

Building Decision-Making Capacity by using GIS and Urban Indicator Analysis, Dakar, Senegal

Final Report

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International Partners: **Ecole Supérieure Polytechnique (ESP), Université Cheikh Anta Diop de Dakar and the City of Dakar, Senegal**

Context

The Urban Indicators project was funded by U.S. Department of Housing and Urban Development (HUD) The University Consortium of Geographic Information Science (UCGIS) with support from HUD and GIS software manufacturer, ESRI, announced a call for proposals in Fall 2000. Five U.S. universities received funding for one year (Feb 1 2001- Feb 28, 2002). Collectively, the five research projects demonstrate how GI technologies and urban indicator data can be used to conduct analyses at the sub-city (neighborhood) scale in order to empower decision makers in developing countries. Each university worked with one or more international partners.

The University of Wisconsin-Milwaukee (UWM) was one of the five funded universities. Our proposal built upon an existing inter-university partnership between the University of Wisconsin-Milwaukee (UWM) and the Université Cheikh Anta Diop de Dakar (UCAD). In Milwaukee, the research team consisted of faculty from the Departments of Anthropology, Geography, and Urban Planning.

UWM Project Goals

- Develop a set of web-based training modules that will allow researchers and students in developing countries (in this case, Senegal) to use simple spatial analysis techniques and Arc View software to map and analyze local indicator data at a range of scales
- Develop a sustainable and replicable strategy to conduct urban indicator analysis using GI technologies in developing countries such as Senegal

Findings and Policy Implications

- The participatory methods and techniques used in this project, increased awareness among key decision makers in different sectors of the advantages in using urban indicators and GI technologies to make policy decisions and day-to-day management decisions. A direct outcome of our project has been the establishment of a regional GIS steering committee that will facilitate the adoption of these methods and work collectively to strengthen the Dakar region's data and GIS infrastructure.
- Our participatory approach facilitated a robust discussion regarding the selection of appropriate indicators that can be used in sub-city analysis. We learned that decision makers in different sectors (e.g., health, urbanism, education) require context-specific indicators that are sometimes not consistent with the indicators selected for use by the Global Urban Observatory. Decision makers in different sectors expressed a strong desire to be equipped with advanced training (skills) in conducting analyses that integrate their conventional approaches using indicator data with the appropriate use of GIS in order to better achieve their sectoral objectives.
- The UWM team has developed an analysis template that allows decision makers to examine large data sets with many variables in order to investigate a specific problem. This analysis template allows a range of users to examine the same data set to provide relevant information to address different problems such as to solve day-to-day management decisions, strategic planning, emergency services delivery, and for developing policy options. The analysis template is discussed in detail in the section on Project Outcomes.
- The research team investigated the potential benefits and limitations of using ArcIMS to facilitate urban indicators analysis in developing countries. Building on ArcIMS' strengths that lie on the server side, we

recommend the following two uses of the software rather than generalized GIS training. These views are in concordance with the vendor's perspective.

- Development of active server pages-based functions that support urban indicator analysis. This will allow local decision makers to analyze datasets with regular web browsers without any need for sophisticated hard- and software.
- Establishment of a regional spatial data infrastructure with variable access privileges to a multitude of datasets, which fosters collaboration among sometimes competing agencies.

Project Activities (February 2001 – February 2002)

Pre-planning Activities

The UWM team began this project with the belief that the building of strong partnerships with individuals and institutions in Senegal would be critical to the development of a sustainable research and development model. UWM and UCAD, Dakar signed an inter-university partnership agreement in March 2001 that emphasizes long term collaboration that includes activities such as student and teacher exchange, technology and skills transfer, and the development of innovative research projects. The Urban Indicators project was the first project that evolved within the framework of the Inter-University partnership agreement building on initial conversations between Prof. Ajitotutu and Prof. Sock in Summer 2000.

Building Partnerships (February through May 2001)

- At the first Urban Indicators Symposium, Feb 6-7, 2001, held in Washington, D.C, the UWM team gave an overview of the approach to addressing the goals of the Urban Indicators project. The UWM team presented a synopsis of planning issues affecting the City of Dakar and commented on the potential role that urban indicators analysis using GIS could play in that context. However, the team noted that a complete needs analysis was not possible without a site visit and without intensive discussions with agency representatives and other actors from the nonprofit sector. Therefore, the UWM team proposed a site visit partially funded through this project.
- The UWM team also played a proactive role in bringing the activities of the five funded universities closer together by developing a mini database to assemble available research literature on urban indicators and GIS.
- The UWM team established electronic communication with representatives of nongovernmental agencies such as ENDA (the regional training provider and national observatory site in Dakar), and our partners at the University. Mr. Alassane Ba (a lecturer in the Department of Surveying, ESP), working with Mr. Moussa Kandji (Economic Advisor to the Mayor, City of Dakar) developed a list of governmental and non-governmental agencies that could potentially benefit from the GIS training materials developed from this project.
- The UWM team nominated Prof. Sock (a member of our project team from Dakar) to serve on the UCGIS/ Urban Indicators Project Advisory Board. Prof. Sock attended the Second Urban Indicators Symposium in Washington D.C on January 7-11th, 2002 in this capacity.

Site Visit and User Needs Assessment (June 26 to July 10, 2001)

Dr. Laxmi Ramasubramanian led the research team that visited Dakar and spent two weeks to conduct a user needs assessment. The team members first met with the Mayor of Dakar, Mr. Mamadou Diop. The Mayor discussed several urban problems affecting the City of Dakar and the entire metropolitan region. The research team also met with the department heads of various city agencies including the departments of Urbanism, Works, and Health and Social Development. The research team conducted individual meetings with decision makers from state and non-governmental agencies. In an informational seminar to representatives from the national government, the City, several large NGOs and university faculty, the research team introduced its ideas for sub-city level urban indicator analysis. During this meeting, the research team displayed U.S examples of how GIS could be used to conduct participatory research and indicator analysis at the sub-city level.

GIS Infrastructure at UCAD

Both ESP and UCAD have a modest infrastructure capable of supporting GIS training. At the time of our visit, the surveying department (located in a satellite campus in the City of Theis) had dedicated three computers running

Windows 98 for the use of students interested in acquiring GIS skills. There is a long-term plan to develop and maintain a complete GIS lab. By participating in this project, ESP received ArcView 3.2 and ArcIMS, as well as access to six ESRI Virtual Campus courses. Concerned about sustainability of this work beyond the life of the project, our partners requested us to pursue the delivery of software updates.

GIS Infrastructure at Government Departments

All government officials we visited, in particular the Departments of Health, Social Development and Urbanism, had personal computers capable of running GIS software such as ArcView. However, none of these individuals had access to GIS software.

Data Infrastructure Assessment

The National Ministry of Geography and Cartography has a digital base map of the Dakar metropolitan region with support from the Japanese International Development Agency. While the database contains limited attribute information, it is invaluable to begin the identification of sub-city areas that will ultimately be the focus of the research. The database consists of land use classifications derived from a SPOT satellite image.

Many of the non-governmental agencies such as ENDA and CSE have access to different datasets collected for small studies or surveys. As such, the data infrastructure is poorly organized and not maintained adequately. For example, our primary data source for attribute data is from the National Census (1987), which consists of information about the population and housing characteristics. Although this information is dated, it is the most up-to-date information that is available to outside researchers.

Geo-referenced street network files for the city of Dakar do not exist. Paper maps created for the purpose of beginning data collection for the 2001 census were purchased from the National Department of Statistics. These maps are at a very detailed scale (1: 2000). For the purposes of this project, paper maps of the neighborhood of Ouakam were digitized at UWM for the purposes of building a dataset for use in the training modules.

Skills Assessment

The Dakar region has several individuals who are skilled in various aspects of research and analysis using GIS and urban indicators. Many of them have received rudimentary training in using GIS through short courses and seminars. Through this project, we have identified individuals interested in evaluating and further refining the training modules being developed through this pilot project. Together this group represents the university, government and civil society organizations.

Education and Training

Prof. Jochen Albrecht ran a two-day intensive course that introduced GIS and the use of ArcView software to seventeen students and an instructor from the Department of Surveying and Civil Engineering at ESP. The students were very enthusiastic to acquire GIS skills training and were very comfortable in working with software and training material developed in English (although we used an interpreter to translate the instruction into French).

Development of Training Materials (August to December 2001)

Philosophy

GIS, in addition to facilitating data analysis at a variety of scales also facilitates the integration of data from a variety of sources. Based on our research on GIS adoption and our experience in the field, we determined that in order to have maximum impact, it was necessary to:

- Develop a data set that includes local geography and locally relevant attribute information
- Develop training modules that focus on problem solving (in this case, how to use urban indicators to make decisions, e.g., day-to-day management decisions, service delivery decisions, or policy decisions)
- Field test the training modules and incorporate feedback from users in the final product

Data Development

The working data set is based on data from the 1987 Census of Population and Housing. The census data we received held over 800,000 records with data about individual attributes. However, in the absence of data regarding housing characteristics, the UWM team selected variables such gender, age, marital status, education level, languages spoken, residential status, employment status, and ethnicity from the dataset to display on maps at the sub-city scale.

Some of the selected variables dovetail quite well with the Global Urban Observatory's description of urban indicators related to Gender Equality. In addition, these variables can be used to develop proxy measures or indicators to better understand the nature of informal employment or migration in the Dakar region.

Base Map Development

At UWM, a digital map of Ouakam neighborhood (called a Commune d'Arrondissement) was created by digitizing paper maps acquired in Dakar. The Ouakam neighborhood consists of 35 smaller areal units, with each areal unit supporting an average population of approximately 1000 people. All our analyses are restricted to this scale.

Project Outcomes

Training Modules and Data Set

Four training modules were developed for this project. Together, they provide decision makers with tools to examine population data at the sub city scale. While each module stands alone, the modules are organized in a sequence of increasing complexity. Each module introduces the user to GIS and geographic concepts using a problem solving approach. The data set has been developed for training purposes exclusively for the purposes of this project. They can be viewed at <http://www.geog.umd.edu/complab/UCCIS/HUD>. Prof. Albrecht wrote the training modules with assistance from Dr. Laxmi Ramasubramanian and graduate students Terry Johnson, Andy Park, and Femke Reitsma.

Module 1: Introduction to ArcView

This is a basic introduction to functionalities within ArcView 3.2 using data about the African continent and Senegal

Module 2: Organizing Spatial Data

Users learn to import GPS data (X, Y coordinates) and digitize a portion of a map based on a satellite image.

Module 3: Analyzing Geographic Patterns and Processes

Users explore the entire training data set in order to investigate a specific problem by using a series of filters (successively narrowing search criteria). Since this module forms an integral portion of the UWM contribution, it is discussed in further detail.

Goal

To facilitate a simple, easy to use sequence of steps that will allow an informed user to investigate data available to him or her. In this situation, the intended audience consists of decision makers or managers who may be using the same data for different purposes.

Caveats

Users must be familiar with the specific dataset(s) they are using and their limitations in order to avoid arriving at spurious conclusions. This training dataset is not an accurate representation of the reality of the neighborhood of Ouakam. It has been constructed for training purposes only.

Procedure

The data is referenced by spatial location. The user, following a pre-selected sequence of steps, successively narrows down the search criteria by using pre-defined queries. For instance, they can:

1. Display in table form a list of all individual records for residents in a particular geographic area such as a neighborhood by identifying the neighborhood by name (in this case, Ouakam). The data can also be displayed on a map.
2. Within Ouakam, a map showing the location of all people of *Wolof* ethnicity can be displayed at the sub-areal unit (census area unit, approximately 1000 people). Percentages of a particular ethnic group in each area can be calculated and displayed alongside.
3. Display all individuals with *Wolof* ethnicity that are also employed.
4. Display all women who are *Wolof*, who are also employed
5. Display concentrations of women, of ages between 25-44 years, who are *Wolof*, and are also employed for each sub-area within Ouakam neighborhood.

Based on data availability, these analyses can be used to:

- explore the issue of gender equality (employed women) within a commune d'arrondissement or compare across communes within the city.
- Explore the emerging spatial patterns that are generated by this type of filtering so that a closer analysis with field surveys or site visits can be initiated.

An obvious use of such analyses is to highlight differential access to resources for women of particular ethnicity. Further use of analyses relates to service delivery, such as siting of new facilities for day care in Ouakam neighborhood. We anticipate that the queries that users generate will enhance the growing awareness of the benefits of conducting sub-city (neighborhood) level analyses using a small suite of key indicators.

Module 4: Display and Presentation

In this module, users learn to display and print maps using the Layout function of ArcView. They also learn to insert their maps and tables into other programs such as PowerPoint in order to make presentations.

Presentations and Publications

Dr. Laxmi Ramasubramanian presented a paper titled Analyzing urban indicators using GIS: Building local capacity in developing countries through participatory research, which was included in the *Proceedings of the 7th International Conference on Computers in Urban Planning and Urban Management (CUPUM)*, July 18th–21st, 2001, at the University of Hawaii at Manoa, Honolulu, Hawaii. A modified version of the paper is currently under review for a special issue of *Computers, Environment and Urban Systems*.

Prof. Jochen Albrecht presented a paper titled Autocorrelation-proof Empirical Bayes Mapping for Urban Indicator Analysis, which was included in the *Proceedings of the 7th International Conference on Computers in Urban Planning and Urban Management (CUPUM)*, July 18th–21st, 2001, at the University of Hawaii at Manoa, Honolulu, Hawaii.

Prof. Bill Huxhold participated in a special session of a United Nations Habitat conference.

Prof. Bill Huxhold presented preliminary findings from this project at a special session at the Urban and Regional Information Systems Association (URISA) conference held in Long Beach, California.