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APPLICATION OF CROP INFORMATION SYSTEM TO THE MANAGEMENT OF RICE PLANTATIONS IN PATIGI LOCAL GOVERNMENT AREA OF KWARA STATE, NIGERIA

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ABSTRACT

This study focused on the application of Crop Information System (CIS) for sustainable rice production in Patigi Local Government Area of Kwara State, Nigeria. The rice fields were identified through the use of Global Positioning System (GPS) while some attribute data concerning each identified rice fields from the farmers were obtained with the use of questionnaires and direct observation. However, secondary data were collected from the existing books, journals, maps and internet. Random Sampling technique was used to draw a population of 224 from a population of 45,712 which was used for 200 people as sampling frame of the entire population. Above all, a number of 224 questionnaires were administered and used in the course of the study. The base map of Kwara State was scanned, geo-referenced and digitized by layers (i.e boundary, district, settlement, road, ward, and rivers) in AutoCAD Map 2000i and Arcview 3.2a GIS Software. Maps and tables were used for presentations and discussions of results. Finally, it was observed that all the geographic queries carried out in this research were as a result of the available database, such that when there is a click on any feature, the spatial and attribute data are easily displayed. The regular up-date of this comprehensive geographic database should be carried out so that, the decision making bodies can have access to information on rice growth and management in the study area.

Keywords: Database, Plantation, Management,

INTRODUCTION

Background to the Study

Accurate and timely information is necessary to evolve strategies for sustainable management of natural resources. Today's "Space Age" supported by computer and communication technologies offer great scope for efficient planning and management of agricultural resources on scientific principles. Global Positioning System (GPS) and Geographic Information System (GIS) technologies are of great use to planners in planning for efficient use of national resources at national, state, and district levels. Application of these technologies in the management of natural resources is increasing rapidly due to great strides being made through space borne remote sensing satellites in terms of spatial, temporal, spectral and radiometric

resolution. Many of the conventional approaches for handling multi thematic information to arrive at optimal solutions are being computerized using GIS utilities.

Agricultural produce has been the major source of food production in many of the developing nations among which is Nigeria. On a global and national scale, rapid increase of population has necessitated high demand of food production. It is therefore imperative to address the changing state of agricultural system as a result of the present day technological advancement.

Rice is important in Nigeria for several reasons. The trend for the production and consumption of rice is growing faster than any other food staples. It is a major contributor to internal and sub-regional trade. Rice is also the staple for most of the peoples in the Niger-Benue trough which divides Nigeria into four parts, Sokoto-Rima Basin in the north-west, Chad Depression in the north-east, Hadejia-Jamaare trough in the extreme north, and Cross River trough in the south. Farmers find rice more adaptable than a high input staple like maize when there is declining soil fertility because of the huge array of varieties they can switch over to every few years (Selbut, 2003). Since it is becoming a staple crop, farmers seem to be willing to grow it all the time no matter the constraints they are facing. It is therefore mandatory to have adequate knowledge on meaningful production areas that can allow the decision-makers to identify population that are most liable to food insecurity and poverty.

Statement of the Research Problem

Referring to the use of agricultural resources, geospatial information is an effective tool for gathering related spatial data that are capable of identifying a specific crop area in order to reduce problems facing food production in a developing nation. Various development measures have been put together so as to curb problem of food insecurity in Kwara State - where the study area falls, resulting from inadequate crop information for proper planning and decision-making. Related to this is the good intension of the Kwara State Agricultural Development Project with the following overall objectives:

- to provide adequate and reliable data that facilitate information for sound decision-making by the management;
- to improve planning support to the project in form of annual work plan, mid-year and monthly reviews;
- to conduct planning studies on specific project constraints during implementation.

However, most of the objectives have not been actualized based on the limitations of the scientific tools involved in crop data gathering and estimation. It is therefore imperative to identify the rice growing areas using Geographic Information System for sustainable agricultural development. This paper attempts the application of crop information system to the management of rice plantations in Patigi Local Government Area of Kwara State, Nigeria.

Justification of the Study

To have geospatial information on crop area and yield in most States in Nigeria is difficult. This has led to misappropriation of land resources evaluation for proper land use strategies. Not only this, patterns of agricultural resource used and the scope of resource demanded are always changing from time to time. Also, detailed maps on location of major staple crops like rice are not readily available for the study area.

Both state and national planners intending to use multi-disciplinary decision support systems require among others, adequate information on where crops are grown in order to monitor agricultural production in a given areas (McGuire, 1997). When adequate information on these component parts of the agricultural system are available or can be collected; political and economic concerns can be addressed through improved management programs.

STUDY AREA

The study was carried out in Patigi Local Government Area (consisting of three districts including Patigi, Lade and Kpada), which was created from Edu Local Government Area of Kwara State, Nigeria. This area is geographically located within $8^{0}50^{1}$ N and $5^{0}25^{1}$E of the equator. The location shares common boundaries with Niger state, Kogi State as well as Edu and Irepodun Local Government Areas (Figure 1 & 2). It has a total land area of about 2924.62sq.km, which is about 5% of the total land area of the state – Kwara State (www.kwarastate.com). Approximately 25% of the land area of the Local Government is used for farming (Kwara State Agricultural Development Project, 2007).

A humid climate prevails within the study area with two distinct seasons (the wet and dry seasons). The wet season lasts between April and October while the dry season falls between November and March. The rainfall ranges between 50.8mm during the driest months to 2413.3mm in the wettest months. The minimum average temperature throughout the state ranges between 21.1^{0}c and 25.0^{0}c while, maximum average temperature ranges from 30^{0}c to 35^{0}c (The Met. Office, 2007).

The soil is red laterite of tropical area formed under seasonal rainfall climatic region. Soil aggregation is poor, with tendency to compact under wet condition. Surface texture is sandy loam. Clay is predominantly kaolite. Soil is about 30-40% clay especially with depth. The climax vegetation was tropical deciduous forest but the influence of man, especially farming activities has turned it into dry woodland savanna, which is characterized with scattered trees and tall grasses. As a result of topographic changes, rainfall differences and edaphic factors, some pockets of other distinct vegetation types are supported within the study area. Various vegetation species contained here are; Raphia Palm (Raphia Sardomical), eiba Pentandra, and Lannea Acida among others. Of grasses, Andopogen Tenctorum is evident where the soil is deep and Morrocymbium Ceresiiforme is frequent in poorer soils (KWADP, 2007).

The study area was chosen because agriculture is the bedrock of its economy and also characterized with various forms of ecological zones that give rise to different types of crop. The typical cropping systems in the study area are, Rice – based system, Sugar Cane-based system, Ground Nut -based systems, Millet-based system and Melon cultivation in areas located along river Niger, the major river in the study area. The major crops cultivated in the location include Rice, Sugar Cane, Ground Nut, Millet, and Melon and some leafy vegetables. Majority of the food produced are for personal consumption, while some households sell small amount of the food in the market to earn additional income for household upkeep (KWADP, 1996).

The total estimated population of Patigi Local Government Area according to National Population Commission (1991) is about 45,494 (22,712 males, 22,782 females) of which farmers account for about 70% (www. Kwarastate.com). Agricultural production is largely peasant and small-scale relying heavily on the use of manual labour equipped with crude implements, while fertilizers, mechanical implement, improved seeds and agrochemicals are also used to some extent (KWADP, 2007).

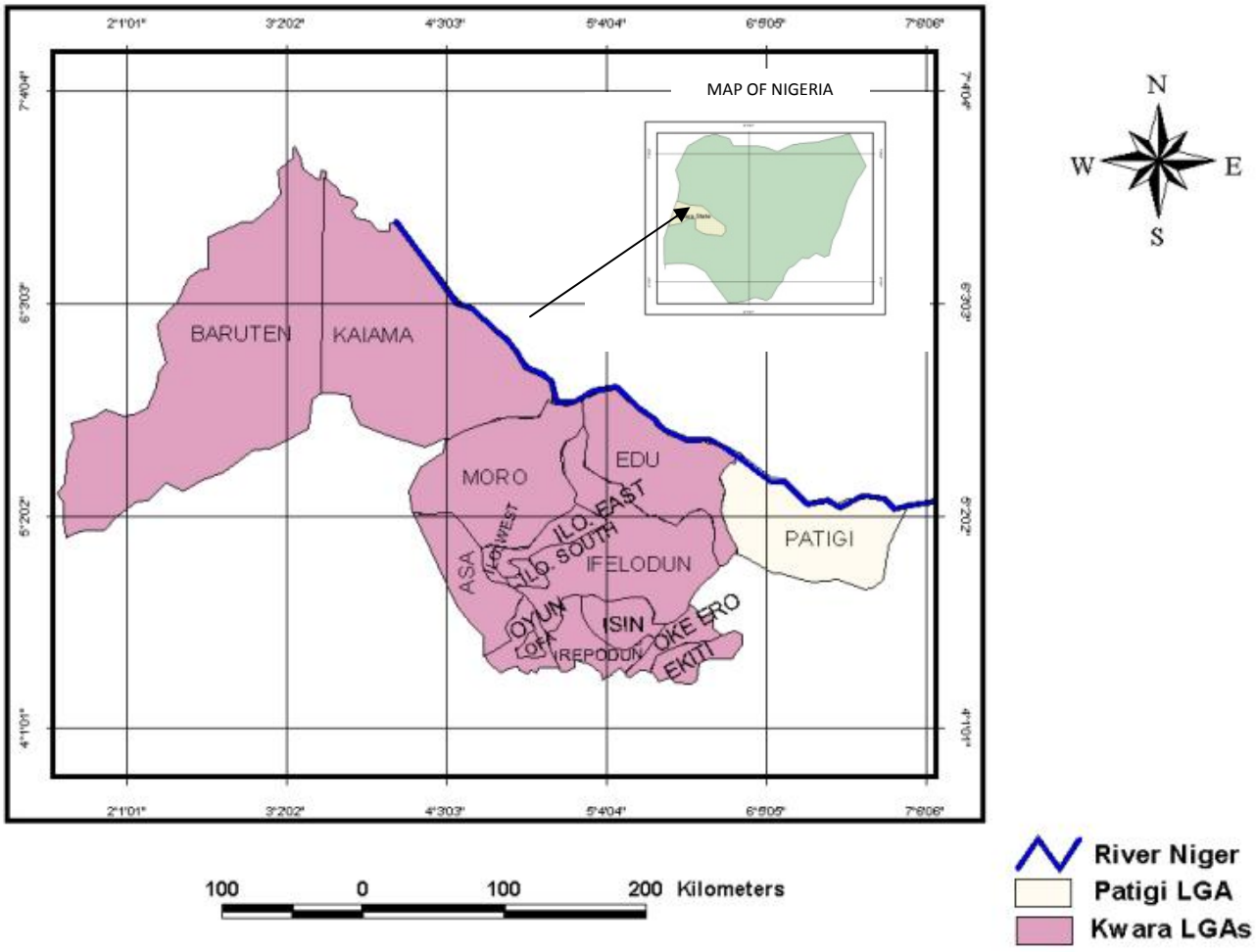


Figure 1: Map of Kwara State showing Patigi LGAs
Source: Kwara State Ministry of Lands and Housing, 1999.

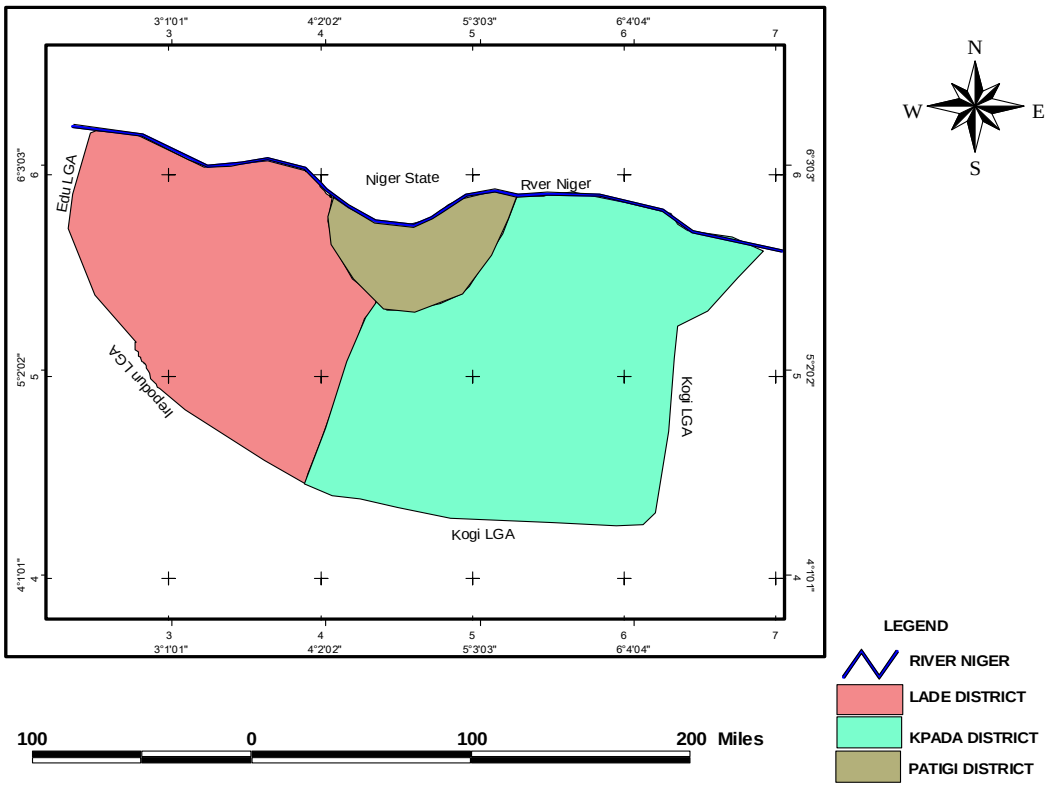


Figure 2: Locational Map of Patigi LGA
Source: Kwara State Ministry of Lands and Housing and Authors' Laboratory work, 2008.

MATERIALS AND METHODS

Thirty-two locations of the major existing rice fields in Patigi Local Government Area of Kwara State were identified using Global Positioning System (GPS). The coordinates were taken on districts basis (Patigi has 13 points, Lade has 7 points and Kpada has 12), which are in degrees, minutes, and seconds and thereafter converted into Universal Traverse Mercator (UTM) for easy manipulations). In order to elicit attributes of each of the locations, two hundred and twenty-four questionnaires were distributed using stratified random sampling technique (i.e. seven questionnaires per each of the 32 Rural Village Areas).

To create database for Crop Information System, the map of Patigi Local Government Areas was extracted, Geo-referenced and digitized from the 1:50,000 topographical map of Kwara State (Kwara State Ministry of Land and Housing, 1996). The map was scanned electronically to convert map lines and points into digital form. Thereafter, this was digitized on screen. Identities of the objects on the map as well as their spatial relationships were then specified. The attributes of rice fields available were linked to the spatial data with Arcview 3.2a GIS software.

The GPS data generated were stored in a relational database, which consist of core dataset (rice points and unique ID) to which the associated spatial data (X,Y coordinates) stored in tables prepared with Arcview 3.2a GIS software were linked. Basically, all data collected through different methods and sources were subjected to Geographic Information System treatment. Spatial searches were carried out to verify and demonstrate the utility of the database created as decision making tool.

RESULTS AND DISCUSSIONS

Rice Growing Points in Patigi Local Government Area

Various locations where rice grows within the study area were identified and shown in figure 3. This shows the predominance of rice farming activity in all the districts under study. That is why Selbut (2003) said that Kaduna State, Kogi State, Kwara State, Niger State and Enugu State, (all in Nigeria) fall under the River Niger drainage system, which is very favorable for rice production.

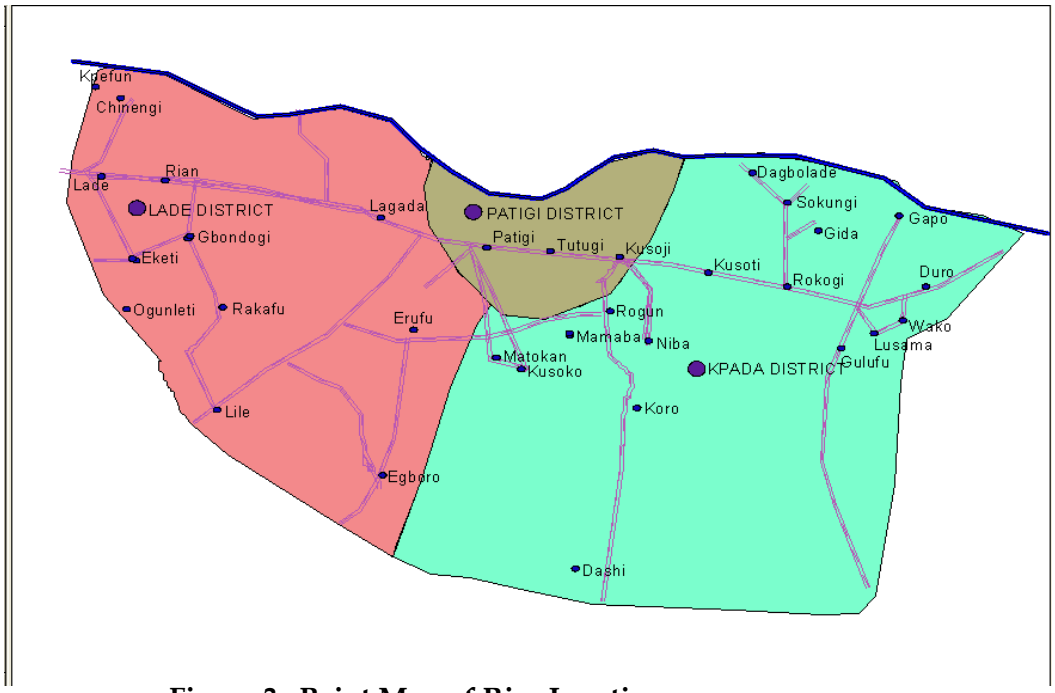
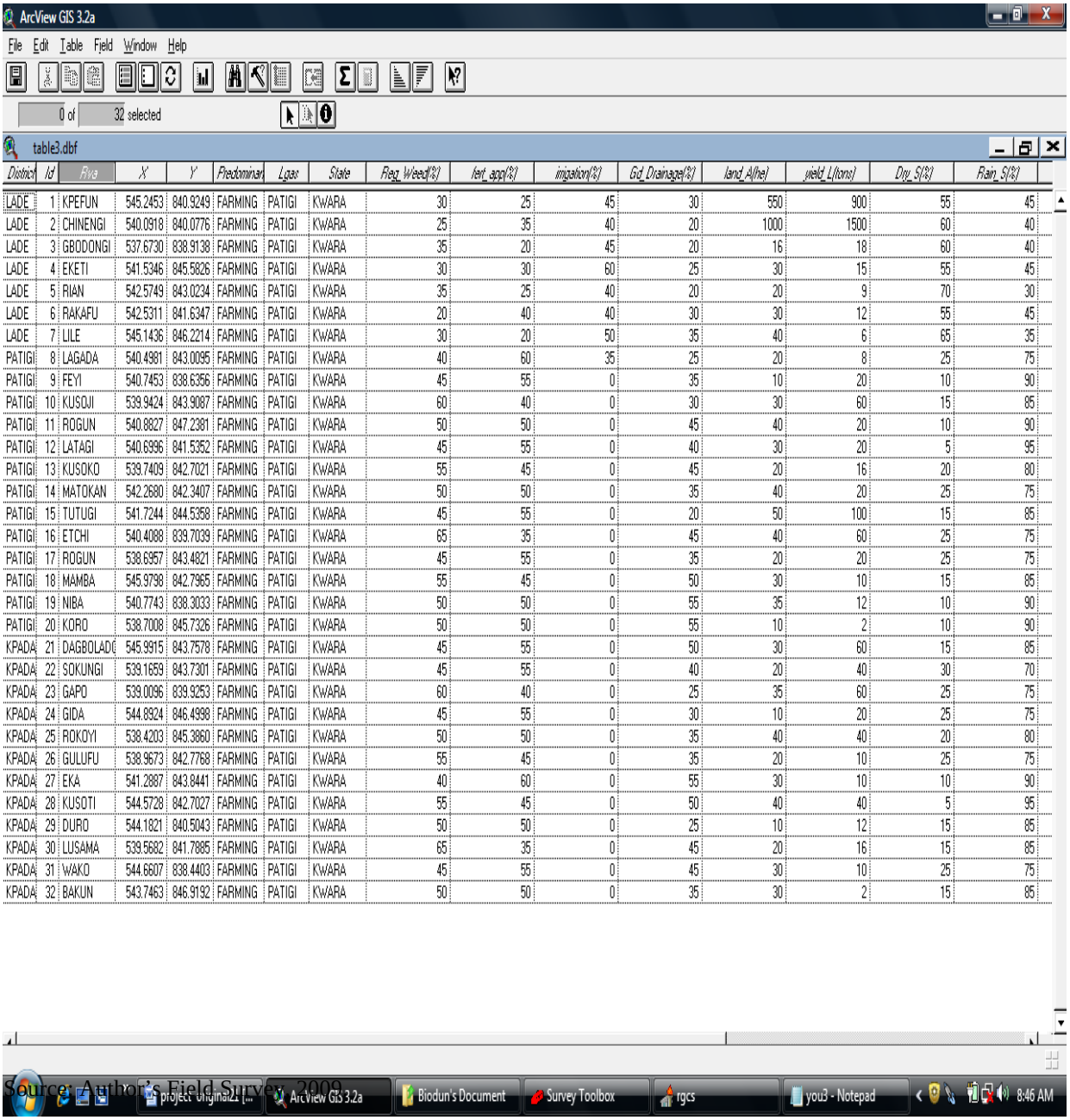


Figure 3 : Point Map of Rice Location

Source: Author's field survey, 2008

Database for Crop Information System (CIS)

Table 1: General Database for Crop Information System (CIS)



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District	Id	Riva	X	Y	Predominan	Lgas	State	Req_Weed(%)	fert_appl(%)	irrigation(%)	Gd_Drainage(%)	land_A(ha)	yield_L(tons)	Dry_S(%)	Rain_S(%)
LADE	1	KPEFUN	545.2453	840.9249	FARMING	PATIGI	KWARA	30	25	45	30	550	900	55	45
LADE	2	CHINENGI	540.0918	840.0776	FARMING	PATIGI	KWARA	25	35	40	20	1000	1500	60	40
LADE	3	GBODONGI	537.6730	838.9138	FARMING	PATIGI	KWARA	35	20	45	20	16	18	60	40
LADE	4	EKETI	541.5346	845.5826	FARMING	PATIGI	KWARA	30	30	60	25	30	15	55	45
LADE	5	RIAN	542.5749	843.0234	FARMING	PATIGI	KWARA	35	25	40	20	20	9	70	30
LADE	6	RAKAFU	542.5311	841.6347	FARMING	PATIGI	KWARA	20	40	40	30	30	12	55	45
LADE	7	LILE	545.1436	846.2214	FARMING	PATIGI	KWARA	30	20	50	35	40	6	65	35
PATIGI	8	LAGADA	540.4981	843.0095	FARMING	PATIGI	KWARA	40	60	35	25	20	8	25	75
PATIGI	9	FEYI	540.7453	838.6356	FARMING	PATIGI	KWARA	45	55	0	35	10	20	10	90
PATIGI	10	KUSOJI	539.9424	843.9087	FARMING	PATIGI	KWARA	60	40	0	30	30	60	15	85
PATIGI	11	ROGUN	540.8827	847.2381	FARMING	PATIGI	KWARA	50	50	0	45	40	20	10	90
PATIGI	12	LATAGI	540.6996	841.5352	FARMING	PATIGI	KWARA	45	55	0	40	30	20	5	95
PATIGI	13	KUSOKO	539.7409	842.7021	FARMING	PATIGI	KWARA	55	45	0	45	20	16	20	80
PATIGI	14	MATOKAN	542.2680	842.3407	FARMING	PATIGI	KWARA	50	50	0	35	40	20	25	75
PATIGI	15	TUTUGI	541.7244	844.5358	FARMING	PATIGI	KWARA	45	55	0	20	50	100	15	85
PATIGI	16	ETCHI	540.4088	839.7039	FARMING	PATIGI	KWARA	65	35	0	45	40	60	25	75
PATIGI	17	ROGUN	538.6957	843.4821	FARMING	PATIGI	KWARA	45	55	0	35	20	20	25	75
PATIGI	18	MAMBA	545.9798	842.7965	FARMING	PATIGI	KWARA	55	45	0	50	30	10	15	85
PATIGI	19	NIBA	540.7743	838.3033	FARMING	PATIGI	KWARA	50	50	0	55	35	12	10	90
PATIGI	20	KORO	538.7008	845.7326	FARMING	PATIGI	KWARA	50	50	0	55	10	2	10	90
KPADA	21	DAGBOLADE	545.9915	843.7578	FARMING	PATIGI	KWARA	45	55	0	50	30	60	15	85
KPADA	22	SOKUNGI	539.1659	843.7301	FARMING	PATIGI	KWARA	45	55	0	40	20	40	30	70
KPADA	23	GAPO	539.0096	839.9253	FARMING	PATIGI	KWARA	60	40	0	25	35	60	25	75
KPADA	24	GIDA	544.8924	846.4998	FARMING	PATIGI	KWARA	45	55	0	30	10	20	25	75
KPADA	25	ROKOYI	538.4203	845.3860	FARMING	PATIGI	KWARA	50	50	0	35	40	40	20	80
KPADA	26	GULUFU	538.9673	842.7769	FARMING	PATIGI	KWARA	55	45	0	35	20	10	25	75
KPADA	27	EKA	541.2887	843.8441	FARMING	PATIGI	KWARA	40	60	0	55	30	10	10	90
KPADA	28	KUSOTI	544.5728	842.7027	FARMING	PATIGI	KWARA	55	45	0	50	40	40	5	95
KPADA	29	DURO	544.1821	840.5043	FARMING	PATIGI	KWARA	50	50	0	25	10	12	15	85
KPADA	30	LUSAMA	539.5682	841.7885	FARMING	PATIGI	KWARA	65	35	0	45	20	16	15	85
KPADA	31	WAKO	544.6607	838.4403	FARMING	PATIGI	KWARA	45	55	0	45	30	10	25	75
KPADA	32	BAKUN	543.7463	846.9192	FARMING	PATIGI	KWARA	50	50	0	35	30	2	15	85

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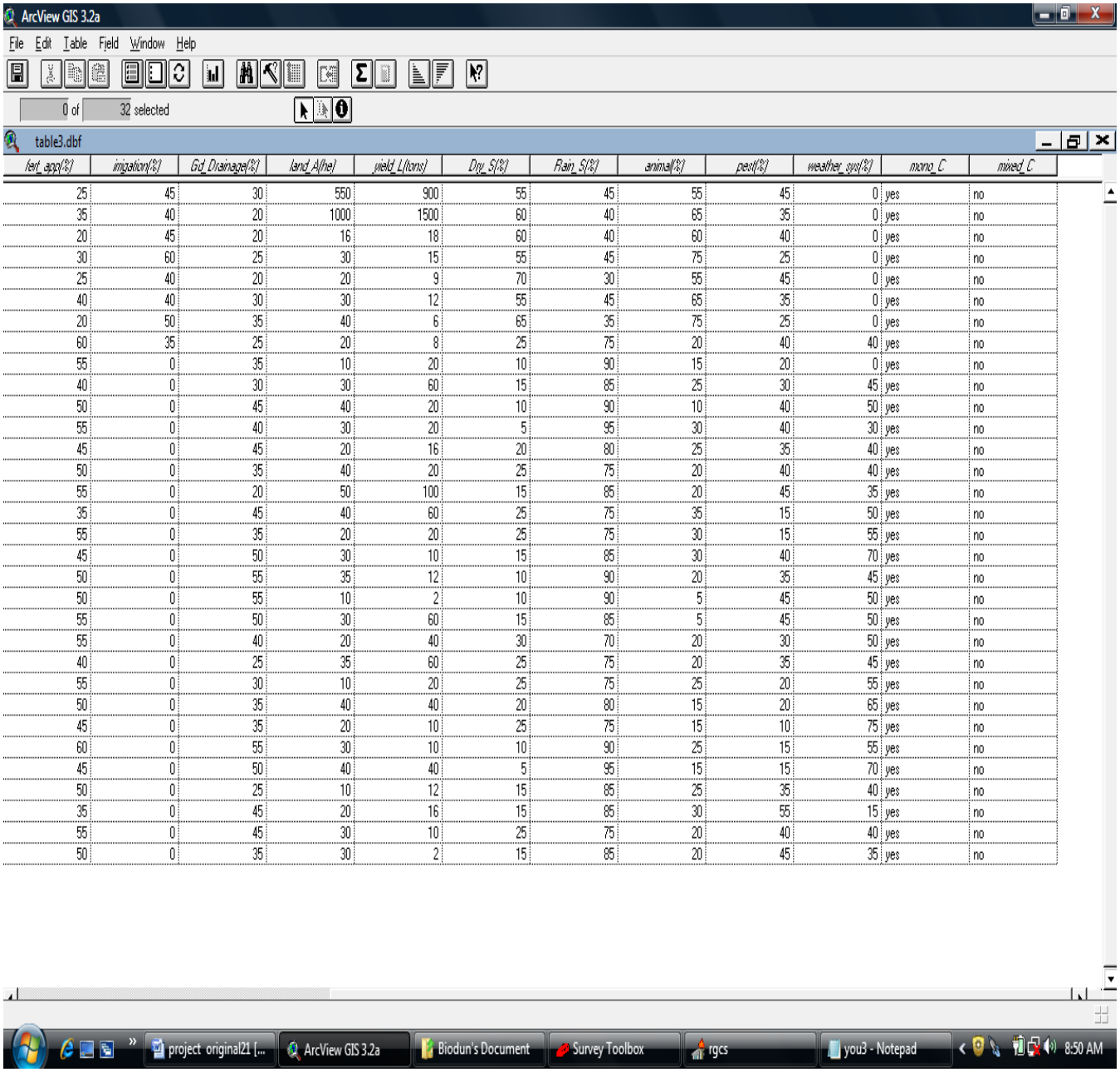
Source: Author's Field Survey, 2009

Table 1 (Cont'd)



fert_app(%)	irrigation(%)	Grd_Drainage(%)	land_A(ha)	yield_L(tons)	Dry_S(%)	Rain_S(%)	animal(%)	pest(%)	weather_sys(%)	mono_C	mixed_C
25	45	30	550	900	55	45	55	45	0	yes	no
35	40	20	1000	1500	60	40	65	35	0	yes	no
20	45	20	16	18	60	40	60	40	0	yes	no
30	60	25	30	15	55	45	75	25	0	yes	no
25	40	20	20	9	70	30	55	45	0	yes	no
40	40	30	30	12	55	45	65	35	0	yes	no
20	50	35	40	6	65	35	75	25	0	yes	no
60	35	25	20	8	25	75	20	40	40	yes	no
55	0	35	10	20	10	90	15	20	0	yes	no
40	0	30	30	60	15	85	25	30	45	yes	no
50	0	45	40	20	10	90	10	40	50	yes	no
55	0	40	30	20	5	95	30	40	30	yes	no
45	0	45	20	16	20	80	25	35	40	yes	no
50	0	35	40	20	25	75	20	40	40	yes	no
55	0	20	50	100	15	85	20	45	35	yes	no
35	0	45	40	60	25	75	35	15	50	yes	no
55	0	35	20	20	25	75	30	15	55	yes	no
45	0	50	30	10	15	85	30	40	70	yes	no
50	0	55	35	12	10	90	20	35	45	yes	no
50	0	55	10	2	10	90	5	45	50	yes	no
55	0	50	30	60	15	85	5	45	50	yes	no
55	0	40	20	40	30	70	20	30	50	yes	no
40	0	25	35	60	25	75	20	35	45	yes	no
55	0	30	10	20	25	75	25	20	55	yes	no
50	0	35	40	40	20	80	15	20	65	yes	no
45	0	35	20	10	25	75	15	10	75	yes	no
60	0	55	30	10	10	90	25	15	55	yes	no
45	0	50	40	40	5	95	15	15	70	yes	no
50	0	25	10	12	15	85	25	35	40	yes	no
35	0	45	20	16	15	85	30	55	15	yes	no
55	0	45	30	10	25	75	20	40	40	yes	no
50	0	35	30	2	15	85	20	45	35	yes	no

Source: Author's Field Survey, 2009.

The map of Patigi Local Government Areas was extracted, Geo-referenced and digitized from the 1:50,000 topographical map of map of Kwara State (Kwara State Ministry of Land and Housing, 1996). This was done through hand-traced with a computer mouse to collect the coordinates of features. An electronic scanning device was also used to convert map lines and points into digital data. Identities of the objects on the map as well as their spatial relationships were then specified. The attributes of rice fields available were linked to the spatial data with Arcview 3.2a GIS software. Some other related information such as location (LGA, District, and Rural Village Areas), Roads, Drainage, Crop (rice yield level, methods of crop management) were linked together (see Table 1).

The GPS data generated were stored in a relational database, which consist of core dataset (rice points and unique ID) to which the associated spatial data (X,Y coordinates) stored in tables that were prepared with Arcview 3.2a GIS software were linked. Basically, all data collected through different methods and sources were subjected to Geographic Information System treatment through specific GIS software known as Arcview 3.2a version. Attribute tables was created and linked to the map in ArcView 3.2a software environment with the Universal Trasverse Mercator Projection Coordinate System of the dataset. In the Arcview GIS environment, the point coordinates of the major rice field locations were imported into Arcview GIS through the Add Event Theme in the Theme Menu after saving the coordinate generated in Notepad (as delimited text file) and finally converted to dBASE (dbf) for editing.

Spatial Searches/Queries

Field search

This aspect of the geographic queries allows for specific searches to be made directly on the map. Here, the verifier would access both the spatial and attribute data by clicking on a point. For instance, a field search was made for Lade district in Patigi Local Government Areas where rice irrigation scheme is concentrated (see figure 4).

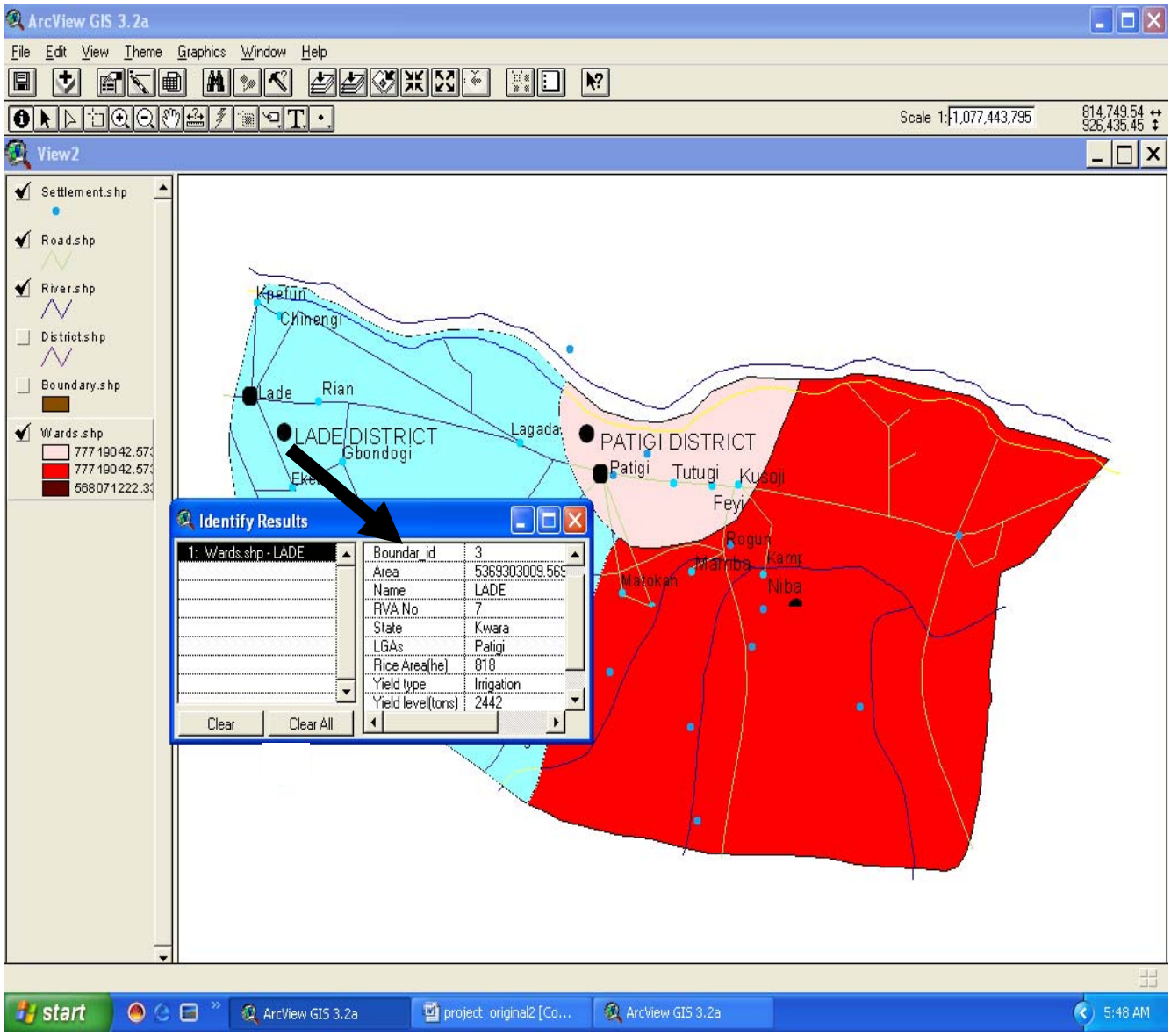


Figure 4: Lade Identities are Displayed for District Identification
Source: Author's Field Survey, 2009.

Distance search

This is to find an object located within a definite distance to a given point. The closest Rice fields to Rivers were queried and turned to yellow, while those ones that are not close turned blue. Hence, the yellow ones are referred to as Low Land Rice Field (LLRF) and the blues as High Land Rice Field (HLRF) (figure 5).

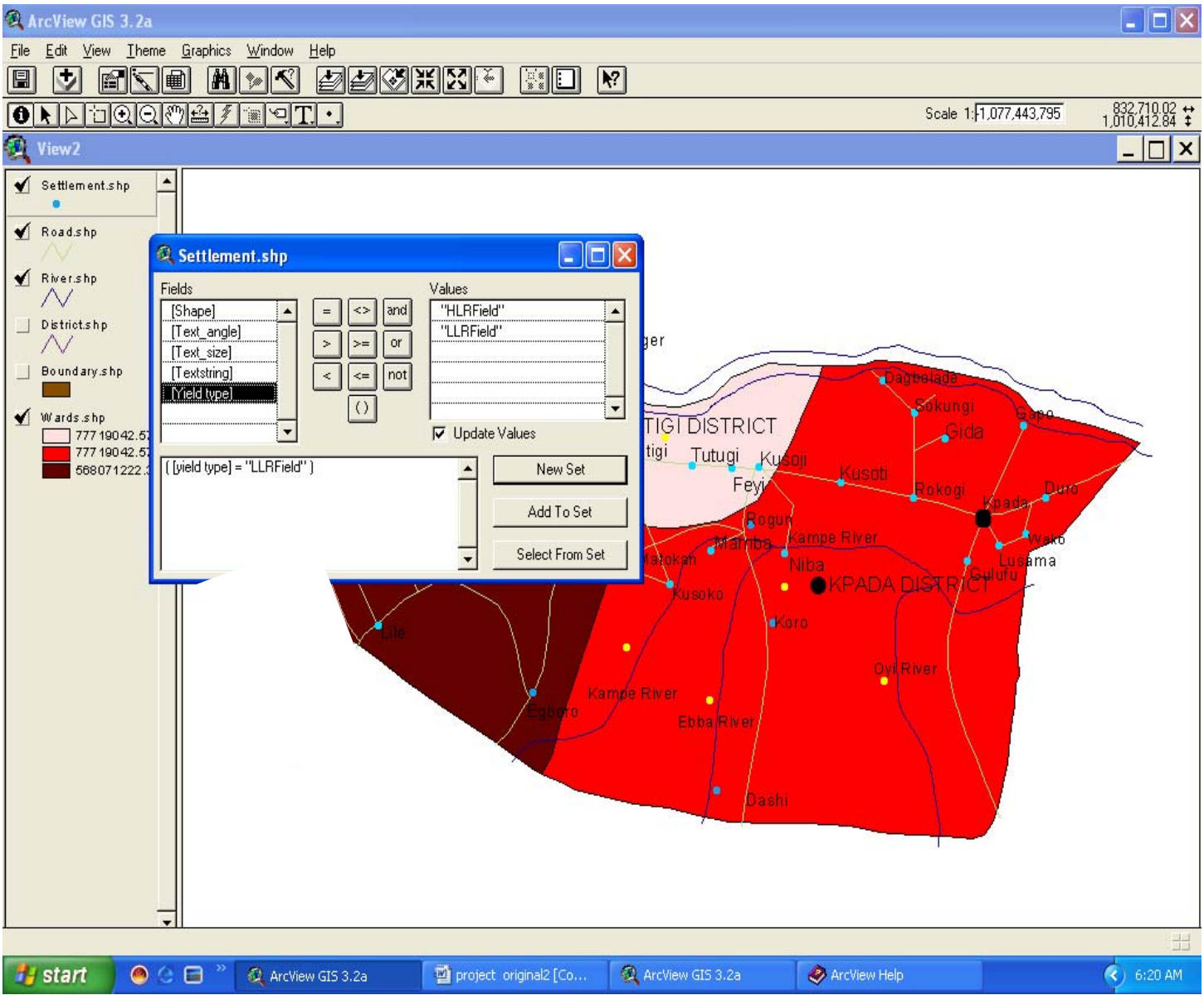


Figure 5: Crop Type Identification -HLRField and LLRField are Identified
Source: Author's Field Survey, 2009.

Information search

This is a geographic query that deals with specific information search. For instance, each district under consideration could be sorted for definite details regarding to rice production. Here, Patigi district is queried to examine its locational point in figure 6. Thus, it turns to yellow.

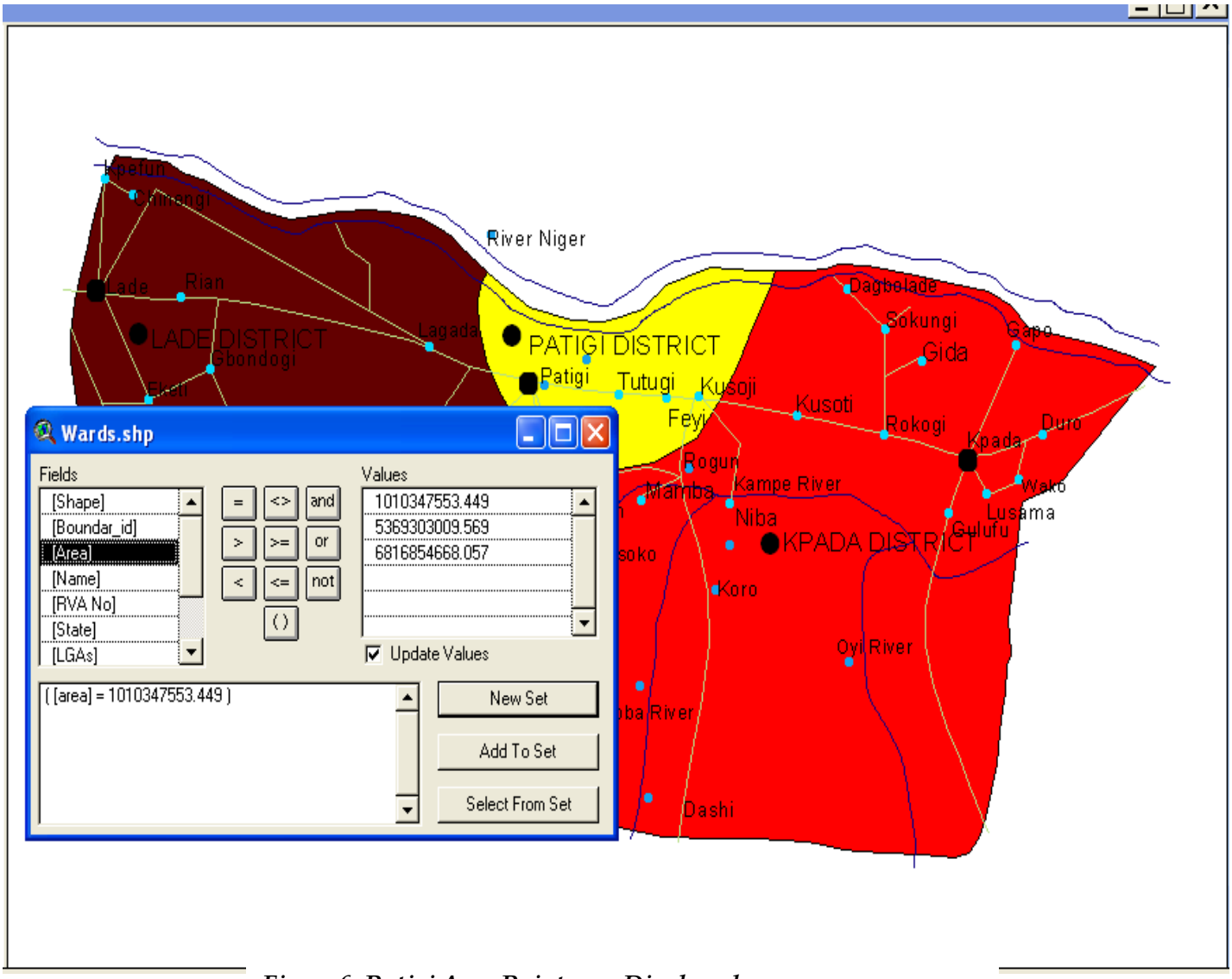


Figure 6: Patigi Area Points are Displayed
Source: Author's Field Survey, 2009.

CONCLUSIONS AND RECOMMENDATIONS

In this study, a comprehensive database on Crop Information System (CIS) for sustainable rice production has been created. This is expected to allow the farm managers and decision makers to carry out more research on what, where, and how best could this be of benefit in various systems/methods of farming for sustainable rice production.

Both the spatial and the attribute data were created for the purpose of comprehensive decision making in geographic scope. This has made it to be simply recognized that database is the heart of GIS without which no queries can be done. All

the geographic queries carried out in this research were as a result of the available database, such that when there is a click on any feature, the spatial and attribute data are easily displayed.

Based on the findings and conclusions of this study, the following recommendations are offered for consideration on sustainable agricultural development within the policy frame: Regular up-date of this comprehensive geographic database through which specific site could be sought to know what is obtainable in that particular field or district through a link between geometric and attribute data. This will enable the decision making bodies to have access to information on each feature under query and at the same time improve upon them. Government should encourage the development of Crop Information System (CIS) for all crops in the entire state and Nigeria as a whole.

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