

**TOWARDS SUSTAINABLE DEVELOPMENT:
USING GIS TO IDENTIFY AND ASSESS OUR ENVIRONMENTALLY
CHALLENGED LANDS (Examples from Ghana)**

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ABSTRACT

For decades the continent of Africa has engaged in the extraction of natural resources from the earth. This continues to contribute immensely to the economic well being of the region.

Nonetheless activities such as mining, construction and timber logging among others have left behind a legacy of environmental degradation and contamination. In order to redevelop these environmentally challenged areas to a socially friendly and economically viable state, there is the need for strategic review of the sites. This is usually through a process of site identification, environmental risk assessment and analysis and eventually coming up with sustainable redevelopment plans.

Emerging Technologies like Geographic Information Systems (GIS) are now being implemented in most of our institutions to support such development plans. The system offers visualization and analysis tools that enable examination of these problem areas. Although some results are being achieved with these new technologies there is still room to further utilize the system to achieve sustainable development goals. There is the need to sustain the system itself. Organizational, Technical and other factors have been identified as drawbacks to fully utilizing the system in most developing countries today.

INTRODUCTION

The challenge for Ghana today, like many other developing countries, is to improve the economic and social well being of the fast growing population with limited resources through Sustainable Development Plans. There is now the rapid search for appropriate technologies that would facilitate these plans set for the country.

Institutions like the Survey Department of Ghana, Geological Survey Department, the Metropolitan Authorities, District Assemblies, Town and Country Planning Department to name a few, all have the responsibility of contributing to the development of the entire nation. Although their areas of interest and responsibilities vary, they all rely heavily on information for their decision-making, services, resource allocation and much more to achieve national goals.

Thankfully many institutions are beginning to appreciate the important role Geographic Information Systems plays in these development plans. It is heartwarming to see all the analogue maps which have long served as an information base for these institutions being transformed into digital formats to be used in a GIS for analysis and decision-support.

This paper highlights some of the techniques and challenges in the implementation process by some of the institutions. It concludes with recommendations of how to fully utilize the GIS to attain sustainable development for the nation as a whole. Examples in this paper are drawn from some Ghanaian institutions from an external viewpoint.

GIS AND SUSTAINABLE DEVELOPMENT

Many definitions have been given for GIS; many are based on perspective or purpose. For this paper however, Grimshaw's definition is used.

“A geographical information system is a group of procedures that provide input, storage, retrieval, mapping and spatial analysis for both spatial and attribute data to support decision-making activities of the organization.” (Grimshaw, D.J. (2000) *Bringing GIS into Business*).

The focus is on three keywords in this definition: *procedures*, *spatial analysis* and *decision-making*. These keywords are highly relevant to the concept of GIS and Sustainable Development Issues discussed in this paper.

Also the concept of sustainable development would be looked at from the developers perspective which is "*Economic and social development that meets the needs of the current generation without undermining the ability of future generations to meet their own needs*". World Commission on Environment and Development (WCED) 1987

Fusing the two concepts together gives a better understanding as to why GIS plays an important role in our sustainable development process today.

It is apparent that 90% of sustainable development decisions if not more, are inherently cross-sectoral or multi-sectoral – *for example when land needs to be reclaimed after a long period of mining activities for development it might require people and data from sectors like environment, mining and agriculture/ forestry for a mutual decision to be taken*. The GIS technology can help establish this *cross-sectoral* information and communication by integration and analysis of data from the different sectors. The results of the analysis offers insight into the place, helps to focus action plans or otherwise select appropriate alternatives.

Also Sustainable Development is complex and requires a lot of analysis and modeling. As we strive not to undermine long term development plans, there is

then the need to undertake *what-if* analysis and modeling to achieve best results. As the GIS technology continues to evolve it provides us with more Geoprocessing or Analysis tools to analyze these complex issues.

To attain sustainable development it is vital to have accurate and timely information that would be the basis for better decisions or informed decisions. The equation for this is the integration and processing of data to get information, which is the end-product of a GIS. Sustainable development also requires this end-product of GIS as a by-product to support decision-making processes. This is illustrated in Figure 1 below.

The good news today is most institutions in Ghana are beginning to understand these concepts and appreciate the powerful role information plays in our decision making.

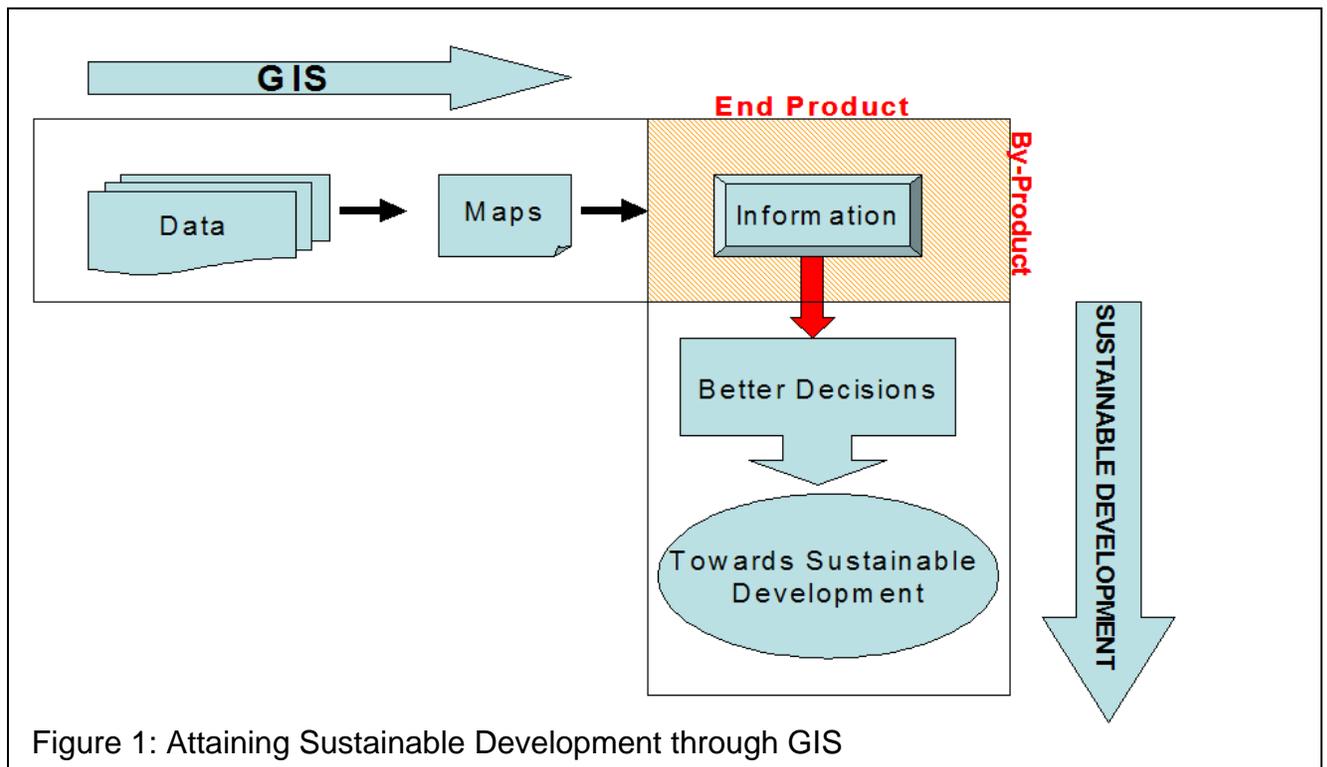


Figure 1: Attaining Sustainable Development through GIS

The Steps in the GIS Implementation Process (Ghanaian Context)

The success or otherwise failure of most GIS projects in Ghana have been greatly influenced by the implementation process adopted. The important factor is sustaining the system itself to attain sustainable development goals. Figure 2 below illustrates the various steps that are usually followed in the implementation process.

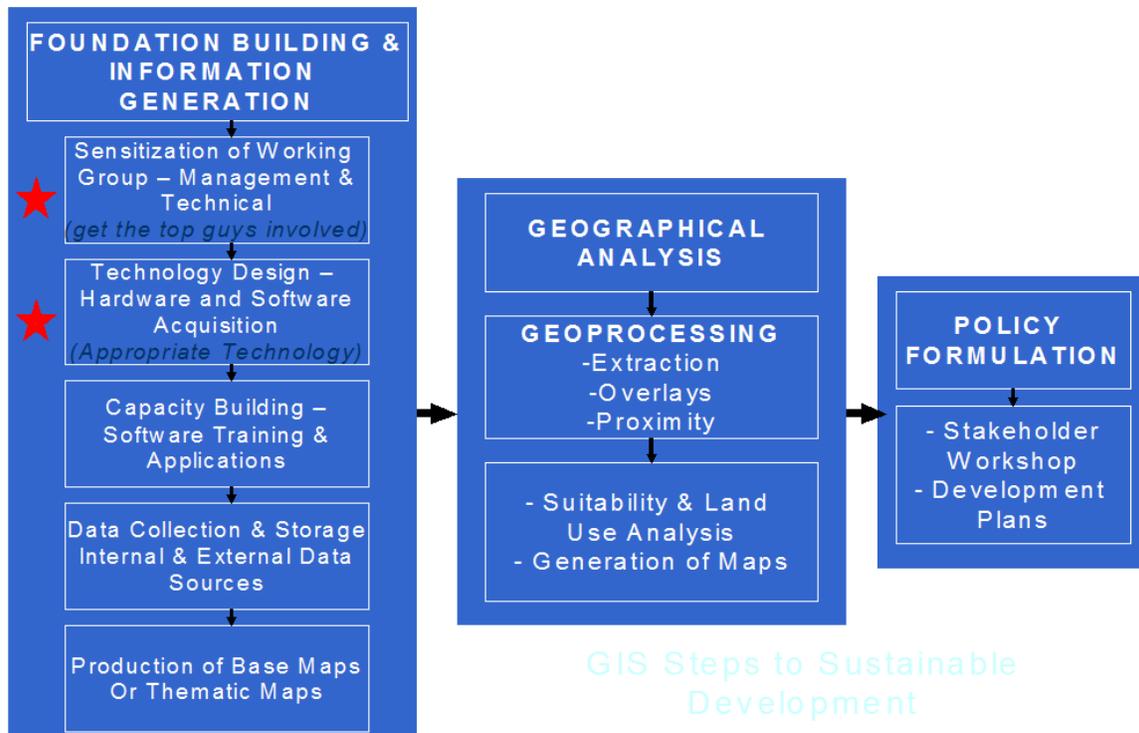


Figure 2: GIS Implementation Steps for Sustainable Development

The steps discussed below highlight some of the levels of the implementation process that tend to be of great importance.

1. Foundation Building and Information Generation

It is very important to get everyone and all stakeholder institutions involved in the system. From the finance people, departmental heads, IT and all potential users. This is usually done through sensitization seminars or conferences. It is from this level that the planning process is then clearly defined. This stage serves as a litmus test to determine if the working group would welcome the technology or not.

Also of importance at the Foundation stage is the Technology Design which focuses on the Hardware and Software acquisition and compatibility. At this stage it is important to clearly identify which software would be appropriate for the organizational needs and which hardware would be compatible.

2. The Geographic Analysis & Modeling

This stage is where the GIS comes into action. It focuses on Identification of patterns and relationships in the geographic data. Geoprocessing Tools or analysis tools are increasing rapidly and range from tools for querying, extraction, overlay and proximity analysis of the geographic data. The Analysis highlights

the measure of spatial distribution of phenomenon, and the existence of patterns and relationships under the study. It is the results of this stage that give an insight into the problem area for solutions to be provided.

3. Policy Formulation

This third and final stage of implementing the GIS for Sustainable Development within our institutions highlights the utilization of the results from the GIS in stage 2 – Base Maps or Thematic Maps. It brings together stakeholders to review the final output of the GIS Suitability Maps to support development plans through Land Use options or constraints.

SOME EXAMPLES

Example 1: ELMINA – KEEA District Assembly

Elmina is a Tourist destination in Ghana under the KEEA District. Fishing is also a vibrant economic activity in the area. The area is faced with environmental challenges as land degradation and water pollution. To solve these environmental and other problems the District Assembly implemented a Project level GIS.

Figure 3: View of Elmina



The GIS implementation was used to integrate data on the various environmental factors for analysis using ArcView GIS software. Training on the software and

applications was also carried out for the district assembly staff who were to use the system for the first time.

Figure 4: Integration of Data using ArcView GIS

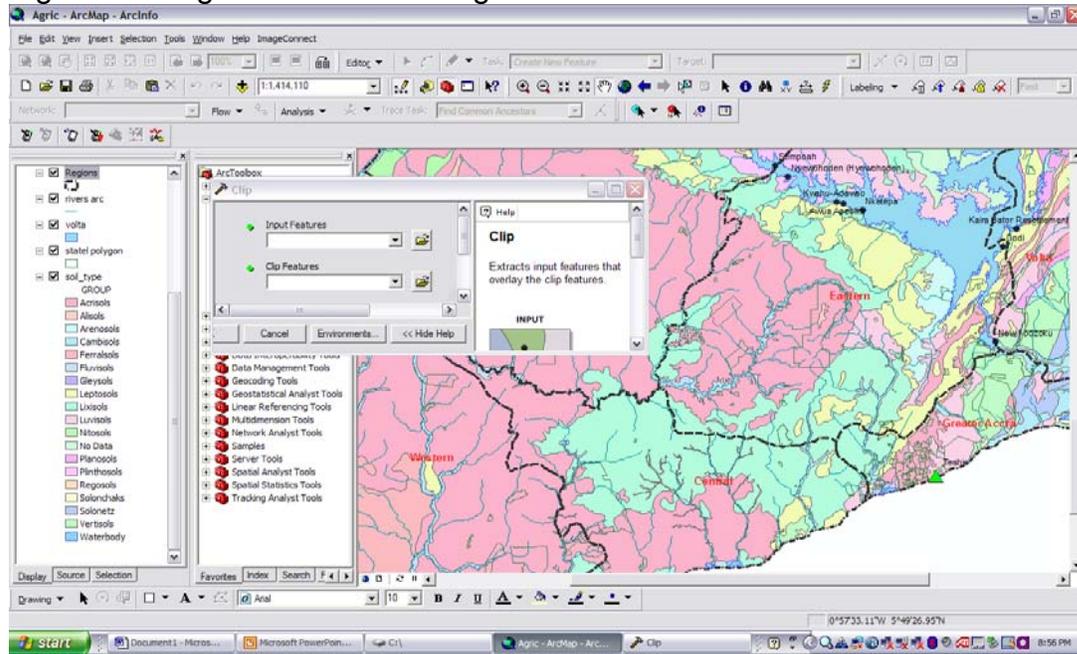
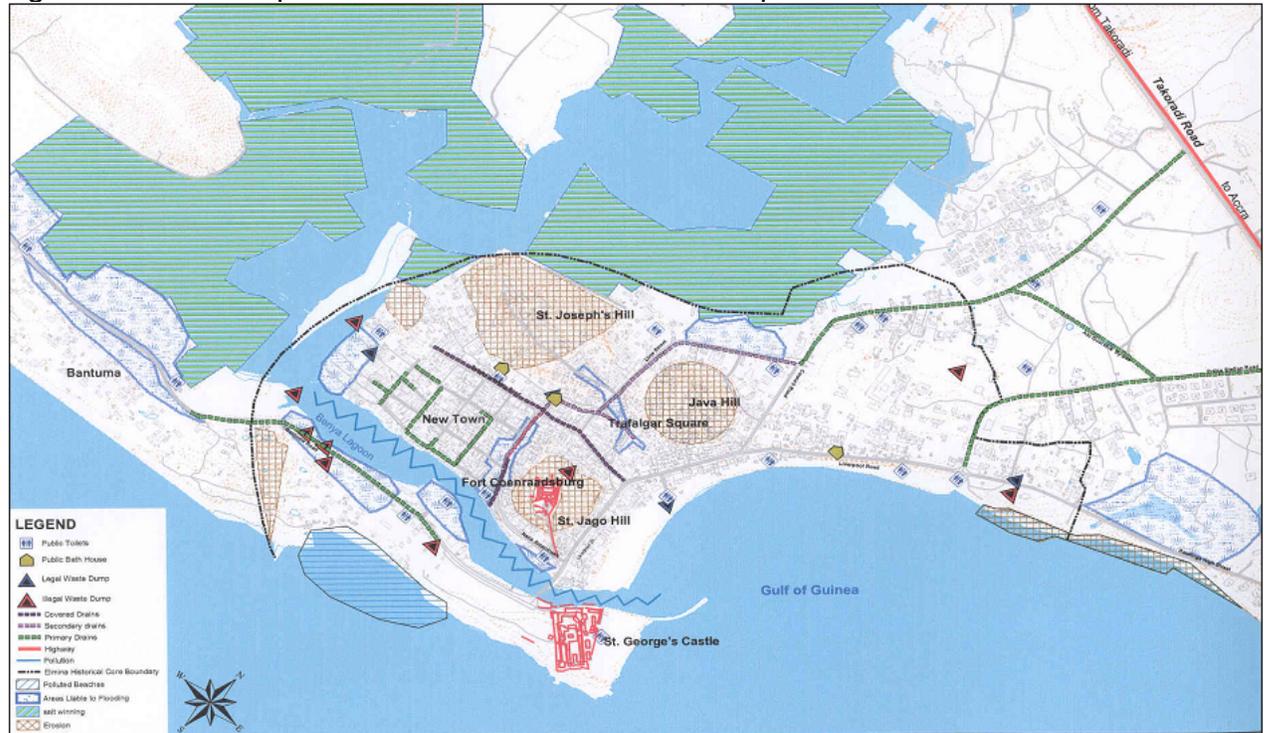


Figure 5: Problem Identification & Visualization in a GIS



The Results of the analysis of the Elmina area were presented as an Action Map for the sustainable development alternatives to be planned.

Figure 6: Action Map of Elmina for Sustainable development



Example 2: Greater Accra Metropolitan Area - Geological Survey Department GIS Project

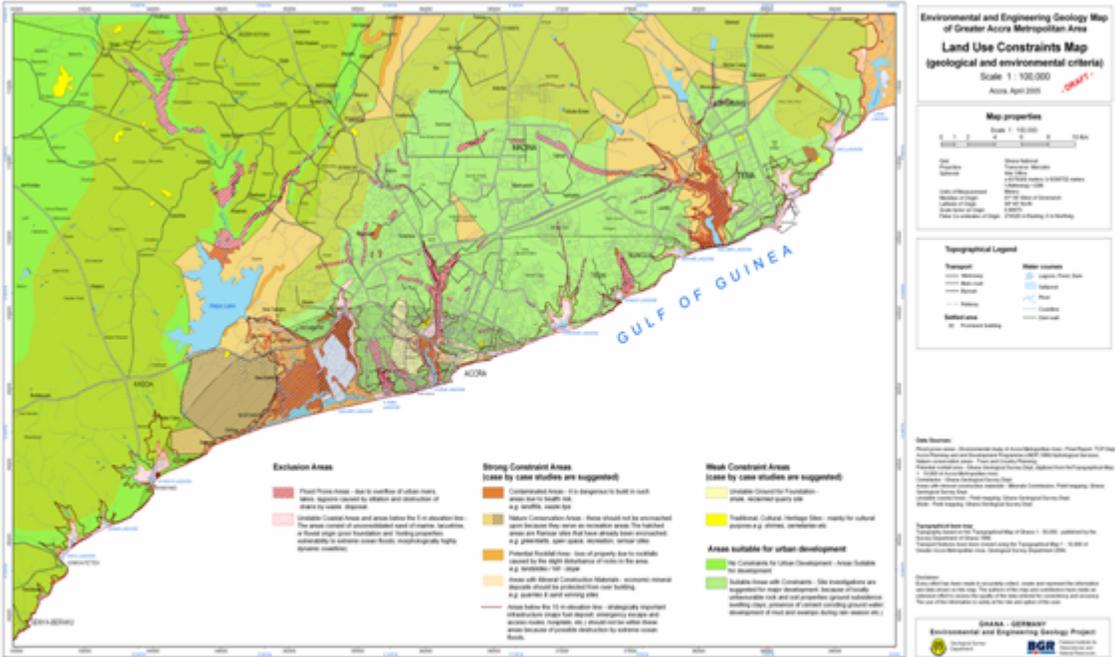
The Geological Survey Department of Ghana also implemented a GIS to address the environmental geological issues in Ghana. The final results of the GIS was to produce Land Use Maps for planning purposes. This was based on a geological assessment of the Greater Accra Metropolitan Area. To do this a thematic map of Ghana was built based on existing underlying rock type. Suitability maps were also produced based on set conditions and rules. This was then used to prepare suitability maps to determine the kind of development activities suitable for different areas.

Figure 7: The constraints that were set for the analysis

- **EXCLUSION AREAS** – THESE AREAS SHOULD BE EXEMPTED FROM ANY SORT OF DEVELOPMENT.
- **STRONG CONSTRAINT AREAS** - THESE AREAS COVER ALMOST TWO THIRDS OF THE TOGO SERIES. DEVELOPMENT IN SUCH AREAS SHOULD BE RESTRICTED AND ONLY ALLOWED AFTER A CASE-BY-CASE EXAMINATION.
- **WEAK CONSTRAINT AREAS** - THESE ARE AREAS WITH WEAK RESTRICTIVE CRITERIA FOR CONSTRUCTION DEVELOPMENT. THEY COVER ALMOST TWO THIRDS OF THE ACCRAIAN FORMATION.
- **AREAS SUITABLE FOR URBAN DEVELOPMENT** - IT HAS BEEN DIVIDED INTO TWO CATEGORIES
 - **SUITABLE AREAS WITH CONSTRAINTS** - THE SUITABLE AREAS WITH CONSTRAINTS COVER THE DAHOMEYAN SYSTEM.
 - **THE AREA OF NO CONSTRAINTS** FOR URBAN DEVELOPMENT COVERS THE GRANITOIDS.

Figure 8: Land use maps based on set suitability constraints

LAND USE CONSTRAINTS MAP OF GREATER ACCRA METROPOLITAN AREA



The Process:

- Overlaying maps with engineering constraints
- Overlaying maps with land use constraints
- Ranking constraints shown on the overall environmental constraint map
- Transforming ranks of constraint into ranks of suitability

The Challenges

Although much seems to be going on in the implementation and use of GIS in Ghana today, there are still many challenges that do not make the impact of this technology to be fully translated into our decision making process.

Organizational Factors:

- Most of the GIS implementation is by Government Agencies that are conservative and bureaucratic.
- GIS is a technology outside the experience of many senior managers
- High resistance to change pattern of work
- Staff willingness and personal beliefs about computerized technology

Technical Factors:

- Hardware and systems compatibility – *failure to link GIS to existing software and hardware*
- Inappropriate software acquisition
- Low Technical knowledge

Other Factors:

- Initial cost of GIS *seems* high
- Cost-benefit analysis absent in the implementation process
- Data cost very high
- Lack of compatibility between data sets
- Project or Departmental Level GIS rather than Web or Enterprise GIS Solutions
- Mostly donor funded GIS Projects which comes to an end when funds run out

Recommendations & Conclusion

Our world is evolving with a lot of issues on natural resources, population, urbanization, pollution, biodiversity, science, technology, and more. GIS should be recognized as a critical infrastructure for sustainable development plans.

It is vital that as we implement this new technology for sustainable development there is also the need to ensure that the system itself is sustained. Institutions should collaborate more to avoid duplication and eliminate high costs. There is the need to shift from isolated desktop applications to enterprise or web based applications to achieve the full benefits of a GIS for sustainable development.