water availability. The additional requirements are land availability (land cover), marketing facilities,

Infrastructures and population density. Those additional requirements were then divided into space requirement (population density and land cover) and marketing requirement (markets and infrastructure) for easy overlaying. Figure 2.1 shows the logic of this research project. The conceptual diagram for the buffering function is shown in figure 2.2.

2.4 DATA COLLECTION

For spatial model development, secondary data were collected from various sources. Maps for land use and soil type were collected from the Survey Department, District Secretariat Office and the Municipal Council of Batticaloa. Some maps (e.g. tanks and roads) were downloaded from web pages and then were transferred to Ms Excel. Some maps were created directly in Excel spreadsheet (e.g. population density using data from Statistical Office, Batticaloa).

2.5 DEVELOPMENT OF RASTER MODEL

The raster model was developed by providing cells value within the re-projected map in spreadsheet. For example, in the soil area raster model, each soil types were represented by different values and colours as given below (figure 2.2). Using **conditional formatting**[5] function in Microsoft Excel, different colours were provided to different valued cells. Like this manner other raster maps were also created in Excel spreadsheet (i.e. raster map models for water availability, infrastructure facilities, population density, land cover and marketing facility).

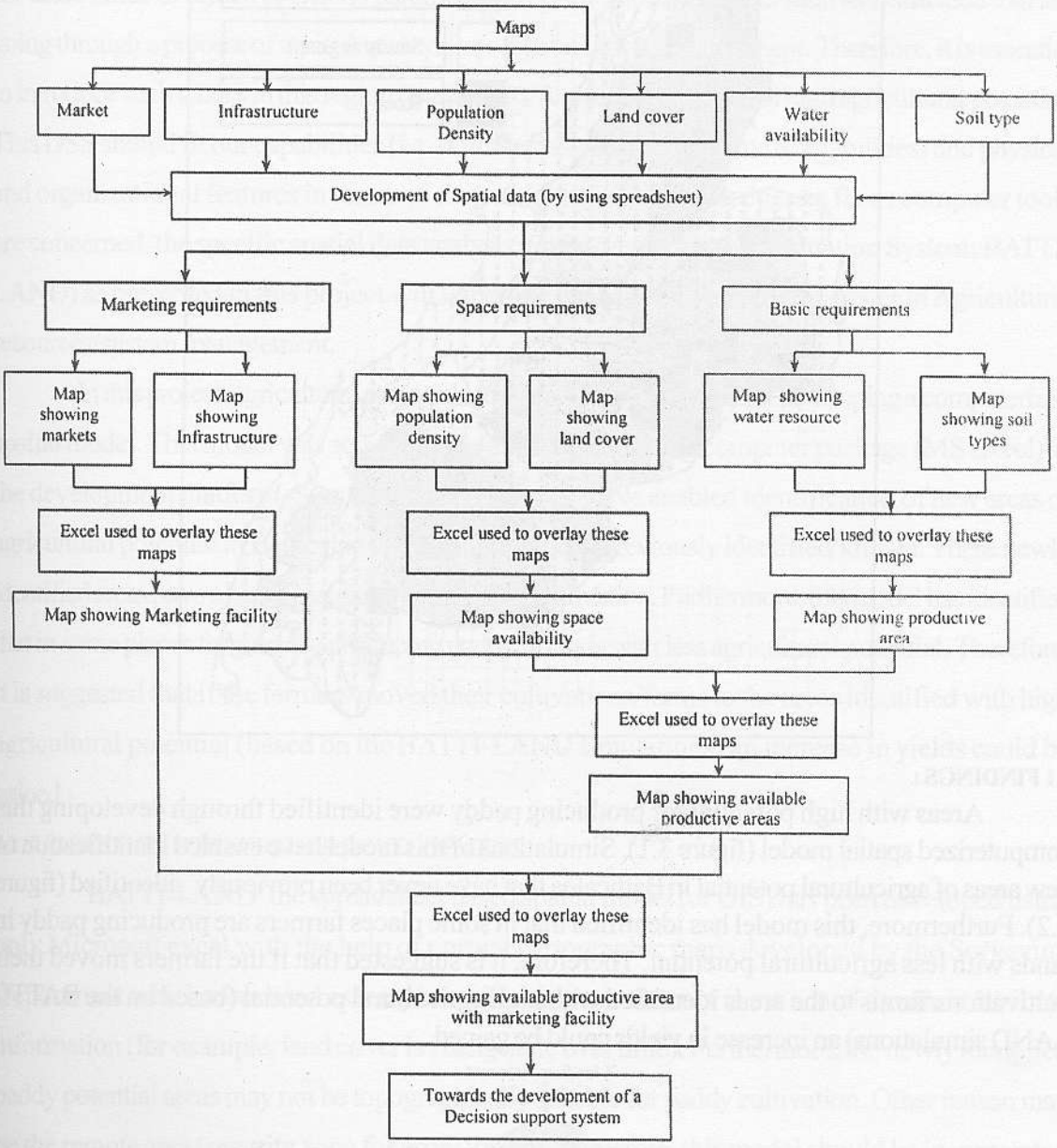
2.6 OVERLAYING

After basic raster maps were created, all the maps were overlaid to develop a final map, which shows agricultural potential area. Maps were overlaid two by two for easy work and to reduce layering errors (mismatch layers). For this purpose, IF and SUM functions were used. Examples are given below.

(Soil map) SUM (water map)

e.g. = SUM ('Fresh water'! AG 11,'Soil types'! AF9)

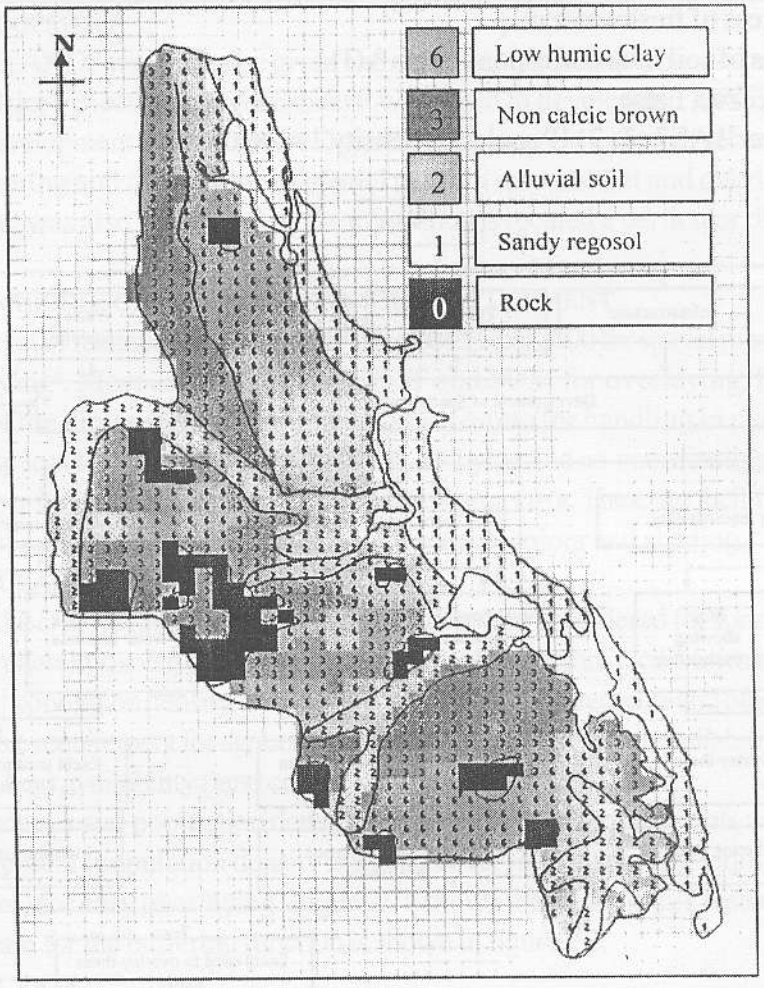
AG 11 - cell address of freshwater map
AF9 - cell address of soil map corresponding to AG11
=IF (Logical test, True, False
e.g. = IF('land over'! AE7=3>3+'Population density'! AD6.0)



Fighure 2.1: The research logic of the project

2.7 BUFFERING

Buffering6 enables the user to find the potential areas near to particular feature (e.g. near main road). 24 buffering maps were developed. Following diagram describe the different buffering approaches according to GIS buffering principle (AND, OR, NOT and XOR). Fundamental buffering map was created in such way that cell value of '1' was provided to all cell which are along the main road, '2' was provided to all cell located 2 km from main road and so on. One of important assumption was taken that is "width of a cell is 1 km".



3.1 FINDINGS :

Areas with high potential for producing paddy were identified through developing this computerized spatial model (figure 3.1). Simulations of this model have enabled identification of new areas of agricultural potential in Batticaloa that have never been previously _identified (figure 3.2). Furthermore, this model has identified that in some places farmers are producing paddy in lands with less agricultural potential. Therefore, it is suggested that if the farmers moved their cultivations/farms to the areas identified with high agricultural potential (based on the BATTI-LAND simulations) an increase in yields could be gained.

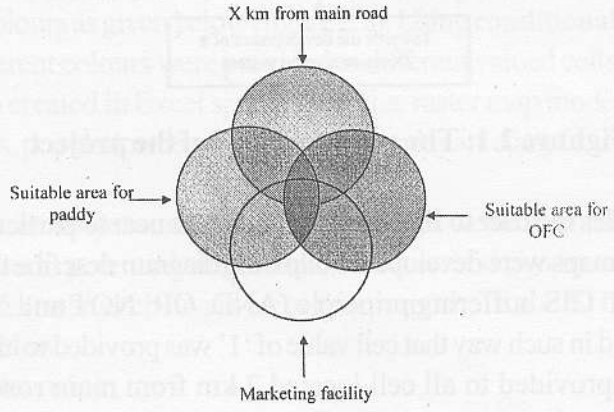


Figure 2.3 Diagran for buffering

4.1 CONCLUSION

Effective understanding of agricultural potential areas in a particular region needs a well-planned Decision Support System (DSS) that incorporates spatial modeling elements. The need for these kinds of effective DSS is paramount in conflict-affected areas such as Batticaloa that are going through a process of agricultural systems rehabilitation/improvement. Therefore, it is essential to introduce such a DSS in this region (Batticaloa), for identifying areas of high agricultural potential. This DSS should fit our capabilities (i.e. skills, infrastructures and time availabilities) and physical and organizational features in terms of cost, economy, and knowledge. As far as computer tools are concerned, the specific spatial data analysis model (Geographic Information System; BATTI-LAND) as presented in this project will hopefully enable decision making easier in Agricultural resources/system management.

In this project, agricultural potential areas were identified through developing a computerized spatial model. This model was achieved by using a cost effective computer package (MS Excel) as the development platform. Simulations of this model have enabled identification of new areas of agricultural potential in Batticaloa that have never been previously identified/known. These newly identified areas have a high potential area for paddy cultivation. Furthermore, this model has identified that in some places farmers are producing paddy in lands with less agricultural potential. Therefore, it is suggested that if the farmers moved their cultivations/farms to the areas identified with high agricultural potential (based on the BATTI-LAND simulations) an increase in yields could be gained

4.2 SUGGESTION FOR FURTHER DEVELOPMENT

'BATTI-LAND' the spreadsheet based spatial model (or GIS) has been developed using only Microsoft excel with the help of normal cartographic maps developed by the Surveying Department which were used as templates. These maps may not show actual dynamic attribute information (for example, land cover is changeable over time). Furthermore, the newly identified paddy potential areas may not be topographically suitable for paddy cultivation. Other reason may be the remote area (security zone for army forces). Therefore, this model should be incorporated with topographical data and remotely sensed data. In this aspect the only reliable data sources are remote sensing data (satellite maps) for spatial development. But, satellite maps are not readily

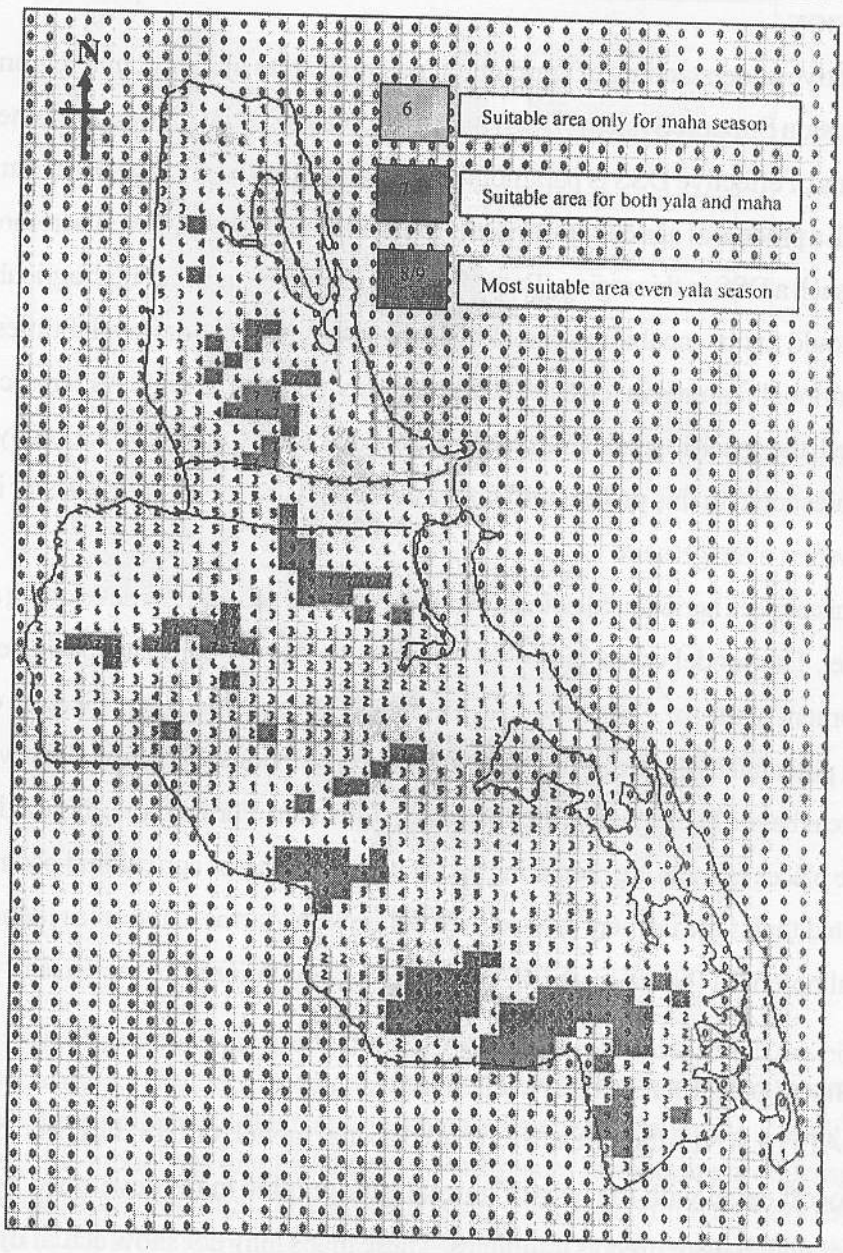


Figure 3.1: potential area for Paddy (Simulated model)

available for Batticaloa district; even if they are available, they are priced at very high costs. e.g.I km X I km remotely sensed image of a part of Batticaloa is prized at US$ 5000 or more (perscomm, Mr. S. Navaneethan, Municipal Commissioner, Batticaloa). Even if it is available (and in hand), costly packages are neede (for example: ERDAS Imagin7, Arc View, MapInfo and Arc Explorer) for spatial development.

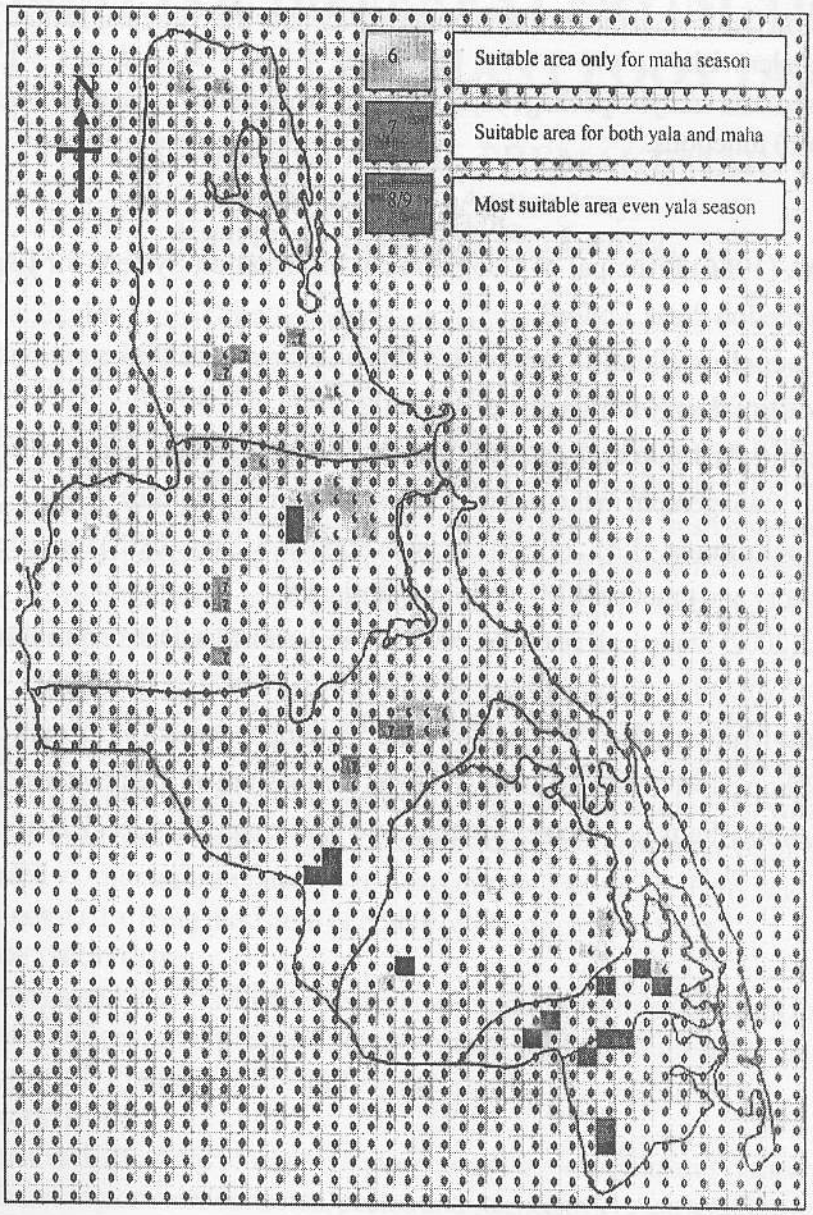


Figure 3.2: Expandable-paddy cultivation areas (that have not previously been identified)

FOOT NOTE:

1. Water scarcity due to warm climate, inadequate river water, sandy nature soil, seasonal variation and etc.
2. Agricultural potential area, will be the term used hereafter. Which means an area where all necessary agicultural resources are available and that area is highly suitable for agriculture (definnition developed by author)
3. Ms. Excell 2000 was the sqreadsheet environment used to develop the GIS model.
4. Overlaying based on the cell vaues located in the map. not like vector overlaying(i.e. based on points, lines and sreas)

5. Special faciliyt to provide the particular colour to particular cell which are particular cell value.
6. Special process in GIS spatial model that facilitates to identify the particular feature by providing conditions of modeler wish.
7. Remotely sensed data analysis package capable of spatial modelling, visualization, conversion, GIS and GIS (web) functions.

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