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APPLICATION OF GEOGRAPHICAL INFORMATION SYSTEM (GIS) IN SOIL SURVEY EXERCISE A NEW METHODOLOGY FOR INCREASED PRECISION

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ABSTRACT

A study was carried out at the Ikwuano, L.G.A., of Abia State Nigeria, where a satellite based technology tool was employed in locating sampling (auger observation) points for a soil survey exercise. Specific coordinates were loaded into a global positioning system (GPS) and the GPS was subsequently used to locate each sampling point without having to cut transverses as in conventional soil survey. The result of this study shows that time consuming and costly procedure can be avoided and increased precision and analytical capabilities achieved.

INTRODUCTION / BACKGROUND TO STUDY

Current methods of agricultural land evaluation suffer from a number of inherent deficiencies that limits their usefulness as a tool for land use planning (Johnson, et al, 1994). Before now in Nigeria, the conventional method of determining the sampling pints (auger observation points or identification observation) in a soil survey exercise, involves the manual drawing of grid lines or transects on a base map at a pre determined scale. Each of these transects is drawn against the backdrop of a chosen base line (e.g a road, river, stream, etc).

The ground truthing and identification (or auger) observations are then done after the base map for the fieldwork has been prepared. This aspect of the work which aims at getting to each sampling point along each transect is quite tasking. A straight course for each transect must be maintained, and in which case where will be the need for a team of field hands/technical staff using survey equipments like: theodolite/ranging poles to cut through the landscape. (Or bush/forest). In a number of cases soil surveyors have had to cope with a lot of stress in locating these points and at some other times where transects are not properly cut, sampling points have been discovered to crisscross one another.

The above methodology is thus quite laborious, time consuming, very costly and highly prone to errors. Moreover, sampling points are not geo-referenced and so cannot be easily located again (months or years) after the initial sampling either for a follow up study or validation exercise, without the cutting of new transects (meaning more cost, time etc). By and large, soil survey in the time past was associated with a lot of stress and the product from such exercise lacked precision (Ojedele, 1999). There is therefore the need to exploit the use of improved options that are available for soil resources inventory. This study was thus aimed at demonstrating the use of Geographical information system (GIS) and the global positioning system (GPS) as a new way of creating a base map for soil survey and also locating sampling (auger) points in the field.

METHODOLOGY

Study Area

The study area Ikwuano Local Government Area of Abia State, Nigeria. The coverage of the area is 310km^2 and it lies between latitudes 5^0 18' and 5^{0}30'N and longitudes 7^{0}30' and 7^{0}41'E in the rainforest zone of Nigeria. The area has a humid tropical climate characterized by a distinct dry and wet seasons. It is also characterized by heavy precipitation of over 2,000mm per annum, mean minimum and maximum air temperature of 22.3^{0}C and 31.0^{0}C and mean annual soil temperature of 28.8^{0}C and relative humidity ranging from 66-79%. The geology of the area is sedimentary formation of coastal plain sand.

ANALOGUE DIGITAL CONVERSION OF PAPER MAP

The paper map of the study area is shown in Figure 1. It is a 1:100000 scale map obtained from the Abia State Ministry of Lands, Survey and Urban Planning Umuahia, Abia State, Nigeria.

Fig 1: Map of the Study Area.

The accuracy of map to be digitised was ensured by using three ground control points whose coordinates were obtained with the aid of a GPS (Fabiyi, 2001). The coordinates of these points were then used as standards during the digitisation of the map. This procedure ensured that the resulting map is accurately geo referenced to the earth surface. The GPS used in this study is the 2000 version of the handheld Garmin etrex 12 channel GPS (Garmin international corporation, Inc Kansas, USA) (Fig 2). Thereafter with the help of a digitiser and by using the cartographic package within the Arcview GIS software environment, the map units, page units, and distance units were specified to facilitate the digitising of the map. The gridding for the resulting map was set to have grid cells (or pixel) size of 1x1 kilometer which translates to a map scale of 1:100 000. The coordinates of each of the grid nodes, which represent the sampling points, were also read off within the Arcview GIS environment.

These coordinates were then programmed (or loaded) into the handheld GPS (Fig 2) as way points values with specific ID number.

Fig 2: The etrex 12 channel Global positioning system used in the study

RESULT AND DISCUSSION

The original map sourced from the state ministry of land, survey and urban planning was successfully digitised with the aid of the Arcview GIS software resulting in a map with Pixel size of 1x1 kilometer as the basic unit for analysis. The resultant map is down in Figure 3. The process was also able to give the co-ordinates of each of the grid nodes, which represents the sampling or observation points. Some of the coordinates are shown in Table 1. This procedure thus eliminates the problem of errors due to manual gridding and it saves time compared to the conventional method by cartography.

Table 1: Co-ordinates of some points on the digitised map.

POINTS	LATITUDE	LONGITUDE
A	7°33'00”E	5°28'30”N
B	7°34'00”E	5°28'30”N
C	7°35'00”E	5°28'30”N
D	7°36'00”E	5°28'30”N
E	7°37'00”E	5°28'30”N
F	7°34'00”E	5°28'30”N
G	7°34'00”E	5°24'30”N
H	7°35'00”E	5°24'30”N
I	7°36'00”E	5°24'30”N
J	7°37'00”E	5°24'30”N
K	7°33'00”E	5°22'30”N
L	7°34'00”E	5°22'30”N
M	7°35'00”E	5°22'30”N
N	7°36'00”E	5°22'30”N
O	7°37'00”E	5°22'30”N
P	7°36'00”E	5°21'30”N
Q	7°38'00”E	5°21'30”N
R	7°31'00”E	5°19'30”N
S	7°32'00”E	5°19'30”N
T	7°35'00”E	5°19'30”N

LOCATING SAMPLING POINTS IN THE FIELD

The coordinates for the sampling points were then loaded into the GPS as Waypoints. By the use of Go To command of the GPS, direction/guidance was obtained to each of the sampling point in the field each at the specified scale of mapping. Thus by this method, the cumbersome process of cutting transects using theodolite with much labour was avoided in that footpaths, roads etc can be followed to get to a point and circumventing obstacles. Hence with this handheld device (the GPS), which is electro magnetically connected to space borne satellites, location of sampling points, and augering were done easily. This is a great advantage over the conventional method of having to cut transects.

The use of this GPS thus quickens the time for soil mapping hence several months work could be achieved in far less period of time. The GPS was also able to provide other data like, speed, direction of movement, time, distance to destination, bearing, elevation, time of sunrise/sunset, trip odometer. And so with a GPS one can know where one is, where one had been and where one is going.

Also with the use of the Arcview GIS software, the digitised map (Fig. 3) was stored electronically in the computer and in diskettes. Hence the map could be edited easily. In the case of the conventional paper maps, once it is drawn and final copy made, any editing or review or changes will involve the drawing of an entirely new map at great cost and time. Also with this GIS/GPS technology data generated in field can incorporated in to create various thematic maps of the same area and scale but with specified themes e.g pH, CEC, available nitrogen, etc, without having to draw fresh maps. This method thus provide opportunities for the reproduction of maps, easy linkage to generate new overlays. It is also cost effective and time saving.

CONCLUSION:

The GIS and GPS provide a quick and accurate way of creating a base map and collection/storage of data in the field. It thus promises to be a utility tool for qualitative data generation.

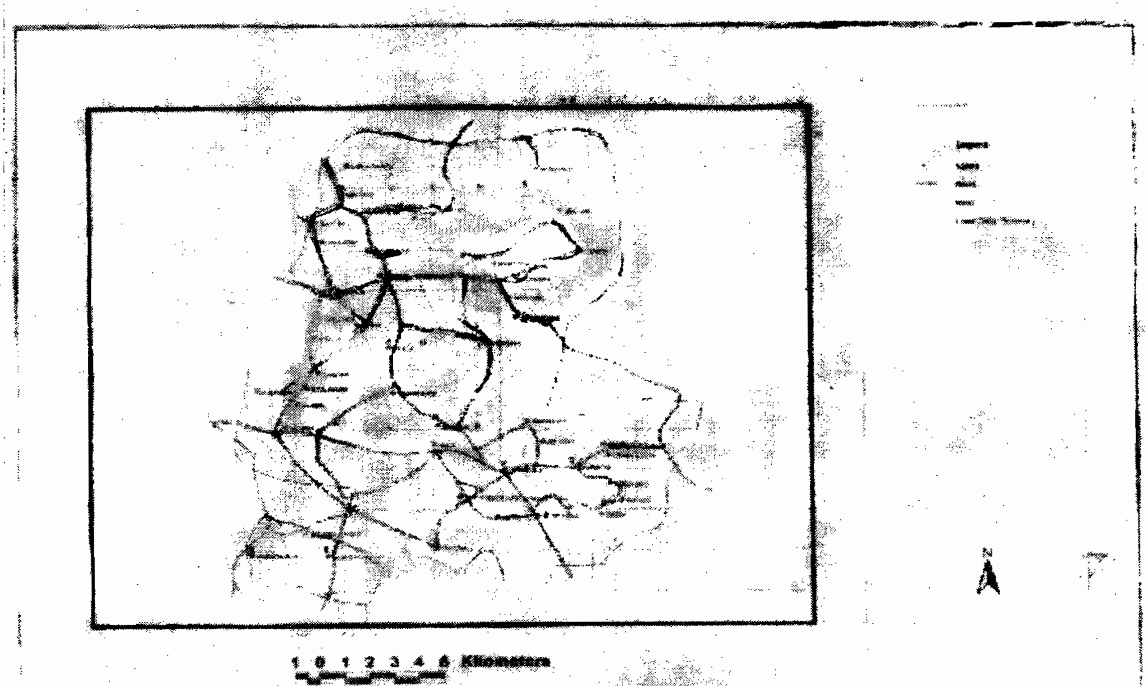

Fig. 3: Digitized map of the study area.

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