AGRICULTURAL LANDUSE PLANNING AND MANAGEMENT IN KADAWA IRRIGATION SCHEME, KANO STATE

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ABSTRACT

Data from NigeriaSat-1 and ILWIS; a geographic information system (GIS) were used to assess the current and potential landuse in the Kadawa sub-sector of the Kano River Irrigation Project. Existing soil map of Kadawa at 1:25,000 and topographic map at 1:50,000 were digitized and used to obtain the land suitability/potential landuse map. Supervised algorithm was employed in the classification of the December 2003 NigeriaSat-1 image of Kadawa area. Overall, rainfed agriculture remained the predominant landuse, accounting for close to 50 percent of the total land area. The different land utilization types within the irrigated areas could not be discriminated at the scale of the study. As a whole, irrigated agriculture accounted for only 5 percent of the total land area. The most comparative advantage of the NigeriaSat-1 is the provision of the most recent source of image for the country at affordable cost in local currency (Naira). Assessment of the adequacy of current landuse management shows that only 36 percent of the total land area is properly managed while 41 percent of the land area is categorized as over-utilized. Within this over-utilized land, the most severe environmental problems are envisaged to be caused by intensive-use established on soils of moderate and marginal suitability. Within the Kadawa sub-sector of the Kano River Irrigation Project serious problems of rising groundwater table and salinity are some of such environmental degradation.

A paper presented at the

INTRODUCTION

In Nigeria, the concept of land sustainability does not feature prominently in legislation or policy. The Land Use Degree No. 6 of 29 March 1978 has been very controversial. Even then, it neither ensures that land use is sustainable nor on- and off-site effects of particular land uses are environmentally acceptable (Anyadiegwu, 1980). To ensure sustainable land management, land degradation, which is a common phenomenon in the arid and semi-arid regions, has to be checked. Although, causal factors of land degradation are mainly natural, inappropriate land uses enhance the degradation processes.

Earth resource satellites provide cost-effective data that have been widely used for natural resource mapping and monitoring (Wilde *et al*., 1996). In developing countries however, availability of high resolution remotely sensed data is often limited either by coverage or cost of image acquisition (Rembold *et al*., 2000). The introduction of NigeriaSat-1 in September 2003 with Nigeria as its primary area of coverage and possible image acquisition in local currency (Naira) seems to be a right step in the right direction. However, being a new satellite data, testing of the image for several applications is necessary even though the images are similar to images from other medium – resolution satellite like Landsat and SPOT. The result from such tests would give credence to NigeriaSat-1 among Nigerian users and decision makers.

This article therefore, aims at

i. testing the accuracy of the information obtained from NigeriaSat-1 for digital mapping and delineating different current land use patterns in an irrigated area around Kadawa, Kano State.

ii. evaluating the possibility of using the data from NigeriaSat-1 to generate an automated potential land use capability classification and assessing the impact of landuse management on the environment.

BACKGROUND

The Kano River Project (KRP) lies between 11^{o} 30' – 12^{o} 03' N and 8^{o} 30' – 9^{o} 40' E within the Hadejia Jama'are River Basin in Nigeria (Owonubi *et al.,* 1993). This project is the largest and the most successful irrigation scheme in the country with a development potential of 61,000 ha of irrigable land.

The ecology of the Kano River Project is Sudan savanna divided into three main seasons. These are:

i. the cool dry season from October to February

ii. the hot dry season from March to May

iii. the warm rainy season from June to September

The warm rainy season is traditionally the farming period for rainfed crops. Rainfall is highest in July and August during which precipitation exceeds potential evaporation. The average annual rainfall (30 years) is about 860 mm (Owonubi *et al*., 1993). Crops grown during the rainy season include rice, sorghum, groundnuts, cowpea, maize and vegetables. By the onset of the cool dry season, most rainfed crops have been harvested and the northeastern dry, cool, harmattan winds prevail. This season is favorable for the cultivation of wheat, Irish potatoes, and vegetables such as tomatoes and carrots in the area.

Geologically, the Kano River Project area belongs to the northern Nigeria Basement Complex. The dominant rock types are granitic gneisses and schists. The

geology is highly weathered and dissected by many rivers. The original geology is covered in many places by alluvial and aeolian materials. Soils of the Kano River Project area belong to the Eutric Cambisols and are classified as Typic Ustropept (Owonubi *et al*., 1993).

DATA ANALYSIS APPROACH AND METHOD

Data Acquisition

The digital data used in this study were collected by NigeriaSat-1 in December 2003 and it is a cloud-free image. The band numbers and wavelengths for the three bands are listed in Table 1.

Current Landuse

For the study of the current landuse, a subset of the image covering fields in and around Kadawa sub-sector was selected, consisting of about 86,000 ha of land or about 838800 32m pixels.

Supervised signature extraction method was used in classifying the image. The different crops under irrigation could not be discriminated at the resolution of the image. A generally classified image was therefore, prepared to be checked during fieldwork, and use subsequent feedback from the field to adapt and refine the original training samples especially among the irrigated crops.

Fieldwork

The fieldwork was carried out in March 2004. The aim was to identify the major landuse/land cover types especially for the various crop types within the irrigated crop class and also to confirm for areas of uncertainty. With the aid of GARMIN GPS, SOFTWARE version 4.52 (GARMIN, 1999), which was hand held and sometimes mounted in the vehicle, coordinates of locations to ± 3m accuracy for more than seventy

locations visited were obtained and their landuse noted. At each location, data on crop type, both growing and harvested, farm size and other physiographic features were noted.

Land Suitability Evaluation

The main components of this investigation included:

i. Establishing homogeneous soil units from an earlier soil map, which had soil series. The soil map at 1:25000 scale was digitized.

ii. Generating a slope map of the study area using the contours from the 1:25000 soil map of Kadawa and the 1:50000 topographic map.

a. A simplified land suitability evaluation was carried out using the soil properties of soil depth, drainage, topography, texture and slope.

iv. The legend of the current landuse/land cover map was reduced to three different categories of land use intensity. To compare the supervised landuse/land cover classification map with the land suitability map, the land suitability map was re-sampled from 50 to 32 m pixel size. Finally the actual and potential landuse maps were compared using a simple cross-tabulation algorithm, which created both a new map and a table (Table 4). Area affected by over- or under-exploitation was evaluated by comparing the level of current utilization against their potential capability.

RESULTS AND DISCUSSION

Current Landuse/Land Cover

Rainfed agriculture is the predominant landuse in the study area accounting for close to 50 percent of the total land area (Table 5). Sorghum-millet-cowpea is the major crop rotation practiced in the rainfed agriculture area. The irrigated area (Table 2) could

not be discriminated into individual landuse at the scale of mapping used in the study and were collectively grouped together as one. Owonubi *et al*.(1993) identified wheat as the main land-utilization type within the irrigated areas in the 1980s. In this present study however, over 80 percent of the total irrigated fields were planted to vegetables mainly tomatoes.

Land Suitability/Potential Landuse

A generalized suitability evaluation of the soil map shows that climatic limitations are prevalent in the study area. Good or very suitable lands for irrigation covers only 15700 ha, about 18 percent of the total land area (Table 6). Such lands with deep soil depth, well drained with flat slopes were only identified in soil units Pa2 and Hta2. The bulk of the soils of the project area belong to the marginally suitable class. As much as 70 percent of the soils have either laterite at shallow depths, rock outcrops, poor drainage or are coarse-textured.

Adequacy of Landuse Management

Table 4 shows a numerical assessment of the adequacy of landuse management in the study area. Only 36 percent of the total land area is properly managed i.e. highly suitable land is located to intensive-landuse. Current use therefore, fits the land suitability potentials. About 23 percent of the land area is under-utilized. These are areas of high suitability being utilized for moderate and extensive intensity-use, and also areas of moderate suitability being allocated to extensive-use. The remaining 41 percent of the land area are categorized as over-utilized. Within this land, most severe environmental problems are envisaged to be caused by intensive-use established on soils of moderate and marginal suitability.

CONCLUSION AND RECOMMENDATION

Periodic assessment of current and potential landuse in an agrarian economy is vital to preventing land and environmental degradation. Data from NigeriaSat-1 could be used for such assessment. In order to meet the increasing demand for food and other agricultural products, vertical increase in production is imperative. The use of remote sensing in a GIS environment becomes critical. This is because the question is not whether landuse intensification is possible but where such land is located. In this study, using data from NigeriaSat-1 gives an indication that about a fifth of the land could be further intensively managed with minimum risk of degradation.

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Table 1: NigeriaSat-1 Bands and study site statistics

Band	Wavelength (um)	Mean data value	Standard deviation
1	0.52-0.62	66.19	42.99
2	0.63-0.69	59.03	38.70
3	0.76-0.90	69.36	44.89

Table 2: Classification schemes used in supervised classification

Inital classification before fieldwork	Final classification for fieldwork	Final classification after fieldwork
1. Irrigated crops i. Wheat ii. Rice iii. Tomatoes iv. Onion v. Maize vi. Vegetables	1. Irrigated crops	1. Irrigated crops
2. Non irrigated crops	2. Non irrigated crops	4. Rainfed/Non irrigated arable land with dense tr
3. Fallow	3. Fallow land	5. Rainfed/Non irrigated arable land with sparse t
4. Settlement	4. Settlement	6. Settlement
5. Bare soil/Rock outcrop	5. Bare soil	7. Fallow/Bare soil/Rock outcrop
6. Forest reserve	6. Forest /woodland	8. Forest reserve/woodland
7. Water body	7. Water body	9. Water body

Table 3: Legend for potential landuse capability classification

Properties	CLASS		
	I	II	III
Soil depth (cm)	Deep	Moderate	Shallow
	> 120	50 - 120	< 50
Draiange	Well	Imperfect	Poor
Topography	Upland plain	Higher terrace	Lower terrace
Slope (%)	0 – 2	2 - 4	>4
Surface soil texture	Loam	Sandy Loam	Loamy sand; Clay; clay loam

Table 4: Potential versus actual landuse (in ha)

Actual/Potential Landuse	High-Intensive	Moderate-Intensive	Marginal-Intensive
Intensive	4399	6697	7817
Moderate	1317	10515	4914
Extensive	2821	31038	39,228

Table 5: Details of landuse/land cover

Landuse	Area (ha)	Percentage
Irrigated area	4399	5
Rainfed with dense vegetation	14885	17
Rainfed with sparse vegetation	27377	32
Fallow	5380	6
Forest/woodland	15677	18
Settlement	5498	7
Rock outcrop/Eroded land	11948	14
Water bodies	725	1
Total	85889	100

Table 6: Summary of broad land suitability grouping

Suitability Class	Area (ha)	Percentage
Good	15705	18
Moderate	10515	12
Marginal	59669	70
Total	85889	100