Research Article

Trends in Internal Medicine

GIS Integrated System for Internal Medicine and Transport Network: A Conceptual Framework of Control Spread of Emerging Infectious Diseases

Jacob Oluwoye, PhD*

Professor/ Director of the Center for Urban and Rural Research (CURR), Alabama A&M University, Alabama.

***Correspondence:**
Jacob Oluwoye, Alabama A&M University, Professor/ Director of the Center for Urban and Rural Research (CURR), Alabama, Tel: (256) 372-4994.

Received: 16 Dec 2021; **Accepted:** 14 Jan 2022; **Published:** 20 Jan 2022

Citation: Oluwoye J. GIS Integrated System for Internal Medicine and Transport Network: A Conceptual Framework of Control Spread of Emerging Infectious Diseases. Trends Int Med. 2022; 2(1): 1-5.

ABSTRACT

Introduction: *The spread of infectious disease in Africa is a major issue that demands the use for the most effective technology for its control and prevention. Geographical Information System (GIS) is an emerging technology with proven capacity to chart the spatial occurrence social phenomena, both statically and dynamically. GIS offers considerable advantages over the traditional cartographic methods from which it emerged. The purpose of this research paper is to explore and demonstrate the capability of GIS in measuring the spread and predicting infectious disease in developing countries and assisting (government) decision-makers in understanding and controlling the spread of communicable disease. Specifically, the aim is to establish an integrated framework for using GIS in epidemiological studies at the grassroots level.*

Methods*: The paper based on the author previous published papers and review of the existing literature.*

Result: *The data collection will center on the virus that has reached Lagos along the coast road from Accra in Ghana; Calabar from infected Cameroon to the east and arrived in the north via a "right hook" of long-distance trucking to Maiduguri. Thus, there is a need for the establishment of GPS base station in Lagos, Nigeria to improve accuracy and precision of satellite data collection through use of differential corrections. There is also a need to link clinical and HIV/AIDS databases to GPS database. The information required to support HIV/AIDS spread analysis can be generally classified into the following three categories :(a) transportation network (i.e. distance; average daily traffic; number of stops; etc.) (b) social/demographic factors (i.e. population; characteristics of HIV carriers/AIDS sufferers; the distance to school, hospitals, and other sensitive areas) (c) other geographical considerations (i.e. tribal affiliation; neighboring country.). The principal social/demographic factor that is operational in the referenced HIV/AIDS spread model is population. This is a GIS database of enumeration district centroids with attribute information, available through the National Population Centre and African AIDS Network. The enumeration district boundary file for each district will be established by drawing lines that bisect each adjacent enumeration district centroid. Through recursive use of this process, enumeration district borders will be shaped such that every district occupies a unique area surrounding its centroid, and collectively the district occupies the entire suburb area.*

Conclusions: *The paper concludes that direct the nature and the geographical focus of control efforts carried out at the state or local government level, where these decisions are constrained by the limited resources for control programs, which are always a reality in developing countries. This integrated GIS is significance because it will provide an important opportunity for improved decision support for the educational interventions, health care delivery systems and management of infectious disease spread at the local, regional and national levels.*

Keywords
Integrated GIS, Emerging infectious diseases, HIV/AIDS, Transport network.

Introduction

The African continent is faced with the challenge of the spread of the emerging infectious diseases that could threatens to erode the growth of its economy and other aspects of social life. Oluwoye [1] noted that attempts to forecast the development of the AIDS epidemic are urgently needed. GIS has a role to play. Its use in the health field varies from simple automated mapping of epidemiological data to sophisticated analysis of satellite images to demonstrate the relationship between disease vectors and the environment. However, the importance of geography seems to have been largely overlooked by most workers in the field; work on spatio-temporal analysis has been even more limited. Most modelling seems to be focused completely within the temporal domain; rarely can one find an attempt to model the spread of AIDS that incorporates the basic spatial dimensions of human life. The paper concludes that effective spatial modelling is particularly important in monitoring AIDS/HIV given its mode of spread, which follows closely the patterns of human interaction and movement. Furthermore, Oluwoye [2], relates statistical methodology and model design to planning and policy making for a viable solution to the HIV/AIDS problem. Demonstrating the benefits that can be derived from adapting the model building approach to planning and decision-making in health and urban development. The chapter concludes that the 'Seldom Do' model approach offers potential for addressing the development of planning and multi-criteria decision processes associated with health and urban development problems in our society.

As AIDS is projected to get of critical import in this century, attempts to foretell and forecast its developments are urgently claimed [3]. Notwithstanding, technological progress has led to the emergence of new self-acting analysis tools, known as geographic information systems (Force), whose use in the health field vary from the simple self-acting mapping of epidemiological data [4], to the sophisticated analysis of satellite images which demonstrate vector/ milieu liaisons [5-8]. Either spatial analysis or the use of geographic information systems for health have been reviewed by several authors [3,9-13]. So, the momentousness of geographical aspect seems to have been largely overlooked and work on spatial-temporal analysis has been more limited. Supreme modelling seems to be fastened fully within the temporal front and rarely can one find an attempt to model the spread of AIDS incorporating the introductory spatial reach of mortal reality [14]. One of the Kabel's main lines of argument is that modelling the geographical distribution of AIDS can contribute to both educational intervention and the planning of champaign care delivery systems. Effective spatial modelling is important in covering AIDS/ HIV given its mode of spread which follows closely the patterns of mortal dealings. Oluwoye [15], developed a conceptual model suitable for spatially analyzing the spread of an infectious disease. This paper focuses on the development of an index to measure HIV segregation as the degree of departure from an even residential distribution of population of HIV carriers /AIDS sufferers as a minority and Non-HIV carriers /AIDS sufferers' population as a majority in a city or country. The paper concludes that the method of indirect standardization examines the relationship between D and E (D), where D is index of dissimilarity and E(D) expected number of HIV/AIDS, to determine the degree to which HIV/AIDS group segregation can be attributed to social class, by correlation expected and actual numbers of HIV/AIDS members across tracts. It is anticipated that aspects of this conceptual design will have application to the demographic stratification of HIV/AIDS.

In this modelling, Geographic Information Systems have a dominant job to play. It has amongst others, the capability to counterfeit, given a genesis spread pattern, other spreads as well as the awaited patterns in the spread. Notwithstanding, Oluwoye [16], reported that the incidence of HIV/AIDS continues to spread within industry with a focus on the land transport sector. Workers in this industry can be especially vulnerable to HIV/AIDS. The transport sector has unique potential to contribute to the reduction of HIV transmission. Many of the situations in which HIV spreads can be changed through strategies and policies in the transport sector. Much population movements is highly fluid with people moving back and forth through these stages frequently-often over a course of days, weeks or months. One of the complex interrelationships that has not been properly understood by scholars, planners, and policy makers, is the magnitude and severity of problems created by commercial roadside development and their contribution to the rapid transmission of HIV.

The spread of infectious disease in Africa is a major issue that demands the use for the most effective technology for its control and prevention. GIS is an emerging technology with proven capacity to chart the spatial occurrence social phenomena, both statically and dynamically. GIS offers considerable advantages over the traditional cartographic methods from which it emerged.

It is evident that a lot of questions concerning the supply of health care are associated with space. Furthermore, the issues of where should health care centers be situated and what services should they offer to answer efficiently the needs of populations varying in numbers, densities and infectious disease problems? These are the problems that GIS can help resolve with their spatial analysis tools.

People are distributed in space and that they aren't evenly distributed. Health problems vary in space and so do the needs of the infectious disease groups.

The purpose of this research paper is to explore and demonstrate the capability of GIS in measuring the spread and predicting infectious disease in developing countries and assisting (government) decision-makers in understanding and controlling the spread of communicable disease. Specifically, the aim is .to establish an integrated framework for using GIS in epidemiological studies at the grassroots level.

Methods

The paper based on the author previous published papers and review of the existing literature. The next issue to be addressed under the research methods is what do one need for a GIS Integrated Planning System?

Analysis of complex urban issues requires lot of time, cost and lots of computer technologies are utilized to scale back the time-consuming steps in planning. In recent years, geographical information systems are getting a strong tool within the fields of geographical analysis or spatial statistics, and furthermore in regional and urban planning. However, a GIS Itself is typically a software package for database and for geometric calculation, not a tool that's well-specified for sophisticated functions, one will say therefore that the necessity for a GIS integrated planning system which consists of a GIS itself and a few subsystems developed for specific planning works stimulate the R&D not only by computer engineers but also by urban planners and civil engineers.

A GIS integrated planning system has the subsequent merits
i. Make storage and retrieval of designing information more efficient than before, that is, improvement of data management.
ii. Under a selected constraint for time and price, we will propose and analyze more alternatives than before, among which we will find more favorable ones. Even within the case where optimization techniques aren't so effective, we will make alternatives with trial and error.
iii. Understand urban issues and policy impacts from a geographical view or a spatial view, more clearly, more quickly and more easily.
iv. Clarify the accountability of decision-making because any steps in planning must be made clear and reorganized to be systematic within the process of system development.

This latter merit should be more emphasized. In practice, the method of decision makings isn't always transparent, or the choice can't be always accounted for. By the system, the method of decision-making is often traced a backward direction from results to origins. Thus, the accountability of decision-making is often improved by the GIS integrated system.

Results

Over the past 20 years, researchers have been developing automated tools for the efficient storage, analysis, land-use planning, and presentation of geographic data [17-19]. This rapidly evolving technology has come to be referred to as "geographic information systems" (GIS). These systems, resulting from the demand for data and knowledge of a spatial nature, could also be widely used across varied scientific fields. Their ability to use topological information and spatial analysis functions distinguish them from variety of other information systems. Large amounts of information are necessary for almost all aspects of infection disease control programs. GIS offer the ability to process quantities of data beyond the capacities of manual systems. Data are stored during a structured digital format, which allows rapid retrieval and use.

In addition, data could even be quickly compiled into documents, using techniques like automatic mapping and direct report printouts [20].

However, applications of the Integrated GIS for the Study and Control of HIV/AIDS Infection for Local Spread along West Africa corridor is shown in figure 1 below.

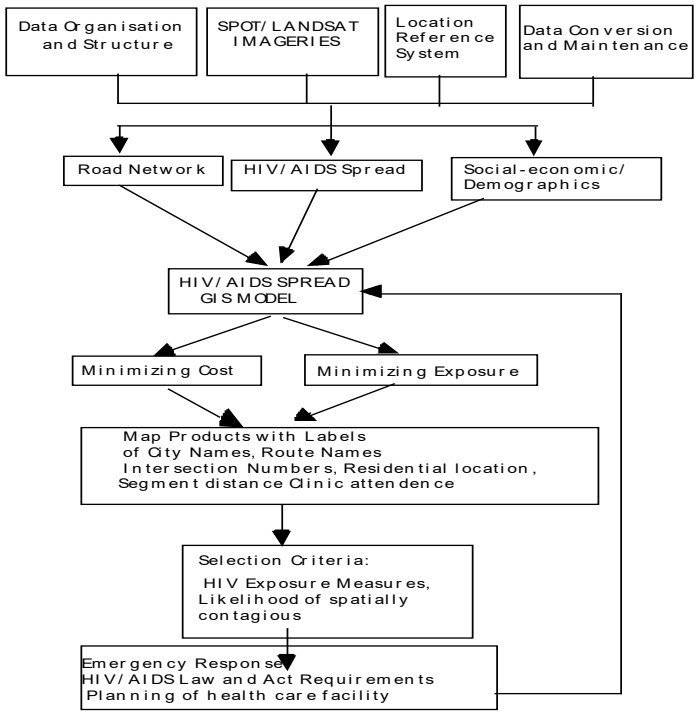


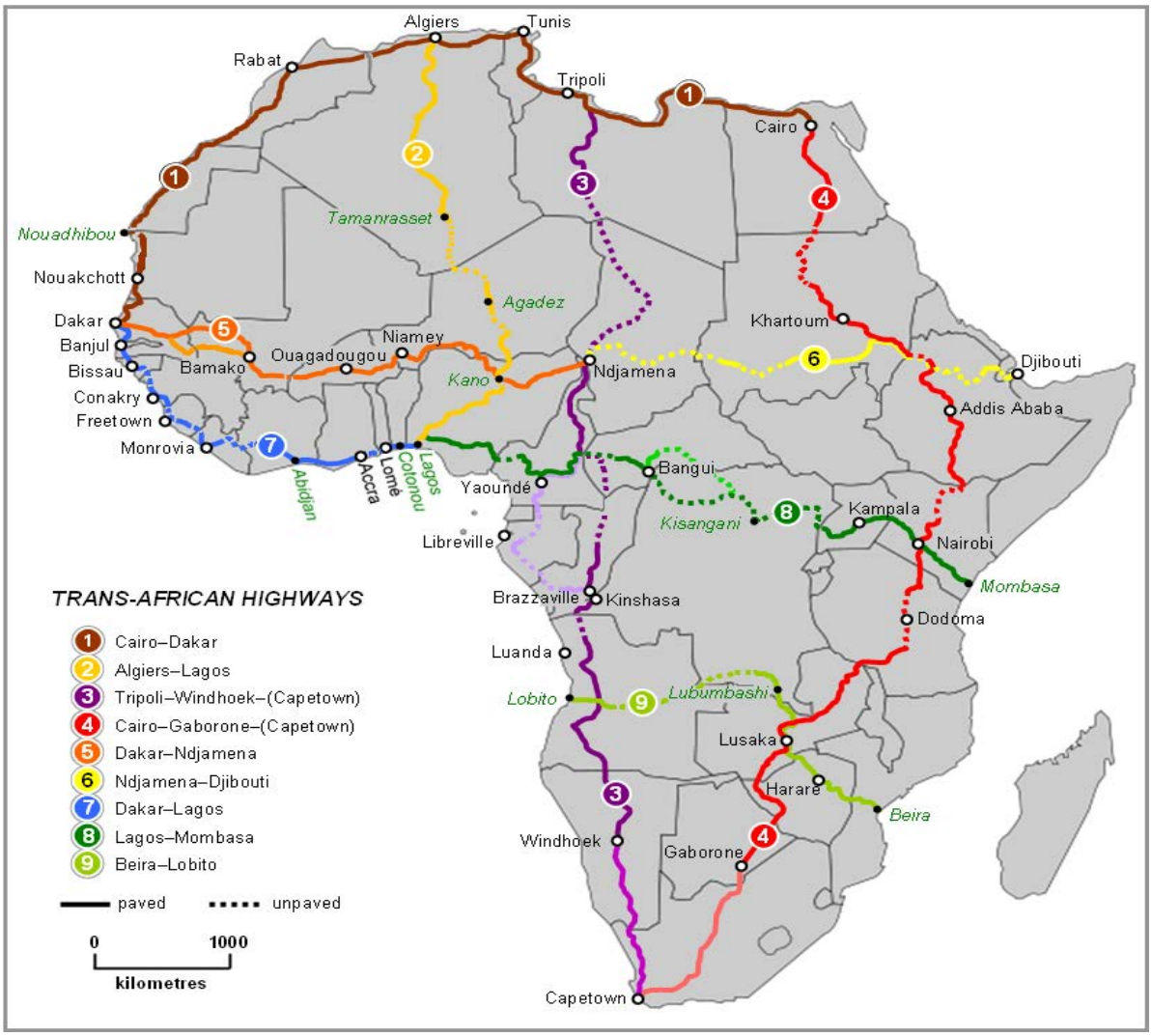
Figure 1: Integrated GIS for the Study and Control of HIV/AIDS Infection.

The pandemic is especially severe in the cities of East and Central Africa and their rural uplands, as well as in the highly connected cities of West Africa. However, only Nigeria, lying between the advancing fronts of HIV-1 from the east, and HIV-2 from the west.

The data collection will center on the virus that has reached Lagos along the coast road from Accra in Ghana; Calabar from infected Cameroon to the east and arrived in the north via a "right hook" of long-distance trucking to Maiduguri. Thus, there is a need for the establishment of GPS base station in Lagos, Nigeria to improve accuracy and precision of satellite data collection through use of differential corrections. There is also a need to link clinical and HIV/AIDS databases to GPS database.

The information required to support HIV/AIDS spread analysis can be generally classified into the following three categories shown in figure 1:
(a) Transportation network (i.e. distance; average daily traffic; number of stops; etc.)
(b) social/demographic factors (i.e. population; characteristics of HIV carriers/AIDS sufferers; the distance to school, hospitals, and other sensitive areas)
(c) Other geographical considerations (i.e. tribal affiliation; neighboring country.).

The principal social/demographic factor that is operational in the referenced HIV/AIDS spread model is population. This is a



Map of Trans-African Highways

GIS database of enumeration district centroids with attribute information, available through the National Population Centre and African AIDS Network.

The enumeration district boundary file for each district will be established by drawing lines that bisect each adjacent enumeration district centroid. Through recursive use of this process, enumeration district borders will be shaped such that every district occupies a unique area surrounding its centroid, and collectively the district occupies the entire suburb area.

The gradient method that is subsequently to be applied is based on the premise that the population in a district or tract is likely to be distributed proportionate to the population densities of neighboring districts (Oluwoye 2007). Consequently, of two equal-sized areas located closer to a neighbor with a greater population density will be assigned a greater proportion of the district population than the area located closer to a neighbor with a lower population concentration.

Conclusions

The paper concludes that direct the nature and the geographical focus of control efforts carried out at the state or local government level, where these decisions are constrained by the limited resources for control programs, which are always a reality in developing countries. This integrated GIS is significance because it will provide an important opportunity for improved decision support for the educational interventions, health care delivery systems and management of infectious disease spread at the local, regional and national levels.

The spread of this disease in Africa is a major issue that demands the use for the most effective technology for its study and control. GIS is an emerging technology with proven capacity to chart the spatial occurrence social phenomena, both statically and dynamically. GIS offers considerable advantages over the traditional cartographic methods from which it emerged. These are well suited the study of the spread of disease and its correlation to various social parameters. It is anticipated that the research will provide valuable insights into the relationship between HIV/AIDS spread and socio-cultural

parameters such as tribal habits, personal interaction between tribes and more general social variables such as community size, transport linkages and existing infection rates. The research aims at isolating these variables and identifying their impact on the transmission of infection. In this way policy for the containment of the infection and the identification of high-risk communities may be achieved.

References

1. Oluwoye J. Managing AIDS-Mapping can mitigate the scourge of Africa. Australasian Geographic Information Systems Application Journal, GIS User. 2002a; 49: 54-55.
2. Oluwoye, JO. Application of Statistical Methodology and Model Design to Socio-Behaviour of HIV Transmission. Edited by JC Misra (Accepted as a book chapter in Biomathematics –Modelling and Simulation and will be published by World Scientific Publisher). 2002b.
3. Scholden H.J, de Lepper, M.J.C. The geographical information systems in public and environment health. Raprr Trimest Statist Sanit Mond. 1991; 44, 60-170.
4. Pyle G F. Mapping tuberculosis in the Carolinas. Sistema Terra. 1994; 3: 22-23.
5. Hugh-Jones, M. Applications of remote sensing to the identification of the habitats of parasites and disease vectors. Parasitology Today. 1989; 5: 244-251.
6. Perry B D, Kruska R, Lessard P, et al. Geographic information systems for the development of tick-borne disease control strategies in Africa. Prevent. Vet. Med. 1991; 11: 261-268.
7. Rogers D J, Randolph S E. Mortality rates and population density of tsetse flies coorelated with satellite imagery. Nature. 1991; 351, 739-741.
8. Malone J B, Fehler D P, Loyacano A F, et al. Use of LANDSAT MSS imagery and soil type in geogaphic information system to assess site-specific risk of fasciolasis on Red River Basin farms in Louisiana, reprinted from Tropical Veterinary Medicine: Current Issues and Perspectives. Annals of the New York Academy of Sciences. 1992; 635: 389-397.
9. Mayer J D. The role of spatial analysis and geographic data in the detection of disease causation. Soc Sci Med. 1986; 17: 1213-1221.
10. Gesier W. The uses of spatial analysis in medical geography: A Review. Stat Med. 1986; 23: 963-973.
11. Twigg L. Health based geographical information systems; Their potential examined in the light of existing data sources. Soc. Sci. Med. 1990; 30: 143-155.
12. Marshal R J A. review of methods for the statistical analysis of spatial patterns of disease. J.R. Statist. Soc. A. 1991; 154: 421-441.
13. Walter S D. Visual and statistical assessment of spatial clustering in mapped data. Stat. Med. 1993; 12: 1275-1291.
14. Kabel R. AIDS: Predicting the next map. Interfaces. 1990; 21: 80-92.
15. Oluwoye, J.O. A Mathematical Concept of HIV Transmission and Social Class Segregation. Unpublished Paper (in preparation for International Conference on AIDS and STDs). FDAB, UTS. 2002c.
16. Oluwoye J.O. Long Distance Truck Drivers On-Road Risk-Behaviours and HIV Vulnerability. Unpublished Paper (in preparation for International Conference on AIDS and STDs). FDAB, UTS. 2002d.
17. Dangermond J. Selecting new town sites in the United States using regional data bases. In: 1983.
18. Aronoff S. Geographical information systems. Management perspective. WDL Publications, Canada. 1989; 4.
19. Oluwoye, J.O. 2001. Spatial interaction and social-behaviour of HIV transmission. In Applicable 2000; 11. Mathematics-Its Perspectives and Challenges, Part V, 399-406. Edited by JC Misra, Narosa Publishing House New Delhi, India.
20. Bernhardsen T, Viakt IT, Arendal. Goegraphical information systems. Norway. 1992.