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EXPLORING DIGITAL GEOSPATIAL TECHNOLOGY FOR EFFECTIVE TEACHING AND RESEARCH IN NIGERIA

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Abstract

Digital geospatial technology is a branch of information and communication technology that allows geographical features and information to be digitally represented and stored in a digital database. It also provides tools and facilities (software) for effective management, integration, analysis, monitoring, and sharing of such information and data to address socio-economic, engineering, and environmental challenges. Geospatial data, also known as geographic or spatial data, is any data linked to a particular location on the earth's surface using a standard referencing system. As diverse as its applications, geospatial data exist in different formats from different sources and could be used in several application areas such as environmental monitoring, urban and regional planning, disaster forecasting and management, disease monitoring, water resources planning, and inventory, among others. By giving precise information on the location and distribution of natural resources, such as water, forests, and minerals, the software is effective in their allocation and management. Critical habitats can be located, environmental consequences may be evaluated, and practical conservation plans can be developed with the aid of GIS.In this paper, an attempt has been made to explore the components of digital geospatial technology, its applications in teaching and research, as well as challenges associated with its usage in Nigeria.

Keywords: ***Digital; Geospatial Technology; Teaching; Research; Nigeria.***

INTRODUCTION

Digital geospatial technology, comprising geographic information systems (GIS), remote sensing (RS), and global positioning systems (GPS), has transformed human comprehension, analysis, and engagement with the Earth. In the 21st century, the utilisation of contemporary information and communication technologies (ICTs) has significantly augmented the engagement in geographical education and research. This covers the usage of computers, software, digital data storage, audio-visual systems, and communication networks. When ICTs are used appropriately, they can be very beneficial to researchers and students. In particular, geospatial technology can help with spatial thinking and make learning more effective and interesting (Robert 2023, 2021; Parkinson 2018). Understanding ICT and becoming proficient in its fundamental concepts and abilities are now considered to be essential components of core educational growth in many nations and among people worldwide.

When completely developed and applied, Geospatial Information Technology (GIT), a specialised subfield of ICT, would significantly aid in the making of logical and well-informed judgements across a wide range of human endeavours. Education, water resource management and research, emergency preparedness, land use planning, crime prevention, health care planning and delivery, and guaranteeing a knowledge-based economy are a few examples of these domains. While industrialised nations use this area of information technology extensively to support their programs and processes for development, most developing nations have relatively limited knowledge, development, and use of this field.

For instance, geospatial information technology development is still in its early stages in Nigeria. Similarly, even among Nigeria's elite, its use and expertise are not widely accepted. This essay examines GIT as a subfield of ICT in general as well as the ways in which these technologies might improve research and instruction in a range of academic fields. In addition to highlighting the issues and future potential of GIT in Nigeria, the article seeks to demonstrate the revolutionary power of digital geospatial technology in education and national development by offering a thorough overview, examining important applications, and addressing difficulties and opportunities.

WHAT IS GEOSPATIAL INFORMATION TECHNOLOGY (GIT)?

This general term refers to a broad spectrum of hardware and software tools for the creation, archiving, handling, and analysis of digital geographic datasets (UN, 2009). The TSA (2008) described it as an information technology field of practice that involves the acquisition, management, integration, analysis, interpretation, and display of geographic data. Geospatial data, also referred to as geographic data, is any information or data that has a spatial or geographic coordinate reference. This type of data is characterised by its absolute or relative position. It contains the earth's surface's physical and cultural elements, like a road network, farming, building, school, clinic, forest reserve, river, highland, lowland, etc. More than 80% of the data in the fields of education, business, and science are of this sort (ESRI, 1991).

One of the most important ICTs for research and education is geospatial technology. Actions. They are excellent resources for disseminating information on engineering, science, and geography as well as promoting geographic thinking. The need for geographic technology and, by extension, geospatial specialists, is rising quickly on a global scale. These experts are employed in the public sector, environmental management, mining, statistics, utilities, agriculture, and demographics. They are utilised in many different technologies, such as Global Positioning Systems (GPS), remote sensing, and geographic mapping applications.

COMPONENTS OF GIT:

Similar to ICT, GIT is a broad and diverse topic, but for the sake of this discussion, it may be divided into three main, albeit connected, categories. Global Positioning System (GPS), Remote Sensing (RS), and Geographic Information System (GIS) are a few of them. Below is a quick discussion of these:

Geographical Information System (Gis):

Many authors have variously defined GIS. Examples of such definitions include:

Geographic Information Systems (GIS) are now essential tools in many different industries, aiding well-informed decision-making and offering instrumental perspectives. (Taylor and Francis). GIS is an adaptable tool that has transformed a number of industries by offering insightful information, assisting with well-informed

decision-making, and facilitating a more thorough comprehension of our surroundings. Its uses are numerous and include disaster relief, environmental preservation, and urban planning. The significance of GIS will only increase with technological advancement, influencing our future in a multitude of ways.

One of the software's unique GIS characteristics that makes it especially significant is its capacity to integrate and mix data from several sources. As a result, GIS may construct overlapping layers that can be dynamically accessed, altered, and controlled inside a single spatial structure by combining data from cartographic sources (maps), earthbound surveys, and remote sensing (satellite and aerial imagery) (Kaminska et al, 2004).

GIS enables us to examine the geographical correlations among various data layers, including infrastructure, land use, and population density. Additionally, GIS aids in the visualisation of complex data by integrating charts, graphs, and maps to portray complex spatial information in an aesthetically pleasing and intelligible manner. By giving precise information on the location and distribution of natural resources, such as water, forests, and minerals, the software is effective in their allocation and management. Critical habitats can be located, environmental consequences may be evaluated, and practical conservation plans can be developed with the aid of GIS. ESRI (1991:2).

Smart GIS is a highly helpful tool for urban planning and development. It may be used to find appropriate places for infrastructure, optimise transportation networks, manage smart cities, and evaluate urban sustainability. Zoning, land use classification, and urban redevelopment initiatives are all aided by land use planning, which promotes efficient and sustainable development. It is a tool in disaster management that can be used for proactive planning and mitigation measures, such as assessing vulnerability to natural disasters including hurricanes, floods, and earthquakes. GIS enables effective response operations during emergencies by providing real-time information on affected areas, infrastructure damage, and resource distribution.

GIS is crucial to environmental research since it helps with forecasting future scenarios, researching the effects of climate change, and developing adaption plans. It can also be useful for executing conservation projects, tracking habitat loss, and mapping

biodiversity hotspots. Using GIS to optimise transportation routes, save costs, and increase logistical efficiency can all help the transportation sector grow. The software supports the development of intelligent transportation systems, incident management, and traffic monitoring. (Department of Environment, UK, 1987:3).

Remote Sensing (Rs):

Similar to geographic information system, the definition of remote sensing varies among authors. As stated by Lillesand and Kiefer (2000:1), it literally refers to the observation of a target by a device that is placed at a distance from it.

But in general, remote sensing is the combined use of contemporary sensors, data processing tools, information theory and processing techniques, communication devices and theory, space and aerial vehicles, and large systems theory and practice to survey the surface of the earth (National Academy of Sciences, 1970:1).

In a similar vein, Campbell (2006:6) described remote sensing as the process of using images obtained from an overhead perspective to extract data about the land and water surfaces of the earth by utilising electromagnetic radiation in one or more electromagnetic spectrum regions that are reflected or emitted from the surface.

The uses of remotely sensed data to address real-world issues are numerous and diverse, but they typically call for connections to other types of data, such as topography, political borders, land use patterns, pedology, geology, hydrology, or vegetation data. These connections have been made within the GIS framework more and more in recent years. The analysis of geographical data, and particularly the analysis of the links between various types of data that are matched to one other within a particular geographic location, is the focus of GIS.

These connections are becoming more and more common inside the GIS framework in recent years. Consequently, GIS is committed to the study of geospatial data, particularly the investigation of the links that exist between various types of data that are matched to one another within a particular geographic area. It is only partially inaccurate to say that GIS is primarily a way of storing, integrating, manipulating, and analysing spatial data, whereas remote sensing is essentially a means of data collecting, despite the fact that it is challenging to draw a clear distinction between the two.

Global Positioning System (GPS):

The United States Department of Defence launched 24 satellites into orbit to form the network that makes up the Global Positioning

System (GPS), a satellite-based navigation system (Garmin, 2009). Although the government first intended GPS to be used for military purposes, the system was opened to civilian use in the 1980s. GPS is available anywhere in the world, at all times, and in all-weather situations.

GPS is available without a setup cost or subscription. GPS satellites send signal data to Earth while travelling in a very precise orbit around the planet twice daily. With this data, GPS receivers do triangulation to determine the user's precise location. In essence, a GPS receiver compares the time a signal was received with the time it was delivered by a satellite. The GPS receiver is informed of the satellite's distance by the time difference. The receiver can now determine the user's position and display it on the electronic map of the unit with the help of distance measurements from a few more satellites.

In order to compute a two-dimensional position (latitude and longitude) and track movement, a GPS receiver needs to be latched onto the signal of a minimum of three satellites. The receiver can figure out the user's three-dimensional position (latitude, longitude, and altitude) if they can see four or more satellites. After locating the user, the GPS device can compute additional data, including travel distance, speed, bearing, track, destination distance, sunrise and sunset times, and more.

Geographic information technologies are becoming more widely available and somewhat easy to obtain these days because to advancements in GIS, RS, and GPS technology, especially in western industrialised countries. Users of geographic information are increasing and getting more reliant on it every day. As a result, integrating geospatial data with demographic and socioeconomic data is becoming a standard method for making decisions in a variety of fields, including business planning, marketing, urban and regional planning, education, health, and the environment.

BENEFITS OF GIT IN TEACHING AND RESEARCH

It is impossible to overstate the value of ICT in general and GIT in particular for education, research, and even national development. These are strong instruments with the potential to significantly impact research and education, especially in the field of technology advancement. Students that use ICT/GIT in their education will be better able to comprehend spatial patterns by visualising intricate spatial linkages and

patterns, such as population distribution, the effects of climate change, or urban growth, using geospatial tools.

I. They are being prepared to live in a world that is always changing, where employment and leisure activities are adjusting to keep up with technological advancements. ICT/GIT has enormous potential to enhance the teaching and learning processes if used properly in any kind of educational environment. A few of these advantages are listed below:

II. **Spatial Awareness and Critical Thinking**

Through interactive maps and visualisations, geospatial technologies bring abstract geographic concepts to life and improve spatial awareness and critical thinking abilities. They also enable researchers and students to properly analyse and evaluate geographical data. They also give researchers and students the tools they need to examine patterns, recognize connections, and make judgements based on spatial data. Their capacity for critical thought, hypothesis formation, and evidence-based reasoning all grow as a result of this process.

Understanding and comprehending spatial relationships, scale, and viewpoints are made possible by spatial awareness. This ability is useful in a variety of sectors, including environmental management, urban planning, and water resources navigation.

III. **Problem-Based Learning:**

Students can be engaged and encouraged to think critically by using geospatial data to generate real-world problem-based learning scenarios. Students are capable of analysing real-world data to solve issues and make wise decisions. Citizen scientists can gather and evaluate data using geospatial tools, which helps with research and community-based initiatives.

IV. **Multidisciplinary Learning**

Through the integration of components from geography, mathematics, computer science, and environmental studies, geospatial technologies can support multidisciplinary learning. Students are encouraged to investigate these interdisciplinary links, which promotes cooperation and teamwork. Working on geospatial projects exposes students to a variety of viewpoints and levels of competence.

This interdisciplinary approach fosters creative thinking and peer collaboration in students while enabling a comprehensive understanding of real-world situations.

V. **Analytical Skills and Data Literacy**

Students gain strong analytical skills through problem-solving and geographic analysis exercises. They gain the ability to collect, analyse, and synthesise intricate geographical data, which improves their capacity for critical thought and well-informed decision-making. In addition to enhancing research skills and data interpretation abilities, teaching students geographic science enhances their data literacy by teaching them how to explore and assess spatial information.

VI. **Real-World Applications and Skills**

In addition, learning about geospatial science fosters students' connection with real-world problems and their consideration of the societal ramifications of their work. Additionally, it gives students real-world skills that are extremely applicable in today's technologically advanced world. These abilities are beneficial for a variety of businesses where spatial data analysis is becoming more and more in demand, as well as for future professions in geospatial-related fields.

VII. **Problem-based Learning (PBL)**

The purpose of geographic information systems (GIS) is to enable researchers and students frame, visualise, and solve problems. Whether the challenges are related to energy, urban greenways, natural hazards, climate change, social injustice, or any of the other complicated concerns facing our day, it even allows students to come up with answers. Geospatial technologies and PBL are a natural match because they require learners to actively engage as scientists, planners, and other professionals in decision-making.

They are free to select initiatives and issues that they believe need to be addressed in order to improve the lives of people in their communities and around the world. Geospatial technologies can be used in research and education to:

i. Promote the quick exchange of ideas made available by the internet and other communication tools both domestically and internationally.
ii. Facilitates rapid and effortless access, selection, and analysis of various types of data, including spatial data.
iii. Encourages the accessibility, availability, and affordability of educational resources that can be utilised to improve teaching and learning processes, such as maps, graphs, charts, aerial photos, and satellite imagery.
iv. Teach earth science, geography, chemistry, biological sciences, history, and math ideas and abilities in an effective manner.
v. In academic institutions, geographic technologies are vital research instruments for disciplines such as geography, demography, geology, and others.

PROBLEMS AND PROSPECTS OF ICT/GIT IN NIGERIA.

Preparing society for the information and communication revolution and globalisation is one of the fundamental issues that most emerging nations, including Nigeria, face. Despite the fact that many nations are working hard to use geospatial technologies to accelerate the development of many industries, particularly education, the reality is that most developing nations, like Nigeria, are still having a lot of difficulties with this endeavour. For example, Nigeria is still considered to be an information-poor society even after 50 years of independence. This is clearly caused by a number of issues, including inadequate money, poor infrastructure, poor planning, and poor execution. The following highlights a few of these elements:

I. Data Accessibility

Obtaining the precise, dependable, consistent, and timely data required for resource allocation and decision-making is clearly difficult in Nigeria (Grabowski et al., 2016). Without a question, having accurate and trustworthy data is essential for a country's economic growth, wise decision-making, the reduction of poverty, and the creation of wealth. Access to trustworthy and high-quality geospatial data, which has been difficult to come by, particularly in developing nations like Nigeria, would be ensured by the use of ICT and GIT.

Cost Implication and Technical Skills

The initial cost for software, hardware, expensive database licensing, and employee training. can play a key role in the development of geographic data infrastructures (Olubusoye et al., 2015). More funding must be invested in the industry in order to fully investigate and reap the benefits of these technologies. Low educational attainment and tight financial constraints have hindered certain Nigerian researchers' technological proficiency, making them the main players in data collecting (Sanjari et al., 2014).

However, the National Geospatial Data Infrastructure (NGSDI), Abuja Geographical Information System (AGIS), and National Centre for Remote Sensing (NCRS), among others, are blatant signs that the importance of these technologies has been recognised in all spheres of national development. But in order to fully reap the benefits of these technologies, both real and potential, developing nations like Nigeria must make sufficient investments in these fields to overcome some of the fundamental obstacles impeding the advancement of these technologies.

II. Policy Consideration

The majority of developing nations, including Nigeria, lack the proper policies and plans for incorporating geospatial technologies into the classroom. Furthermore, even in cases where such policies are in place, there is always the issue of poor execution, which is typically brought on by insufficient or improper planning. Much work still needs to be done in order to accomplish this goal, even though the Nigerian government has acknowledged the value of geospatial technologies as an essential tool for national development and is continuing to make efforts to participate actively in the global village.

III. Poor Infrastructures

The majority of underdeveloped countries, including Nigeria, lack the internet, telecommunications, and electrical infrastructures that are essential to the advancement and efficient use of geospatial technology. In Nigeria, there is still no consistent source of power, even with massive investments being made in the energy sector. For this reason, if we are to be successful in the field of geospatial

technology today, this is a problem that has to be thoroughly investigated.

IV. Digital Divide

One of the fundamental issues with the use of geospatial technologies in most developing African nations, including Nigeria, is the digital divide. The phrase 'digital divide' refers to the division of the world's population into two groups: those who possess modern information technology, such as smartphones, televisions, internet access, and other hardware and software components of geospatial technologies, and those who do not. Even if these technologies have made the world a smaller place, conditions there are still far worse than in western, affluent countries like the United States and the United Kingdom.

This is a result of the continued high rate of illiteracy and the continued disparity in important geospatial technology infrastructure availability and accessibility between rural and urban cultures. Because most specialised gear and software packages for managing geographical information require specific training in addition to ordinary ICT literacy, this issue is even more problematic in the geospatial technology field.

V. 4. Inadequate Digital Geospatial Datasets In The Country

Nigeria, despite its long history of independence, still lacks digital geospatial datasets, which are necessary for the nation to engage in and reap the full benefits of the geospatial information technology industry. Basic geospatial datasets such as the nation's topographic, hydrographic, administrative boundary, transportation, cadastral, land use/cover, and geological databases are not only still available in analogue form but are also, for the most part, out of date. Therefore, frequent updating and digitalisation of the foundational geospatial datasets is crucial if Nigeria is to actively participate in and fully benefit from the world of geospatial technology to assure national growth.

CONCLUSION

One of the fundamental needs upon which great nations are constructed is education. While research is a cornerstone of national development, providing a critical foundation for innovation, problem-solving, and informed decision-making, it is an investment that takes time to pay dividends but generates the highest returns when compared to any other avenues where resources can be committed. Education is a key instrument for enhancing human capital in developing nations like Nigeria, where a sizable portion of the population subsists on subsistence levels.

Digital geospatial technology has enormous potential to improve research and teaching in many different sectors. Through the provision of visualisation, analysis, and collaboration capabilities, these technologies have the potential to enhance students' and researchers' comprehension of their surroundings and aid in the resolution of intricate problems. In order to optimise the use of geospatial technology in education, it is critical to tackle the obstacles and seize the opportunities as the area develops. The field of geographic information technology is still in its early stages of development in Nigeria. Even among the elite of Nigeria, digital geospatial datasets are still in their infancy and lack widespread use in terms of understanding and applications.

As a result, Nigeria must switch from an analogue to a digital system in order to fully profit from the world of geographic information technology. Innovations bring about the much-desired national development, and the efficient use of relevant geospatial technology facilities in education and research will undoubtedly increase the quality of the teaching and learning process.

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