Multipurpose Cadastre: An Under-utilized NGDI Dataset

Eugene Chukwunwike ONYEKA, Nigeria

Key words: Multipurpose, Cadastre, NGDI, Landparcel, Attribute

SUMMARY

Cadastre started simply as a public register of land boundaries and later went on to include the various other interests in the land. The twin concepts of planning and management were introduced over the ensuing centuries and millennia and required the incorporation of other available information concerning the land parcel. From this stage, what had started simply as cadastre became multipurpose cadastre. This development substantially increased the usefulness of cadastre and made it much more relevant to the needs of the society. However, it became impracticable to have so much information on one map or to handle and combine too many map themes of the same geographical area. With the introduction of computers into multipurpose cadastral processes it became possible to hold the various map themes in different layers, attach attribute data to them using Database Management System and combine or disaggregate them in a GIS environment according to any desired purpose. But multipurpose cadastre is ordinarily limited to only a single land parcel. In order to derive maximum benefit from multipurpose cadastre it is necessary to take cadastre beyond the single land parcel and to cover the entire country in a national multipurpose cadastre. In this way, multipurpose cadastre can become one of the most widely and frequently used datasets in a National Geospatial Data Infrastructure. This paper explains some of the numerous benefits envisaged from multipurpose cadastre as a fundamental dataset. It discusses the essentials of a national multipurpose cadastre, evaluates the status of these essentials in Nigeria and points out where the prevailing conditions cannot support national multipurpose cadastre. In such situations, it proffers solutions. In addition to technical issues, the all-important question of sustainability is also addressed.

Multipurpose Cadastre: An Under-utilized NGDI Dataset

Eugene Chukwunwike ONYEKA, Nigeria

1. INTRODUCTION

Cadastre and land surveying are believed to have originated in ancient Egypt and were necessitated by the need to re-establish the boundaries of farm holdings after their obliteration by the annual floods. Egypt has had a cadastral system since about 3000 BC. In its original form cadastre was simply a public register of the land boundaries that defines the separate holdings of land. Subsequently, it included various other interests in the land holding. It was somewhere during the ensuing centuries and millennia that the twin concepts of planning and management were introduced (Binge, 2003). Before the system could be used for planning and management, it became necessary to incorporate every available information about the land parcel. Such information include the nature of the soil, the vegetation cover, the land use, any improvements such as buildings and details of the occupants, the slope and aspect of the land, drainage and details of the water, telephone and electricity services. Cadastre necessarily has to contain these records if it has to service the requirements of the society. Records such as these may be referred to as *Multipurpose Cadastre* and are concerned with the provision of reliable information for planning the better use and administration of land.

1.1 Multipurpose Cadastre, GIS and Geospatial Data Infrastructure

Any map which contains information on all of the above themes would certainly be overcrowded with details. The solution would have been to present information on each of the above themes on a separate map of the same parcel of land but, quite often, depending on the use to which the map is to be put, two or more of such maps may need to be combined. Thus, apart from the problem of having to deal with too many maps of the same parcel of land, there is also the issue of overlaying one map upon another map of the same parcel of land for a more detailed and multifunctional information.

In the early 1960s, computers were introduced into the field of multipurpose cadastre (often also called Land Information Systems (FIG 1998)). With the aid of the computer, it was possible to hold the various map themes in different layers. A layer is a logical separation of mapped information according to theme (Burrough 1987). The computer also made it possible to attach attribute data to the maps. This was achieved by the use of Database Management System (DBMS). A DBMS is an application software that facilitates the organization, storage and retrieval of data from a single database or from several databases. One of the most modern DBMS models is the relational database. It allows the interchange and cross-reference of data between different records. The relational database model got so popular that it became the computer industry’s standard (Rockester 1993). By 1992 the term GIS (Geographic Information System) had more or less been adopted as a general expression for all projects and systems that involved land management (Binge 2003). Today, GIS can be defined as an integrated computer information system designed for collecting, managing, displaying and analyzing large volumes of spatially referenced and associated attribute data (NASRDA 2003). Its overlay facility and spatial search are among the major assets of GIS. For instance, if there are two environmental datasets of a given geographical area such as soil types and crop productivity boundaries, the GIS can superimpose one dataset on the other. By so doing one can determine the most productive soil type for a specified crop. With several datasets more complex analysis can be carried out. The possibilities to query, retrieve, process and analyze information in a timely manner using a GIS have aggrandized the interest of both data users and producers. GIS, as the driving technology, is one of the most important components of Geospatial Data Infrastructure.

1.2 What is Geospatial Data Infrastructure (GDI)?

According to Groot (1998) Geospatial Data Infrastructure consists of the technology, policies, standards and institutional arrangements necessary to acquire, process, store, distribute, and improve the utilization of geospatial data from many different sources and for a wide group of potential users.

Since there are different national and transnational initiatives on GDI, the components of GDI are also seen differently. Whichever way it is seen, one of the backbones of GDI at any level is the interconnected geospatial databases consisting of the fundamental datasets and thematic datasets. While thematic datasets are application specific, fundamental datasets have national coverage and are needed consistently by more than one government agency in order to achieve their objectives (NASRDA 2003). Thus a fundamental dataset is considered necessary for most applications as compared to a thematic dataset which is required for a specific application. Following from this, a variable number of data layers considered to be of common use and of national or transnational importance is “fundamental”.

2. BENEFITS OF MULTIPURPOSE CADASTRE AS FUNDAMENTAL DATASET

2.1 Multipurpose Cadastre as Fundamental Dataset

From the foregoing, a dataset that makes the “fundamental” list should have a national coverage and should be considered necessary for most applications. The list is thus a variable one because the moment a dataset in the list ceases to satisfy the above requirements it ceases to be “fundamental”. Conversely, if a hitherto thematic dataset now satisfies the above requirements, it qualifies as a fundamental dataset.

We have seen that multipurpose cadastre contains every available data (both spatial and attribute) pertaining to a land parcel. Since its constituent layers contain almost any conceivable theme, when multipurpose cadastre is extended over the entire country in a national multipurpse cadastre, it should constitute one of the most widely used datasets in a National Geospatial Data Infrastructure (NGDI). This is in line with the recommendations of FIG-Commission 7 Working Group 1 “Vision Cadastre” looking at trends and developing visions for cadastral systems in 2014. The Bogor Declaration (United Nations 1996) states, among other things, that cadastral systems should be part of a national spatial data infrastructure.

2.2 Benefits of Multipurpose Cadastre

Numerous benefits are accruable from Multipurpose Cadastre as a fundamental dataset in a NGDI. Some of the benefits are:

2.2.1 Property Inventory

By assigning a common identification number to all land parcels belonging to the same person or organization, it is possible to have the list of all land parcels belonging to that person or organization. Conversely, it is possible to detect situations where the same parcel of land has been allocated to more than one person. Furthermore, by including chattels in the attribute record, movable items like machinery located on each land parcel can be listed.

2.2.2 Project Implementation and Monitoring

Multipurpose cadastre can facilitate the display of the geographic spread of government projects. By attaching attribute data to the project locations, such details as the sectoral groupings of the projects or the total cost of a project type within a state can also be displayed. Public administrators will certainly find this application area useful in justifying political decisions.

2.2.3 Crime Prevention and Detection

The police can include the criminal records of individuals in their multipurpose cadastral database. This will help them narrow down suspects when certain kinds of crime are committed. They would also be better placed to take steps to prevent the perpetration of certain crimes.

2.2.4 Utility Management

Utility Management refers to the act of organizing and controlling the proper use of the services provided for the public such as electricity, water, communication, mails, oil, gas and sewerage. These services are often provided along surface and underground lines referred to as utility lines. Proper distribution and management of utilities require a spatial inventory of the utilities and utility lines. With the aid of multipurpose cadastre, the management of public utilities would be able to know where their services are required. They would also be able to decide when available facilities in any of their areas of coverage are over-stretched due to increased population, and arrange for the upgrading of the facilities. The spatial inventory of utility lines also facilitates the location of an affected spot in the event of a problem and the prevention of damage to utility lines during construction work.

2.2.5 School Management

As cities and other settlements grow, the multipurpose cadastral database is updated. Primary and Secondary School Management Boards would be able to know when many children begin to travel unduly long distances in order to attend schools. The boards would then arrange for schools to be sited in their neighborhood.

2.2.6 National Identity Cards

Multipurpose cadastre would provide a solid database for a national identity card scheme since every citizen would be practically "georeferenced".

2.2.7 Census Mapping

Since multipurpose cadastre can display every land parcel in an area, it will prove beneficial as a census management tool. It will help to establish census tracts, and prevent tract overlaps or gaps. It will also identify completed and outstanding tracts and assist generally in census data maintenance since census is not necessarily a 10-year affair. Furthermore multipurpose cadastre can provide input for an indirect estimate of the population. This can be achieved by applying the number of residential buildings in an area to the average number of occupants per building.

2.2.8 Population Estimates

By having all the required information on persons living on all parcels of land within the country and updating them regularly, direct estimation of the national population together with such details as the age, occupation and sex of individuals would be reduced to a matter of compiling these already available details. This would be of immense benefit to planning agencies.

2.2.9 Electoral Processes

Transparent electoral processes are critical to the survival of democracies. Multipurpose cadastre can provide a transparent means of compiling and checking the voters register. It can also facilitate the effective siting of polling-booths, in the monitoring of elections and in the collation of election results.

2.2.10 Agricultural Yield Prediction

A land parcel, which is the unit of cadastre, is described by Dale (1976) as an area of land which may be identified as a unit for recording information and may, for example, be a field under uniform cultivation or a unit of ownership such as a residential plot of land. Multipurpose cadastre thus provides the basic unit for agricultural yield prediction. Healthy vegetation is infrared-reflective and advantage can be taken of this characteristic of healthy vegetation to monitor the performance of crops using satellite images, with the land parcel as the basic unit. In this way yield can be predicted and early arrangement made for storage, in the case of a bumper harvest, or for food imports in times of low yield.

The above list is by no means exhaustive. Multipurpose cadastre provides data at a micro level (parcel level) which generally allows for various kinds of detailed and accurate planning. However, certain fundamental requirements have to be satisfied before multipurpose cadastre can be effectively extended over the entire country for the greatest benefit to the society.

3. THE IMPERATIVES FOR A NATIONAL MULTIPURPSE CADASTRE

3.1 Spatial Reference Framework

Spatial Reference Framework, also called Geodetic Reference Framework, serves to give spatial meaning to the other datasets; it provides spatial compatibility between different spatial datasets; it is the foundation for the National Geospatial Data Infrastructure. Epstein (1998) defines geodetic reference framework as survey ground control system which consists of a set of monumented points whose relative locations are accurately measured according to well defined measurement standards. The word *standards* incorporates the choice of such parameters as the reference ellipsoid, the map projection, the meridian of reference, the co-ordinate system and its origin, the scale factor and such other parameters that govern the effective and practical use of the survey control system. It also includes the choice of an optimum geoid for the country.

The reference ellipsoid chosen for Nigeria is that whose dimensions were determined by the British geodesist, Alexander Ross Clarke, in 1880. It has a semi-major axis, *a*, of 6,378,249.145 meters and flattening, *f*, of 1:293.465. The adopted projection is the Transverse Mercator which has been modified to take care of the problems created by the shape and extent of the country. Transverse Mercator projection is suitable for countries like Nigeria with appreciable north-south extent (Nigeria extends from about latitude 4^o N to 14^o N) because the scale is true along the meridian of reference (central meridian) and scale errors increase in magnitude with increasing distance from the central meridian. Furthermore, because the country also has appreciable east-west extent (longitude 2^o 30’ E to 14^o 30’ E), it is divided into three belts each with its central meridian. The three central meridians are 4^o 30’ E, 8^o 30’ E and 12^o 30’ E, with 2^o of longitude on either side of each central meridian. Even with this, the scale error at the extremities of the belts are as much as 1/1,600 which is more than the linear error of 1/3,000 permitted for ordinary cadastral surveys. In order to take care of this problem, the surface of the earth is projected onto a sphere whose diameter is $1/4{,}000^{th}$ part less than the actual diameter of the earth. The projection is then made to a plane from the smaller sphere (Federal Republic of Nigeria, Federal Surveys Notes on Projection, Publication No 500/632/6-75). By this step, distances along the central meridian, which otherwise would be true, have been shortened by 1/4,000 of their true length and the maximum distortion along the edge of a belt has been reduced to approximately 3/8,000.

The geodetic co-ordinates (sometimes referred to as geographic co-ordinates) of latitude, longitude and height (Ø, λ, h) are used alongside rectangular grid co-ordinate systems and are mutually convertible. The real origin of each belt lies at the intersection of the central meridian with the parallel through the centre of the map, namely 9^{o} N. These origins are replaced by a false origin near the south-west corner of the map so chosen that all co-ordinates referred to it are positive. Although the co-ordinates of the Nigerian geodetic controls have not been subjected to least squares adjustment to ensure internal consistency (Nwilo 2003), they are generally serving the nation well. The problem is with the geoid.

The geoid, the equipotential surface of the earth's gravity field that is closest to mean sea level (Langley 1998) and to which heights should be referenced, has not been determined for Nigeria (Nwilo 2003). As a result, the geoidal undulations are not known except for a limited number of points whose heights have been determined by classical levelling techniques. The geoidal undulations, N, are required in order to obtain orthometric heights from the ellipsoidal heights readily provided by GPS receivers.

$$N = h - H$$

where h is ellipsoidal height
H is orthometric height.

The orthometric heights are usually desired in engineering and other large scale applications.

3.2 Current Large Scale Map of the Country

The geodetic reference framework mentioned above does not make practical sense to many users if there are no identifiable ground features to relate the spatial datasets to the ground. These features are provided by a seamless, current and digital large scale map covering the entire country and tied to the geodetic reference framework.

3.3 Cadastral Overlay Delineating all Cadastral Parcels

Another important requirement for a national multipurpose cadastre is a cadastral overlay delineating all cadastral parcels in the country. Each cadastral parcel is assigned a unique parcel identification number for purposes of information retrieval and for linking information in other files.

3.4 A Series of Attribute Datafiles

Attribute data are not normally entered on the spatial database for two main reasons. The first is that the spatial database would get overcrowded with the numerous attribute data usually involved. The second reason is that such a block entry does not allow for the manipulation of the various classes of attribute data, as may be desired. For these reasons, a separate attribute data file is created for each parcel. These files contain the parcel identification numbers of the relevant parcels for purposes of information retrieval and for linking information in other files.

3.5 File Linkage Facilities

File linkage entails assigning common identifiers, called link paths, to the set of records that are required to be linked. Several sets of links can be created and the records to be linked can reside in the same or in different databases. Using a query language, the link paths are used to manipulated the files and display any desired records. The extent to which the files can be manipulated will only be limited by the skill and imagination of the user and by the manner in which the database had been structured.

4. CURRENT CADASTRAL PRACTICE IN NIGERIA: PROBLEMS AND SOLUTIONS

The manner in which cadastre is currently practised in Nigeria does not lend it to use as a fundamental NGDI dataset. Some of the factors militating against its use are discussed below.

4.1 Lack of Awareness

One of the major factors militating against the use of multipurpose cadastre is lack of awareness, on the part of policy makers, of the numerous possibilities offered by the scheme. Therefore, the starting point for initiating and implementing a national multipurpose cadastre is to mount an awareness campaign targeted at both policy makers and potential users.

4.2 Existence of Cadastral Records in Analogue Form

Another hindrance to effective application of multipurpose cadastre is that most cadastral data still exist only in the form of conventional hard copy maps. There is the need to digitize these maps to facilitate their use in a national multipurpose cadastre. Digitizing is the process of encoding spatial data into computer compatible form. Some of the principal ways by which analogue maps can be digitized are discussed below.

4.2.1 Tracing

This method involves the use of an instrument called a digitizer which is an electronic or electromagnetic device consisting of a tablet upon which the map or document to be digitized can be placed. To this is connected a hand-held pointing device called a puck, or an electronic pen called a stylus. The puck is equipped with cross hairs to facilitate precise pointing. Most digitizers can be used in two modes. In the first mode, called point digitizing, a control button on the puck is clicked when the intersection of the cross hairs is centred on a point. This encodes the X and Y co-ordinates of that point. In the second mode called stream digitizing, the stylus or the intersection of the cross hairs is placed at the beginning of the line and a command sent to the computer to start recording co-ordinates at stipulated equal time or distance intervals. The operator now traces the line with the stylus or the intersection of the cross hairs, as the case may be, taking care to follow the curves as closely as possible. At the end of the line, or at a junction, the computer is instructed to stop accepting co-ordinates.

At the beginning of the digitizing exercise the computer must be informed of the scale of the map to be digitized and the area to be covered by the exercise. This later requirement is usually given by the minimum and maximum X and Y co-ordinates.

4.2.2 Scanning

Another means by which spatial data can be entered into the computer is by the use of a conventional scanning machine. Although the output from a conventional scanner often consists of a set of pixels (grid cells) that record the presence or absence of an image, such an output can be converted to vector images. The vectorizing process consists of threading a line through the resulting swarm of pixels using appropriate algorithms (Burrough 1987). Scanning remains a very popular method of digitizing maps because it does not call for much direct involvement from the operator.

4.2.3 Scaling

If the coordinates of the turning points in a map are available, they can be typed into a file or supplied to a programme via the key board so that the points are automatically plotted. This method is very accurate. Where it is not possible to plot all the points in this way, the missing dimensions can be scaled from the hard copy map and applied to the drawing as if it were being edited. The major advantage of this method is that it does not require any additional equipment such as a digitizer or a scanner.

4.3 National Integration

Cadastral matters are best handled as close as possible to the relevant local community. In Nigeria they are controlled at the state level. Although the various state cadastral survey standards are common in many respects, they are tied to various local origins. This is the situation even within some cities and their environs. For instance, in the south eastern part of Nigeria, the city of Enugu and its environs have two local origins in use, namely TB 20 and ECS 120. The advantage of this system is that it provides computations on a local plane and thus obviates the difficulties in applying the corrections necessary for presenting the results of measurements on a spheroidal surface. With a local plane thus adopted, field points and boundary lines can easily be re-established when the need arises using the true horizontal distances and bearings. The use of local origins, however, has a drawback: surveys tied to the various local reference systems must be transformed to the national reference system before they can be used in a national multipurpose cadastre. Each transformation is done in three sequential steps, namely translation of origin, rotation of axis and scale change. The translation of the origin of the local system to the origin of the national system can be achieved by having the co-ordinates of the local origin in each of the two systems. The other two aspects of the transformation, namely the rotation of the axis and the scale change are then effected. Details of the transformation process are given in Ezenwere et al (2002). When the transformation of the various origins to the national geodetic reference system is accomplished, the co-ordinates of the corners of all cadastral parcels in the country would be given with respect to the origin of the national geodetic reference system. The result would be one large, seamless map of the entire country containing the locations of the various parcels. When fully implemented, this will serve the cadastral overlay requirement discussed in section 3.3 above.

4.4 Presenting New Cadastral Records in Computer Compatible Forms

While steps are being taken to digitize existing cadastral records, there should be a regulation requiring that all newly prepared cadastral plans or maps should be presented in computer compatible forms such as in diskettes or CD-ROMs. This will facilitate their use in updating the multipurpose cadastral database. This mode of presentation is in addition to the normal presentation of hard copy records of these items. The above requirement is urgent because, while efforts are being made to digitize existing records, fresh, non-digital records should not be accumulated.

4.5 Shortage of Relevant Qualified Manpower

The concept of multipurpose cadastre is new in Nigeria and there is yet insufficient number of qualified local personnel to man the various nodal points required for the implementation of the scheme. In order to remedy this situation efforts should be made to attract Nigerians in the diaspora who have the requisite qualifications and experience to come home and assist in mid-wifing the scheme. Furthermore, every project in this scheme should include a training component for local personnel and should be locally implemented to an agreed minimum percentage to strengthen local capacity.

4.6 Funding and Sustainability

Going by the current mode of cadastral practice, there is no doubt that a multipurpose cadastral scheme will ultimately be self-sustaining. Government had usually required land owners to pay for the cost of services involved in managing the records of their land. Thus, landowners are required to make such payments as survey fees, registration fees, search fees, charting fees and transfer fees. This has been a significant source of revenue to government. Recently, landowners were also required in some states of the federation to pay 'computerization' fees for computerizing the records of their lands. The matter of paying for cadastral services is, therefore, not new to Nigerians. But it is expected that a huge financial outlay will be required at the initial stage of the implementation of a national multipurpose cadastre. It is suggested that the federal government, as the biggest stakeholder in a national multipurpose cadastre, should provide the seed money for the take-off of the scheme. It should also make available some annual grants for the first few years of the scheme. Thereafter, after the society has imbibed the idea of a national multipurpose cadastre, the scheme can be sustained by the fees regularly paid by the numerous bodies that would seek information from the multipurpose cadastral database. Such bodies include:

- National Electric Power Authority
- Nigerian Telecommunications Limited
- National Population Commission
- National Planning Commission

- Independent National Electoral Commission
- Nigerian National Petroleum Corporation
- Customs and Excise Department
- The Nigeria Police
- Immigration Department
- Inland Revenue Authorities
- Oil Exploration Companies
- Construction Companies
- Advertisement Agencies
- Insurance Agencies
- Banks and Other Financial Institutions
- Ministry of Housing and Urban Development
- Federal and State Ministries of Agriculture
- Federal and State Ministries of Education
- Ministry of Environment

5. SUMMARY

This paper discusses how cadastre, intended for recording the boundaries and interests in a parcel of land, developed into multipurpose cadastre. Part of the reason for the development is that it would be more beneficial to the society if multiple uses of cadastre were made. This arrangement would, however, result in a map overcrowded with details. Computer technology makes it possible for the contents of such a map to be separated into layers, based on as many themes as are desired, and to re-assemble any group of these layers according to any required purpose. The technology also allows attribute data to be attached to these map layers and for the map layers to be easily updated or revised, in order to maintain currency of the information contained therein.

By extending multipurpose cadastre to the entire country and integrating the resulting national multipurpose cadastre into the National Geospatial Data Infrastructure, multipurpose cadastre can be turned into one of the most frequently used geospatial datasets with numerous benefits to the society. This is in line with the recommendations of FIG-Commission 7 Working Group 1 “Vision Cadastre” looking at trends and developing visions for cadastral systems in 2014.

REFERENCES

Binge M. c. 2003. Surveying GIS: The Need for a Multipurpose Cadastre Revisited. Available at www.pobonline.com

Burrough P.A. 1987. Principles of Geographical Information Systems for Land Resources Assessment. Clarendon Press, Oxford.

Dale. P. 1976. Cadastral Surveys within the Commonwealth. Her Majesty’s Stationery Office, London.

Epstein E. 1998. Guidelines for Beginning and Sustaining A Coorperative Effort to Build a Land Information System at the Local Level Based Upon a Geodetic Reference

Framework. Prepared for the Ohio Geographically Referenced Information Program (OGRIP). School of Natural Resources, The Ohio State University, Columbus, Ohio 43210.
Ezenwere O.C. and Ekpete B.O. 2002. Geodetic Framework for Cadastral Survey Practice in Nigeria. CECTA (Nig) Limited, Enugu.
Federal Republic of Nigeria, Federal Surveys Notes on Projection. Publication No. 500/632/6-75.
FIG 1998. Cadastre 2014. Report of FIG-Commission 7 Working Group 1 "Vision Cadastre", looking at trends and developing visions for cadastral systems in 20 years time. FIG-Congress in Brighton.
Groot R. 1998. "The Role of National Mapping Agencies in the Development of National Spatial Data Infrastructure". Paper presented to the International Conference of Spatial Information Technology at Wuhan.
Langley R.B. 1998. "The UTM Grid System", GPS World. News and Applications of the Global Positioning System, February. Pp 46-50.
NASRDA 2003. Draft Report on National Geoinformation Policy. Prepared by National Committee on Geoinformation Policy, National Space Research and Development Agency (NASRDA), March. 48pp.
Nwilo P.C. 2003. "The Role of Spatial Reference System Framework and Fundamental Datasets in National Geospatial Data Infrastructure (NGDI)". Proceedings of the National Geospatial Data Infrastructure (NGDI) Stakeholders/Users Workshop, February. Pp 25-31.
Rockester J.B. 1993. Computers: Tools for Knowledge Workers. Richard D. Irwin, Inc., Homewood, IL.
United Nations 1996. The Bogor Declaration. Report from the United Nations Inter-Regional Meeting of Experts on the Cadastre, 18-22 March, Bogor, Indonesia.

BIOGRAPHICAL NOTES

Eugene Onyeka holds a BSc degree of the University of Nigeria in Surveying (1975). He also holds a MSc degree in Land Surveying (Photogrammetry Option) of Ahmadu Bello University (1983). He taught surveying for seven years (1976-1983) at Kwara State College of Technology, Ilorin before joining Home Construction and Dredging (Nig) Limited. At the company, he first served as the Chief Surveyor and later as the Project Manager (Dredging). In 1985 he became a Member of American Society for Photogrammetry and Remote Sensing. On obtaining his Surveyor's Licence in 1986 he commenced a professional surveying practice focussed on cadastral surveys. In 1992 he joined the academic staff of Enugu State University of Science and Technology. He is currently spending a two-year leave with the Centre for Geodesy and Geodynamics.

Mr. Onyeka served as a member of Anaocha Town Planning Authority (1996-1997). He is a member of the Nigerian Environmental Society and a member of Geoinformation Society of Nigeria where he is currently the Treasurer. In August 2001 he was elevated to the status of Fellow of the Nigerian Institution of Surveyors. In October 2002 he was appointed a Consultant to the National Space Research and Development Agency. He serves on the

National Technical Committee on Earthquake Phenomena and on a Sub-Committee on Census Mapping. He also serves on the Editorial Board of the Nigerian Journal of Surveying and Geoinformatics. The combination of academic and practice backgrounds has had a positive influence on his research efforts. His publications include:

- Onyeka E.C. 1981.Precision of Field Survey Measurements. The Map Maker, Vol 6 No 2, January, pp 14 – 18.
- Onyeka E.C. 1997. Reducing Incidents of Oil Spills and Leaks by Monitoring Conditions of Oil Pipelines. ESUT Journal of Environmental Management, Vol 1 No 1, December, pp 1-8.
- Onyeka E.C. 2002. Development of a National Multipurpose Cadastre. Environmental Review, Vol 4 No 1, February, pp 465-483.
- Onyeka E.C. 2004. World Court Judgement on Bakassi Peninsula: The Need for the Surveyors' Updated Maps of Nigeria. Nigerian Journal of Surveying and Geoiformatics, Vol 1 No1 ISSN: 1597-2674. January, pp 79 – 98.
- Onyeka E.C. 2004. Methodology and Presentation of Utility Mapping. ESUT Journal of Environmental Management, Vol 2 No1, August, pp 59-65.

He also has a number of publications in Conference Proceedings, amongst which are:

- Igbokwe, J.I., M.N. Ono and E.C Onyeka 2001. "Application of Remote Sensing Techniques in Population Management". Proceedings of the 36th Annual General Meeting and Conference of the Nigerian Institution of Surveyors held at U.K. Bello Arts Theatre, Minna, Niger State, 30th May to 1st June, pp 9-13.
- Nwilo, P.C., Onyeka, E.C and Onojeghuo, A.O. 2002. Implementation of an Automated Land Information System for FESTAC Town, Lagos. O.O.Ayeni (Ed) in Proceedings of AARSE/ Abuja 2002 International Conference, 14-18 October.
- Onyeka, E.C. 2002. "Development of a National Environmental Monitoring Service Using High Resolution Satellite Images". Proceedings of the 37th Annual General Meeting and Conference of the Nigerian Institution of Surveyors held at Concord Hotel, Owerri, Imo State. May.
- Onyeka, E.C. 2003. "Integrated Solutions to Petroleum Products Diversion Using Geospatial Information Techniques". Proceedings of the 38th Annual General Meeting and Conference of the Nigerian Institution of Surveyors held at Confluence Hotel, Lokoja, Kogi State. May.
- Onyeka, E.C. 2004. "Expanding the Sphere of Surveying for National Development: Prospects and Problems". Proceedings of the 39th Annual General Meeting and Conference of the Nigerian Institution of Surveyors held at Obi Wali Conference Centre, Port Harcourt, Rivers State. May.

CONTACTS

Mr. Eugene Chukwunwike Onyeka
Centre for Geodesy and Geodynamics
National Space Research and Development Agency
PMB 437, Garki
Abuja
NIGERIA
Tel. + 234 92342203, + 234 42250535
Mobile +234 8035536240
Fax + 234 92342220, + 234 42250535
Email: econyeka@yahoo.com
Website: www.nasrda.gov.ng