GIS:
Supporting Environmental Planning and Management in West Africa

Principal Authors

André Bassolé *(consultant, Burkina Faso, Chairman of the Board, EIS-AFRICA)*

Jake Brunner *(formerly World Resources Institute, Conservation International)*

Dan Tunstall *(World Resources Institute)*

Collaborating Authors

Frédéric Ouattara (Burkina Faso)

Nestor Compaoré (Burkina Faso)

Anzoumana Koné (Cote d'Ivoire)

Ndey-Isatou Njie (The Gambia)

Abdoulie Manneh (The Gambia)

Baboucar Barry (The Gambia)

This synthesis report is available in French and English editions. The 13 case studies and both editions of the synthesis report are available on the WRI website at www.wri.org and from EIS-AFRICA at www.eis-africa.org. A CD-ROM with both the English and French synthesis reports and all the background case studies is available from WRI and EIS-AFRICA. The materials can also be found on websites supported by USAID, www.frameweb.org and www.afr-sd.org (emis).

A Report of the Joint USAID/World Resources Institute Information Working Group for Africa

November 2001

Carol Rosen
Publications Director

Hyacinth Billings
Publications Manager

Maggie Powell
Cover Design and Production

Each World Resources Institute report represents a timely, scholarly treatment of a subject of public concern. WRI takes responsibility for choosing the study topics and guaranteeing its authors and researchers freedom of inquiry. It also solicits and responds to the guidance of advisory panels and expert reviewers. Unless otherwise stated, however, all the interpretation and findings set forth in WRI publications are those of the authors.

ISBN 1-56973-491-7
Printed in the United States of America on recycled paper.

Contents

Acknowledgments

We wish to thank our co-authors for helping to compile information, draft country and case study reviews, and organize country workshops. Their hard work made this report possible. In a broader context, it is their expertise and dedication that have been (and will continue to be) responsible for helping to overcome the many barriers standing in the way of bringing spatial information and GIS technology to bear on social, economic, and environmental problems in their countries.

The co-authors and national coordinators are: Frédéric Ouattara and Nestor Compaoré (Burkina Faso); Ndey-Isatou Njie, Abdoulie Manneh and staff of the National Environment Agency, and Baboucar Barry (The Gambia); and Anzoumana Koné and staff at the Comité National de Télédétection et d'Information Géographique in Côte d'Ivoire.

We would also like to thank our colleagues on the joint USAID/World Resources Institute Information Working Group for Africa (IWG) who helped define the project and select the focal countries. The IWG reviewed the methodology, the principal findings, and the recommendations at its annual meetings. A full list of the members of the IWG can be found in Annex 6.

This report would not have been possible without the support of Karen Holmes, our principal editor and writer, and Jillian Salvatore, who helps administer the work of the IWG and provides outstanding administrative support to the WRI Information Program. Hassan A. Hassan graciously provided the Preface, based on his long experience in bringing information technologies to bear on the difficult development problems in Africa.

Finally, we want to thank the reviewers of the manuscript. WRI reviewers include: Susan Minnemeyer, Norbert Henninger, Mathilde Snel, and Anthony Janetos. External reviewers included: Peter Gilruth (formerly UNDP/UNSO, currently Raytheon), Peter Freeman (Development Ecology Information Service), Paul Bartel (USAID/AFR/Sustainable Development), Patrick Gonzalez (Famine Early Warning Program, US Geological Survey), Jacob Gyamfi-Aidoo (Executive Director, EIS-AFRICA), and Bob Kakuyo (UNEP, Department for Early Warning and Assessment). We appreciate their interest in this work and the many suggestions and observations they made. However, the final wording of the report is solely our responsibility.

A.B.

J.B.

D.T.

Preface

Most rural Africans depend on natural resources—the land, water, and wildlife—for their livelihoods. Even those living in the towns and cities rely on clean air and water, sanitation services, and proper waste disposal to maintain the health and well being of their families.

This report, *GIS: Supporting Environmental Planning and Management in West Africa*, is an important one for those of us committed to improving the management, use, and conservation of natural resources and the environment in Africa. What is uniquely useful about this study is that authors in three countries—Burkina Faso, Côte d'Ivoire, and The Gambia—have identified and documented successful attempts to use modern information technologies, specifically geographic information systems (GIS), to improve the quality of public decision-making in their countries, particularly with respect to the environment and natural resources management.

From Burkina, we have examples of using GIS to enhance the management of regional water systems, to plan for drought and provide early warning of famine, and to develop national environmental action plans. In Côte d'Ivoire, we see that GIS is being used to strengthen management of forest concessions, boost collection of local taxes, and make better decisions about investments in new public services and infrastructure. GIS is being deployed in The Gambia to identify the most suitable sites for new waste disposal facilities in the Greater Banjul area, as well as to help optimize agricultural investment and production while protecting the environment and natural resource base. I know from my experiences in Ghana, Kenya, Nigeria, Sudan, and Uganda that there are many other examples of policymakers beginning to use geospatial information to strengthen their decision-making processes and in turn to make this information available to the public.

We in Africa need access to the best possible information on our natural resources so we can derive optimal value from them, maintain our natural capital, and enhance people's incomes and living standards.

The sponsors of this study, the joint USAID/WRI Information Working Group, along with their many collaborating African authors, are to be congratulated. Their report sheds much needed light on how Africans are making use of these important information technologies. Thanks to this effort, more experts and policymakers throughout Africa can learn from these experiences and become inspired to document their own.

Much remains to be explored and learned, however. We look to such groups as EIS-AFRICA, the newly formed pan-African NGO, and the African Association of Remote Sensing for the Environment to continue to support the development and use of GIS and provide the networks and meeting places for bringing Africans together to share ideas, information, and technologies.

I strongly recommend to my colleagues in the international agencies and governmental organizations that we sustain these initial efforts and help develop the training capacity and the underlying information systems needed to create more such success stories.

Hassan M. Hassan — Sudan
Former Lead Environment Specialist,
Team Leader Natural Resources,
World Bank

Executive Summary

Access to timely, accurate information is fundamental to sound decision-making. Geographic Information Systems (GIS) is an information technology increasingly used in public policymaking, particularly for environmental planning and management. Over the past decade, international assistance agencies have worked to help developing countries, especially in Africa, adopt GIS as a tool for strengthening environmental policy development.

This study examines the uses and impact of GIS in policymaking in Africa. Sponsored by the Information Working Group for Africa (a joint activity of the U.S. Agency for International Development and the World Resources Institute) and carried out in close collaboration with EIS-AFRICA, a pan-African non-governmental organization and network of GIS experts, the study's objectives were to:

- increase understanding of the impact of GIS-based analysis on environmental planning and management in West Africa; and
- encourage and provide a basis for dialogue between decision-makers and GIS analysts in West Africa and elsewhere on the continent.

Several key premises provide a conceptual framework for this study. In essence, the hypothesis is that, for GIS to have a significant impact on policy requires not only equipment, data, and trained staff, but also an active dialogue between scientists, GIS experts, policymakers, and civil society. Policy dialogue stimulates the emergence of a demand for GIS analysis, which generates data products and services. Awareness of novel GIS applications gives rise to new ideas among decision-makers, who identify needs for GIS analysis, leading to increased demand, and the cycle continues. These interactions are most effective within a fully supportive geo-information policy environment at the national level.

The study was carried out over a two-year period (January 1999–December 2000) and focused on three West African countries: Burkina Faso, Côte d'Ivoire, and The Gambia. Two levels of assessment were targeted: a "macro-level" assessment involving a review of GIS activities at the country level, and a "micro-level" review of four or more specific projects with a GIS component for each country. The macro assessments highlighted the levels of: national awareness of GIS and its uses in policymaking; capacity development; and supply and demand for GIS products and services in the country. Analysis of micro-level case studies examined the policy and other impacts of GIS activities, as well as related issues and problems concerning the application of GIS to policymaking in each country.

Because the use of GIS is in its early stages in many West African countries, and because policymakers remain relatively unaware of its benefits, the achievements to date of GIS-based analysis are perhaps not spectacular. However, several important results have been observed, falling into three general categories:

- planned impacts,
- opportunistic impacts, and
- multiplier effects.

With respect to **planned impacts**, GIS has successfully helped to: identify and guide needed government action on environmental planning and management; enhance the accuracy and efficiency of government operations; increase the transparency of government decision-making; and help build national networks of geo-information professionals. For example, in Burkina Faso, GIS analysis undertaken for a famine early-warning program provided timely and accurate predictions of crop production shortfalls, enabling the government to take corrective measures. In Côte d'Ivoire, introduction of GIS-based tools has helped increase the efficiency and transparency of forest management as well as improving public management in other economic sectors, including transportation and health care.

In some cases, the policy impacts of GIS analysis were indirect and unexpected. In one such example of an **opportunistic impact**, the on-site inspection of areas

selected through GIS analysis as suitable for future waste-disposal facilities in The Gambia revealed that some of the areas were actually human settlements. These findings led to the development of draft legislation to reform the official recording of land allocation to make the system more comprehensive.

GIS-based analysis performed for one project can often exert **multiplier effects** by attracting attention from far afield. The GIS components of various projects in West Africa have generated much interest among policymakers from other ministries and neighboring countries. For instance, GIS analysis of water resources in Burkina Faso spurred visitors from Côte d'Ivoire, Mali, and Togo to use these analyses to plan their water basin projects. In Côte d'Ivoire, spatial databases built for one municipality of Cocody have led several others to adopt similar tools for managing their territories.

Based on the findings of the macro- and micro-level studies and associated interviews and national workshops, this report puts forward several recommendations for achieving the optimal contribution of GIS technologies to policymaking in Africa:

1. *Expand Awareness of GIS Value and Use.* Greater awareness is needed among African decision-makers of the value and usefulness of GIS analyses. This can be brought about through, among other things, briefings and workshops where policymakers have an opportunity to gain a better understanding of how GIS tools are developed and used.

2. *Strengthen the Policy Dialogue Process.* The processes for encouraging and enhancing dialogue between policymakers and GIS practitioners should be strengthened in all three countries studied. The process should be user-driven and should feature input from all levels of users (i.e., mid-level as well as senior government officials) and from civil society and other stakeholders.

3. *Establish National Geospatial Information Policies.* All African countries should establish national geospatial information policies that address key issues and problems related to how this information is developed, accessed, and used. Some principal issues and problems include: how to enhance access to information and information sharing; setting the rules that determine standards and protocols for data collection, storage, labeling, and integration; data ownership; confidentiality and privacy; and copyright protection.

4. *Strengthen Local Capacity.* Capacity building is an essential component of developing national GIS strategies in West Africa. GIS capacity should receive more attention from the government and education sectors, and capacity should be developed and based in universities and the private sector as well as government agencies.

5. *Expand Access to Geospatial Information.* The results of GIS analyses—including databases, maps, and studies—should be made available to the public through the media, through regular government and private marketing and distribution channels, and increasingly through the Internet. Wider access will help strengthen the policy dialogue process by requiring policymakers to be more transparent in how they make decisions on resource pricing, allocations, concessions, revenues, and use.

6. *Continue to Study the Use of GIS in Policymaking.* Each African country should conduct a periodic review of the development and use of GIS, taking into account the interests of the public, government, business, NGOs, academia, and other affected parties. In addition, more countries in Africa should develop case studies on the use of GIS in policymaking, thus building a stronger network of GIS users and experts.

Introduction

Information plays an important role in the formation and implementation of policy. The provision of timely, accurate, useful information can spell the difference between a desirable policy outcome and an indifferent or even damaging one. Making such information widely accessible can elevate the policy debate within government as well as between government and citizens.

Geographic Information Systems (GIS) is an information technology that has found increasing application in public decision-making — particularly in environmental planning and management — over the past 20 years.

> *GIS is a "system of computer software, hardware, data, and personnel to help manipulate, analyze, and present information that is tied to a spatial location."*[1]

GIS allows users to collate and analyze information far more readily than is possible with traditional research techniques. With GIS, investigators can map, model, query, and analyze large quantities of data all held together within a single database.

In many countries, GIS is now used extensively in government, business, and research for a wide range of applications. Important uses include environmental resource analysis, land-use planning, locational analysis, tax appraisal, utility and infrastructure planning, real estate analysis, marketing and demographic analysis, habitat studies, and archaeological analysis.

Over the past decade or so, international assistance agencies have been engaged in efforts aimed at helping developing countries, particularly in Africa, to adopt GIS technology. These efforts have encompassed acquisition of computer software and hardware as well as the development of human capacity to apply GIS technology in environmental policy development.

The time is right to ask: How is GIS being used by developing-country policymakers? What impact has there been on the decision-making process and the quality of decisions made? This study aims to help answer these questions in the context of environmental planning and management in Africa. It is sponsored and overseen by the Information Working Group for Africa (IWG), a joint activity of the U.S. Agency for International Development (USAID) and the World Resources Institute (WRI). The IWG was formally established in March 1998 to:

- identify issues and opportunities relating to the use of information technology for improved environmental policy analysis in Africa;
- supervise the preparation of studies from the state of the art application of information technology for environmental monitoring and policy development and assessment; and
- advise African and USAID staff and institutions as needed on how to harness information technologies to address specific strategic objectives.

This study was carried out in close collaboration with EIS-AFRICA (the former EIS Program in sub-Saharan Africa), an African NGO and network of experts with knowledge of GIS-supported projects in Africa. Specific objectives of the study are to:

- increase understanding of the impact of GIS-based analysis on policy issues related to environmental planning and management in West Africa; and
- encourage and provide a basis for policy dialogue between decision-makers and GIS analysts in West Africa and elsewhere on the continent.

The intended audience for the study is primarily African policymakers and GIS practitioners. It also may be of use to those concerned with international assistance for policy and technological cooperation, especially as it relates to environmental protection and natural resources management. Other potential readers may be those interested specifically in GIS and the processes by which the applications of this technology are being propagated throughout the world.

1. http://www.gis.com

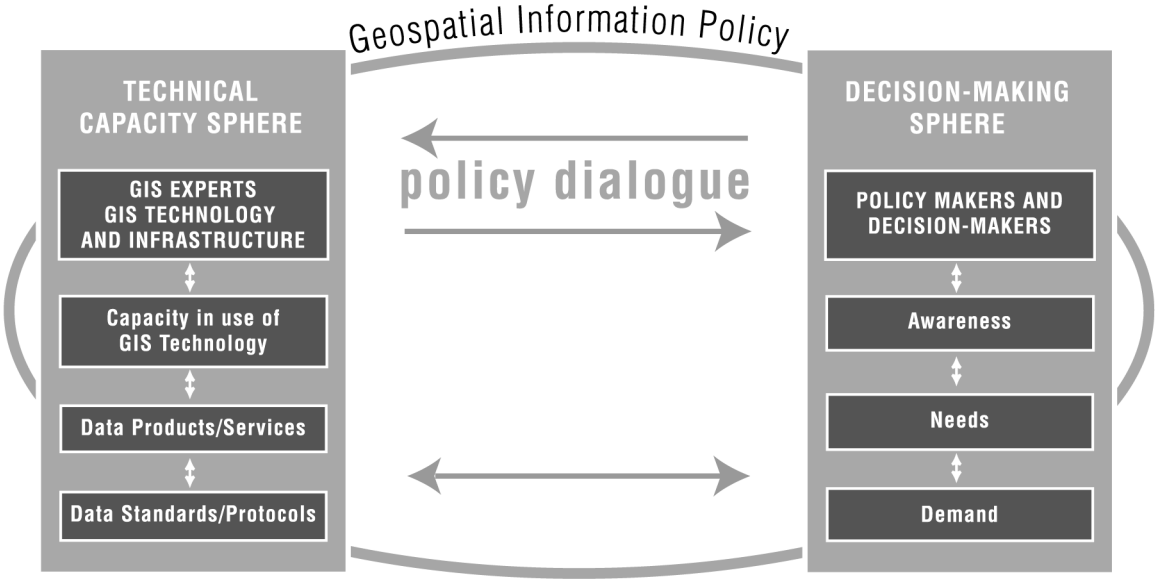
Conceptual Framework

This study is founded on a conceptual framework sketched below. (See Figure 1.) In essence, the hypothesis is that, for GIS to have a significant impact on policy requires not only appropriate equipment, high quality data, and skilled analysts, but also an active dialogue between scientists, GIS experts, policymakers, and civil society. Policy dialogue stimulates the emergence of a demand for GIS analysis, which generates data products and services. Awareness of novel GIS applications gives rise to new ideas among decision-makers, who identify new needs for GIS analysis, leading to increased demand, and the cycle continues. These interactions are most effective within a fully supportive geo-information policy environment at the national level.

The left side of Figure 1, the "Technical Capacity Sphere," encompasses the availability and operational status of several relevant factors. One is the equipment and infrastructure required for GIS analysis, including computer hardware, software, communications networks, etc. Another key factor is human resources, i.e., skilled technicians who can operate GIS equipment to produce meaningful information capable of influencing policy development and implementation. Necessary elements of human capacity include a critical mass of experts—with various levels of technical, analytical, and managerial skills and with different experience and backgrounds—as well as training facilities in the government, academic, and private sectors. Other components of the mix are: strategic planning and institutional development, with a view to achieving the maximum contribution from GIS technology to environmentally sustainable economic growth; institutional support, including budget; and developing and maintaining core data, project data, and analyses.

The "Decision-Making Sphere" is represented on the right side of Figure 1. It is composed of non-experts in GIS who need data and analyses to support, enhance, or influence decision-making. For GIS to fulfill its potential contribution to policymaking, experts must help raise

Figure 1. Conceptual Framework



policymakers' awareness of the technology and convince them by means of practical and useful GIS applications of its effectiveness and efficiency in improving the quality of their decisions. For their part, decision-makers may facilitate (or hinder) the expansion of GIS technology in an organization or a country by creating (or neutralizing) the necessary conditions for increasing demand for data products and services. Decision-makers' needs are turned into effective demand for GIS analysis when they have access to sufficient financial resources to support projects, capacity building, and infrastructure. Meeting these needs provides an opportunity to change existing policies or adopt new ones.

Policy dialogue, represented in the center of the figure, is a process by which the two spheres, technical capacity and decision-making, interact. The process of dialogue is responsible for the extension of GIS applications into the many arenas of socioeconomic policy. It is fed by the interactions between GIS experts and the user community, which may be drawn from diverse arenas (environment, agriculture, health, transport, defense, social welfare, etc.). These interactions allow non-experts to see GIS as a useful tool for meeting their needs for data and analysis. At the same time, GIS experts are able to perceive opportunities to innovate and develop new applications, thus extending the horizons of the technology in a given country.

The contribution of GIS technology and applications to decision-making processes is most effective in the context of a comprehensive, coherent national policy on geospatial information. Such a policy should address numerous relevant issues, such as: the respective roles of government and the private sector, and how each can function most effectively and efficiently; access to data and information; standards on data formats and data integration processes; and clearly understood (and widely observed) rules on data ownership, custodianship, copyright, privacy, data documentation and metadata, pricing, etc.

The conceptual framework outlined above is suitable for understanding the immediate demands for and uses of GIS in policy- and decision-making. However, it does not reflect some underlying factors that may fundamentally inhibit the use of GIS in a country. For example, "Geospatial Information Policy," which helps bring together supply and demand for data and analysis, needs to be understood in the broader context of a country's overall "information culture" and approach to development of and access to information. If a country's legal framework—its constitution, statutes, and/or regulations—severely restricts access to governmental information (as is the case in many African countries), then information flow will be greatly curtailed. Both the supply and demand for information will be suppressed, and GIS and similar information tools are not likely to thrive. Furthermore, though not shown explicitly in Figure 1, it is important to bear in mind that the "Decision-Making Sphere" is not limited to senior government policymakers, but in fact is strongly linked to civil society. If civil society organizations are not permitted to participate in important environmental planning and management decisions, then policy-relevant information will tend to be tightly held within a relatively small circle. In these circumstances, GIS analyses, though they may be technically accurate, will not be as widely used or have as great an impact on policy as would be the case given broad civil society participation in public decision-making.

Methods

This project on GIS Case Studies in West Africa was carried out by the Information Working Group for Africa over a two-year period (January 1999-December 2000). Although Africa as a whole is the target, for practical reasons it was not possible to consider covering the whole continent at once. A progressive approach was adopted, starting with a pilot project in West Africa. Our intention is to eventually extend the study with the assistance and guidance of EIS-AFRICA to other sub-regions.

Three countries were selected for the study: Burkina Faso, Côte d'Ivoire, and The Gambia. This group provides diversity with respect to language and history (two Francophone and one Anglophone) as well as the level of GIS development and the intensity of GIS use in policymaking.

The methods developed for this study consisted of identifying and documenting case studies illustrating the use of GIS analyses in, and resulting impacts on,

environmental policy processes. Two levels of assessment were targeted: a "macro-level" assessment involving a review of GIS activities at the country level, and a "micro-level" review of three or more specific projects with a GIS component for each country. (Details on the criteria used to make these macro- and micro-assessments are presented in Annexes 1 and 2, respectively.)

The country case studies were conducted by African nationals. The EIS-AFRICA network was selected to help implement the study because of its knowledge of GIS-supported projects in the selected countries. The project's Regional Coordinator, André Bassolé, serves on the IWG, oversaw the project, and worked as a team with WRI staff. The Regional Coordinator organized the project, and identified and mobilized national experts to carry out the case studies. (A list of national experts is provided in Annex 3.)

In The Gambia, two national experts were identified and supervised by a National Coordinator, with back-up support from the National Environment Agency (NEA). In Burkina Faso, two national experts provided back-up support to the Regional Coordinator. In Côte d'Ivoire, a single national expert was involved, backed by his institution, the Comité National de Télédétection et d'Information Géographique (CNTIG).

These experts identified potential case studies in each of the three countries, which were then reviewed by the Regional Coordinator and other members of the project team. The criteria used by the project team to select case studies were: extent to which the candidate case studies illustrated the level of GIS development in each country and the state of policy dialogue between decision-makers and GIS analysts; and the potential to use the results of the analysis to influence existing policies and decisions.

The selected case studies were then prepared by the national experts, and the resulting reports reviewed by the Regional Coordinator and project team. Interviews were also carried out by the Regional Coordinator, followed by one-day workshops prepared and organized by the national experts. Members of the project team from WRI attended each of the three workshops organized successively (August 1999) in Banjul, The Gambia; (September 1999) Ouagadougou, Burkina Faso; and (December 1999) in Abidjan, Côte d'Ivoire.

In June 1999, initial results of the study were presented at the AfricaGIS '99 meeting in Accra, Ghana. AfricaGIS which is held every two years is an Africa wide conference of GIS experts. The project was also discussed at the October 1999 meeting of the IWG, held at WRI's offices in Washington, DC. Input from the members of the IWG was taken into account in completing the research. In August 2000, preliminary results of the study were presented at the EIS-AFRICA annual meeting in Nairobi, Kenya—a conference of the GIS/EIS community in Africa and representatives of international cooperation agencies.

Findings

MACRO ASSESSMENTS: LEVEL OF GIS DEVELOPMENT IN COUNTRIES STUDIED

Presented below are the findings from a review of country-scale activities of GIS development in the three focal countries. The indicators examined (see Annex 1) highlight the level of: national awareness of GIS and its application to policy, capacity development, and supply and demand for GIS products and services in the country.

Burkina Faso

GIS was introduced in Burkina Faso by international consultants in the early 1980s, through development projects in such sectors as water resources management, regional natural resources management, and famine early warning systems. At the end of the decade, the first training opportunities appeared; some of these addressed specific national needs, while others were aimed at promoting the products of particular GIS software vendors. In 1989, UNEP organized a training workshop on vegetation mapping using GIS software. At the end of the workshop, the participants (including UNEP's Focal Points) were supplied with personal computers and GIS software. This marked the beginning of operational use of GIS in Burkina Faso. The UNEP workshop was followed by similar training sessions organized by the AGRHYMET Regional Center in Niamey, Niger.

During the 1990s, GIS technology was gradually introduced in various fields through governmental agencies (IGB, DGH, DASU, Cadastre, etc.). In the private sector, GIS began to be used by consulting firms (BERA, Geo-Conseil, etc.) and in academia (EIER, CREPA, ENRECA, etc.). In 1991, the PNGIM (National Program for Environment Information Management), a countrywide network of users and producers of geo-information, was launched. Established within the context of the PANE (National Environmental Action Plan), the creation of PNGIM was a very significant event in the development of GIS capacity in Burkina Faso. PNGIM, with support from the PNGT (National Program for Rural Land Use Management), began a process of coordination of GIS technology development at the national level. This process led to the first achievements in standardization: a common classification scheme in land-use/land-cover; a national topographic spatial database at a scale of 1:1,000,000; and a topographic database at 1:200,000 covering the whole country. (A national topographic database is now being developed at a scale of 1:50,000.)

At present, stand-alone systems are well distributed within Burkina Faso. GIS is often applied in projects linked to natural resources management or other fields with geographic content (e.g., local land-use planning, forestry, natural resources management, urban planning and management in some municipalities, mining, water resources management, development planning, national atlas, environment protection, and the fight against desertification). There is a variety of GIS software in use: the most common are PC ArcInfo, ArcView GIS, Atlas GIS, MapInfo, and IDRISI. Burkina Faso has organized national and regional meetings on GIS applications, including hosting the 14th Meeting of the International Advisory Committee of the EIS Program in Sub-Saharan Africa (March 1999).

The main challenges facing Burkina Faso today are to: complete the process begun in 1991 for coordinating the production and use of geospatial information in the country; produce a national plan for geospatial information (including the adoption of regulations to implement the results of present coordination efforts); strengthen the capacity of geospatial analysis in local universities; assess the usefulness of GIS in national and local decision-making; and continue to build awareness and support for spatial analysis within the policy community at all levels.

Côte d'Ivoire

Côte d'Ivoire is one of the leading countries in Africa with respect to GIS capacity. GIS was introduced in the 1980s by the former DCGTx (Direction Générale de Contrôle des Grands Travaux), a powerful governmental agency attached to the Office of the Prime Minister. DCGTx was charged with overseeing implementation of important development projects, with a view to maximizing return on investment. The agency has since become BNETD (Bureau National d'Etudes Techniques de Développement). BNEDT includes the national mapping agency, CCT (Centre de Cartographie et de Télédétection). National GIS capacity was also developed via CNTIG (Comité National de Télédétection et d'Information Geographique), created in 1992, as well as in training units and research laboratories. These include LATIG (Laboratoire de Télédétection et d'Informtion Géographique) and CURAT (Centre Universitaire de Recherche et d'Applications en Télédétection), entities affiliated with IGT (Institut de Géographie Tropicale) at the University of Cocody in Abidjan.

Principally via CNTIG, but also with contributions from the above-mentioned institutions, Côte d'Ivoire developed national capacity to apply GIS in various sectors. Among these sectors are environment management and protection, cadastre[2] and land tenure, health and educational infrastructure planning, electoral division of the country, urban management, etc. These uses of GIS applications have demonstrated the national socioeconomic benefits of using geospatial information.

However, until late 2000, there was no consensus on the use of a common geospatial dataset for the country. Various institutions had created a series of data products using different base maps. CNTIG is now managing important geospatial data (including country-wide, regional, and some urban datasets) organized in a catalogue with sample products.

Côte d'Ivoire has organized and hosted important fora in the field of GIS and remote sensing, including AfricaGIS ' 95 and the 1998 conference of AARSE

2. Cadastre is "a public record, survey, or map of the value, extent, and ownership of land as a basis of taxation." (Microsoft Bookshelf 98)

(African Association of Remote Sensing for the Environment). Ivorian experts have made presentations on national experience with GIS and remote sensing at scientific and technical meetings in Africa and elsewhere.

The Gambia

GIS development in The Gambia is said to have begun with the Kemoto workshop on environmental information management organized in January 1994 with the support of the United Nations Sudano Sahelian Office (UNSO). This workshop laid the foundation for a national strategy on environmental information that provided the basis for expanding GIS in The Gambia.

Development of GIS products and human capacity was boosted by the Gambia Environmental Action Plan (GEAP). This plan included the establishment of an environmental information system (EIS) that helped strengthen national capacity in GIS applications.

GEAP was a catalyst for consensus building and harmonization of actions. Thanks to GEAP, data products needed for its implementation were produced, and the necessary national capacity to develop and maintain the environmental information system was created. GEAP was the principal vehicle helping to raise awareness of GIS, through activities undertaken by the network of data centers, and by an exhibition of GIS capabilities at the National Environment Agency's Environmental Information Center in Banjul.

The USAID-funded Agriculture and Natural Resources (ANR) Project also provided a baseline of data for natural resources management. It funded the commissioning of a new aerial photography mission of the Gambia in 1993 (at scales of 1:25,000 and 1:50,000) as well as the interpretation of these photographs for the production of land-use/land-cover maps. The project ended prematurely, and in early 1997, the GTZ-funded Gambia-German Environmental Management Project (GGEMP) undertook the completion of the maps. Hence, a national land-use/land-cover database is now available for The Gambia.

MICRO ASSESSMENTS: GIS CASE STUDIES

In this section, we first present an overview of the case studies carried out in each country (four or five per country). These summaries contain information on executing agencies, funding entities, GIS products and services developed, and the policy and other impacts achieved by the projects. Also outlined are the main GIS- and policy-related issues and problems identified by participants in the national workshop convened in each of the three countries studied to review the case studies. *(For details on each case study, see Annex 4.)*

Following this summary of cases is a discussion of the policy impacts of the GIS activities studied. We explore both planned and unanticipated impacts, as well as multiplier effects in agencies and policy arenas far removed from those directly involved in the cases examined.

Finally, we consider the case study findings as they relate to the conceptual framework that guided this study. This entails assessing the implications of the findings for level of awareness of GIS in the region, existence of a demand for GIS products and services, and existence of national geo-information policies.

Overview of Case Studies: Burkina Faso

Four case studies were performed in Burkina Faso and reviewed at a national workshop in September 1999. These cases examined GIS activities within projects addressing diverse environmental and natural resources issues, including rural water supply, food security/famine early-warning systems, control of desertification, and national land use planning. One project began in the late 1980s, but for the most part, projects were undertaken from the mid- to late 1990s.

Diverse entities financed and executed the GIS activities studied. Funders included the Government of Burkina Faso as well as international organizations (UNDP, WHO, AFDB) and bilateral assistance agencies (USAID, EU, Italy, France (GTZ), the Netherlands). Executing entities were national governmental bodies and international agencies.

Results and impacts:

- In the first case study, GIS experts created spatial analyses of climate, agricultural, and population data to provide information required for a *famine early-warning system*. Spatial maps highlighted zones with crop production deficits. These analyses provided timely warnings about projected crop production shortfalls for the 1997–98 growing season, which enabled government officials to take corrective actions. GIS studies also accurately predicted crop production deficits in the 2000-01 growing season.

- A second project produced a spatial database for use in the development of a *national land-use master plan*.

The study had little impact because it was never released. Interim project results are being used by students and researchers.

- To support the development of a *national action program on desertification*, GIS analysts developed spatial presentations (national, regional, and provincial levels) of the phenomenon of desertification. These incorporated numerous maps of diverse parameters, including vegetation type, land-cover, surface and underground water resources, grazing areas, and population and socio-economic data. These efforts established a base line from which time-series maps of projected ecosystem changes were produced. Results were used to identify priority sites for urgent action against desertification. In addition, the project brought together GIS specialists and helped reactivate a national network of geo-information producers and users. However, the National Action Program for Burkina Faso presented to the U.N. Convention to Combat Desertification and Drought did not include the maps, so the public has not been able to see the results of the GIS study.

- The fourth case study entailed development of a spatial database with more than 500 *maps of water and natural resources in southwest Burkina Faso*. These maps showed existing water supply facilities and were used to help plan new ones. The study covered 12 regional river basins and included the use of large-scale LANDSAT images. GIS analysis highlighted the need for water basin management, and convinced the relevant ministry to expand the project nationwide. The GIS component of the project has attracted attention from other ministries of the Burkina Faso government and from neighboring countries *(see Annex 7)*.

Issues and problems highlighted by reviewers of case studies during the national workshop:

- Workshop participants highlighted data issues (availability, quality, and access) as matters of concern. Despite the efforts of the PNGIM, many data are still difficult to access and use. This appears to be due to the lack of an information management culture in government agencies. Most of the existing data are known only to a limited group of people; consequently, recurrent investment of efforts and funds are made in redundant data collection rather than maintaining core GIS databases. PNGIM produced a metadatabase in 1998, but it has not been widely distributed.

- GIS is used mostly as a means of producing digital maps; all too rarely is spatial analysis used as an analytical tool to support decision-making. None of the three case studies presented at the workshop included scenario analysis based on simulations showing the effects of changes in the value of key variables. GIS analyses often are quite static, and the GIS analysts do not make projections which could generate proactive planning and management.

- GIS applications suffer from a lack of research input. Universities often are not involved in development projects, and their scientists had no input in any of the cases studied. Consequently, outdated datasets are frequently used, and little opportunity is afforded for the latest scientific knowledge to be applied in the implementation of development projects.

- Although the PNGIM has promoted communication between data producers and users, there is no sustained dialogue between policymakers and GIS analysts. Workshop participants attributed this phenomenon to several factors. One of which is a perception that GIS analysts are not open-minded, often working in isolation with a "protectionist" attitude. Policymakers, for their part, are not sufficiently aware of the benefits of GIS technology.

- Workshop participants also observed that the development of national GIS capacity has been driven by a "project-oriented" mentality that has influenced development policy in general in Burkina Faso. The expansion of GIS applications has been based in isolated projects rather than proceeding according to a strategic plan or holistic vision. Consequently, certain key institutional and policy issues have not been properly addressed, such as the production of core datasets and the emergence of a national synergy around geo-information management.

Overview of Case Studies: Côte d'Ivoire

Five cases of GIS applications in Côte d'Ivoire were prepared for this study and reviewed at a national workshop held in December 1999. These cases focused on GIS activities within projects addressing diverse policy issues: road network management, health sector infrastructure, urban management, management and taxation of forest concessions, and integration of regional development processes into national development planning.

Each of the projects took place in the mid- to late 1990s. All projects were executed by CNTIG for the

relevant national government agencies (dealing with roads, public health, forests, etc.). Most of the projects were financed from the national budget; one was funded by the budget of a municipality and another was co-funded by the World Bank.

Results and impacts:

- In the first case study, GIS experts developed an application for *management of road maintenance*, including a spatial database and thematic maps of the national network of roads and bridges. Several parameters were analyzed, such as state of the pavement, date of paving, construction of new river-crossings, etc. The GIS system established objective criteria for the selection of roads to be maintained and increased the transparency of decision-making in this area. The availability of such a management tool facilitated discussion between the government and international financial institutions on structural adjustment in the transport sector, including transferring operational aspects of road maintenance to the private sector.

- Another GIS-based tool was created to provide a more equitable basis for planning the *expansion of health care infrastructure*. Analysts produced a semi-automatic management system featuring a spatial database and thematic maps of potential sites for new health centers. The system incorporates criteria such as population, distance from an existing facility, financial capacity, and existence and condition of local road networks. The analysis provided an improved justification for investing resources in the expansion of village health-care centers. It also increased the transparency of such investment planning, and promoted the perception that selection of villages to receive new health centers would be based on need and merit rather than political influence. The GIS analysis attracted considerable attention from other ministries interested in adopting this tool to bolster their credibility.

- For the municipality of Cocody, one of ten in Abidjan, GIS analysts designed a decision-support tool based on detailed data on all the *land administered by the municipality*, the people living there, and the economic activities being conducted in the area. The system contained a fiscal management module, providing for optimization and automation of procedures for tax assessment and collection. Use of the GIS analysis led to a sharp rise in tax revenues collected from business enterprises in the municipality. Other municipalities have become interested in this application of GIS technology, and at least five have launched similar initiatives. There has been some negative political fallout, however, from officials who are threatened by the loss of discretionary power in collecting and spending tax money.

- A GIS-based system for the *management of forest concessions* was developed to enable faster and more accurate computation of taxes owed by concessionaires. Analysts mapped all the forest concessions in Côte d'Ivoire, including precise definitions of the area and boundaries of each concession. The system also provides improved means of monitoring the status of each concession, detecting environmental degradation, and ensuring that concessionaires take corrective measures. The use of this tool has enhanced the efficiency and timeliness of taxing forest concessions, and the prompt billing of concessionaires has improved the government's fiscal position. The system has also enabled prior errors to be corrected; for example, some concessionaires were harvesting up to 10 km outside the true boundaries of their concessions *(see Annex 7)*.

- GIS analysts created spatial databases and *thematic maps of each region of the country* for use in regional development planning processes. These maps showed regional socio-economic infrastructure and electoral divisions. The GIS component enables officials to create various development scenarios and provides reliable information for the initiation and implementation of development projects.

Issues and problems highlighted by reviewers of case studies during the national workshop:

- GIS is used mainly by CNTIG; only a few other government agencies (BNETD/CCT) as well as some research and training institutes (CRE, IGT CURAT) are applying the technology. There is a crucial lack of GIS capacity outside CNTIG, seemingly the effect of a policy of centralized GIS technology development in the country. CNTIG has developed many GIS-based systems for other agencies, but the appropriate human capacity is often lacking within the recipient institutions.

- Increased awareness of GIS technology and its benefits is needed, especially in the private sector. Indeed, the private sector is notably absent from the GIS scene in Côte d'Ivoire, apart from local hardware and software distributors.

- There has been very effective policy dialogue between CNTIG and the highest policymaking bodies in the country. The CNTIG, under dynamic leadership, has been well funded and its work recognized internationally. Likewise, BNETD/CCT has ongoing communication with these authorities.

- However, at present there is almost no functional communication between BNETD/CCT and CNTIG. Access to data is not easy, even for other departments of the same institution. There seem to be strong feelings of data ownership that prevent these institutions from adopting a common spatial database accessible by different users for various applications.

- It is worth noting that the enhanced efficiency and transparency associated with GIS use may not always be welcome, as the case study of the cadastre of the municipality of Cocody (a district in Abidjan) illustrates. The use of GIS had the potential to increase municipal revenue fourfold through improved tax recovery. However, the computerized cadastre, although complete, is not being used because it threatened the financial interests of those who benefited from the traditional, slow, discretionary procedures.

Overview of Case Studies: The Gambia

Four case studies of GIS applications in The Gambia were prepared and reviewed at a national workshop in August 1999. The GIS activities were conducted in the context of projects addressing: selection of waste disposal sites in the national capital area (Greater Banjul Area, or GBA); land-use planning for development and environmental protection; land-use/land-cover mapping; and updating and revision of the GBA Master Plan.

Projects were carried out in the mid- to late 1990s by governmental bodies. They were financed by various entities, including a governmental agency (the National Environmental Agency), bilateral assistance agencies (USAID and GTZ), and an international organization (FAO).

Results and impacts:

- In the first case study, GIS analysts produced an *integrated spatial database of the Greater Banjul Area*, which was used to identify potential sites for future waste-disposal facilities. Project staff determined site-selection criteria and gathered relevant data from various institutions that were used to exclude sites (e.g., high flood areas, areas with soils subject to leaching, areas closer than 300m to human settlements, etc.). On-site inspections were conducted to confirm the results of GIS analysis. This effort brought together several institutions that previously had worked in isolation, including the National Environmental Agency (NEA), municipal councils, and the Department of Land and Surveys. One unexpected result was the discovery during field checks that some of the potential waste-disposal sites were human settlements; the land transactions associated with the establishment of these settlements had not been officially recorded. Consequently, authorities initiated a policy change to incorporate local land-allocation subsystems in the official land-management system.

- A second case study featured the use of GIS to develop models predicting the *suitability of specific land parcels for different types of crops*. Data on soils were integrated with data on climate, agroecological zones, and farming systems to create the models. The resulting GIS-based tool is capable of generating land-suitability maps for several different crops in any part of the country. Policy recommendations to increase the efficiency of use of scarce land resources have been developed and submitted for adoption.

- Analysts at the National Environmental Agency used GIS studies to create an integrated, digital *national database on land-use in The Gambia*. This database provides a basis for monitoring land-use changes throughout the country, assessing their implications, and guiding development accordingly. The availability of the spatial database and land-use maps has helped to raise awareness of GIS applications in The Gambia. This GIS-based tool caught the attention of the Department of Forestry, which used the data to carry out a national forest inventory. Likewise, digital data were used by the UN's World Food Program to assess food-aid requirements and develop a food-aid distribution strategy.

- For revising and updating the GBA Master Plan, GIS studies were used to produce a *land-use map of the national capital area*. GBA is the largest and fastest-growing urban area in The Gambia, with a projected population of half a million by 2005. GIS technicians identified, collated, and integrated relevant datasets. The resulting analysis was used to create a plan for meeting the housing and infrastructure needs of a rapidly growing population. This involved the redesignation of major land-use zones as a direct outgrowth of the GIS findings. These datasets, however, have not been made available to the public *(see Annex 7)*.

Issues and problems highlighted by reviewers of case studies during national workshop:

- Workshop participants agreed that The Gambia is at a stage where assistance in building national GIS capacity could yield important results. Development of GIS technology is in its early phase. The National Environmental Agency is a key player, but the private sector is not yet involved in GIS operational activities nor in training.

- Policy dialogue seems limited to a technical level, i.e., between analysts and mid-level policy officials. There is a need to enhance this dialogue at higher levels of decision-making. The management of the NEA is willing to host EIS-Africa meetings with a view to strengthening this dialogue in the policymaking sphere.

DISCUSSION: IMPACTS OF GIS-BASED ANALYSIS ON ENVIRONMENTAL PLANNING AND MANAGEMENT POLICIES IN WEST AFRICA

Given the early stages of GIS development in many West African countries, as well as the relative lack of policymaker awareness of the benefits of this technology, it is perhaps not surprising that the impacts to date of GIS-based analysis on environmental planning and management have not been spectacular. Nevertheless, some important impacts were observed and reported through the case studies, associated interviews, and one-day workshops. We present these in three broad categories: planned impacts, opportunistic impacts, and multiplier effects. *(For further details, consult the case studies included as Annex 4.)*

Planned Impacts

1. One important impact of GIS studies has been to **identify and guide needed government action on environmental planning and management.**

- In Burkina Faso, GIS analysis undertaken for a famine early-warning program provided timely and accurate predictions of crop production shortfalls, enabling the government to take corrective measures. The GIS-based estimates proved to be more credible than field-based projections, thus strengthening confidence in the technology in the policy sphere.

- GIS also highlighted the need for water-basin management; consequently, a regional program in southwest Burkina Faso was expanded to nationwide coverage.

- GIS has been used to: select sites for future waste disposal facilities (The Gambia); monitor the status of forest concessions and survey corrective measures taken to address environmental degradation (Côte d'Ivoire); develop a food-aid distribution strategy (The Gambia); and identify priority sites for urgent action to combat desertification (Burkina Faso).

2. Another result of GIS-based analysis has been to **enhance the accuracy and efficiency of government operations.** Such reforms have often been driven by structural adjustment programs.

- Due to improved information provided by GIS studies about economic activity within its boundaries, a municipality was able to collect more of the tax revenues owed it by business enterprises (Côte d'Ivoire).

- The introduction of a GIS-based tool brought about significant improvements in public management performance in the forestry sector, and in the process did away with a great deal of suspicion between the government and concessionaires. The use of GIS eliminated controversy concerning concession boundaries: formerly, parcel boundaries were estimated on millimeter grid paper, leading to confusion and disputes over inaccuracies. GIS also provided timely, accurate statistics on timber harvests, enabling prompt computation and billing of taxes owed to the government by the concessionaires. (Prompt collection of taxes, which formerly took 2-3 years to compute, also improved the national fiscal position.) In addition, GIS-based analysis helped officials distribute tax revenues fairly among local beneficiaries, which previously had been problematic when the boundaries of a parcel fell into more than one administrative entity (Côte d'Ivoire).

3. GIS can also serve to **increase the transparency of government decision-making**.

- Improved information enabled the establishment and use of objective criteria to select roads to be maintained, thereby increasing transparency in road maintenance planning (Côte d'Ivoire).

- GIS studies improved the basis for justifying investment in new health care infrastructure, and contributed to a perception that selection of villages to receive new health centers will be based on need and merit rather than political influence (Côte d'Ivoire).

- The availability of more precise information on the size, boundaries, and status of forest concessions provided a fairer basis for management of forest concessions, including tax computation (Côte d'Ivoire).

4. GIS-based analysis can also **help build national networks of geo-information professionals** and promote policy dialogue both activities that strengthen environmental governance.

- The results of GIS analyses used to prepare a national plan of action to fight desertification led government officials to reactivate PNGIM, a network of producers and users of geo-information in Burkina Faso.

- GIS studies to identify sites for future waste-disposal facilities in the Greater Banjul Area of The Gambia brought together institutions that previously worked in isolation, including the National Environmental Agency, municipal councils, and the Department of Land and Surveys.

Opportunistic Impacts

In some cases, the policy impacts of GIS analysis may be indirect and unexpected. For example, in The Gambia, the on-site inspection of areas selected through GIS analysis as suitable candidates for future waste-disposal facilities revealed that some of the areas were actually settlement sites. The settlers of these areas obtained their land from customary authorities, whose transactions are not recorded by the land administration. These findings led the National Environmental Agency to propose official recording of land allocation by these customary authorities. Draft legislation based on this proposal was developed and submitted to the government for parliamentary review.

Multiplier Effects

GIS-based analysis performed for one project can often exert multiplier effects by attracting the attention of policymakers from other ministries and even neighboring countries. In this manner, policymakers become more aware of GIS technology and the benefits of using these applications in designing and implementing policy.

- A spatial database and more than 500 associated maps of regional water resources covering 12 river basins in southwestern Burkina Faso has attracted considerable attention to the uses of GIS technology. Visitors from other countries (Côte d'Ivoire, Mali, Togo, etc.) are using the information in planning their water basin projects. Other ministries in Burkina Faso are requesting GIS technical support for their activities in the region, including the Ministry of Health (trypanosomiasis control) and the ministry responsible for management of livestock grazing areas.

- In Côte d'Ivoire, the GIS-based tool developed for the Ministry of Public Health to facilitate planning of investment in new health care infrastructure has stimulated great interest. Other ministries, particularly the ministry in charge of the national road network, have requested the development of similar decision-support tools.

- The urban spatial database built for the municipality of Cocody led other municipalities in Abidjan (Yopougon, Treichville) and elsewhere in Côte d'Ivoire (Daloa, San Pedro, Mafféré) to adopt similar tools for managing their territories.

Conclusions

The following section begins by relating the findings of the case studies to the conceptual framework for this study. We thus draw some conclusions about the use of GIS in West Africa and resulting policy impacts. Finally, we present recommendations for enhancing the contribution of GIS to improved environmental planning and management in the region.

RELATING CASE STUDY FINDINGS TO THE CONCEPTUAL FRAMEWORK

The conceptual framework for this study posited that the effective use of GIS technology in policymaking depends on three key elements: level of policymaker awareness of GIS and its potential benefits; the existence and level of demand for data products and services; and

the existence of a data or information policy and technical capacity in the country considered.

Level of awareness. A review of case study findings reveals that all three countries are at an early stage of applying GIS analysis, and overall awareness remains low. The level of awareness varies among the countries studied and appears to be broadly linked with the level of economic development.

Although the level of awareness seems higher in Côte d'Ivoire than in the other two countries, there has been a lack of political will to make GIS-based systems fully operational. For example, the introduction of a spatial database for urban tax collection, land allocation, and cadastral management in the municipality of Cocody in Abidjan has been stalled by conflicts of interest associated with its use.

Demand for GIS products and services. The existence of a demand for GIS products and services is directly linked to the level of awareness within the user community. Case study findings show that demand exists in the countries considered, but its volume does not reflect the range and importance of national needs. For example, many sectors do not yet have recourse to GIS technology for planning and management purposes. Except for Côte d'Ivoire, GIS applications were not common in many important sectors, such as public health. GIS-based research is used in trypanosomiasis vector and disease control in Burkina Faso, but no use for public health planning or monitoring was observed. (Recently, a new private GIS group, Centre SIGET-A, has been established to support analysis of natural resource projects in Burkina Faso. It also runs a training program for African students.)

National government and international aid agencies are the principal drivers of demand for GIS analysis. Private sector involvement in GIS activities is marginal, and generally limited to supplying hardware and occasionally software and training. The private sector is rarely involved in providing geo-information services. In The Gambia, the GIS market is currently considered not worth investing in. In Burkina Faso, independent consultants have emerged, but well-established companies are limited. The first private firm delivering GIS and remote sensing services was established in 1993, but remains the only one making these activities its principal business. Other practitioners either are linked to training institutions or engage in GIS as an auxiliary area of activity.

In Côte d'Ivoire, CNTIG seems to have captured the market for providing GIS services and thus inhibited private geo-information initiatives. A few other governmental institutions have the capacity to provide geo-information services, but rarely do private companies in Côte d'Ivoire adopt GIS as a major field of activity.

Lack of capacity to productively use GIS-based tools is an important factor limiting demand. In two of the three countries studied (Côte d'Ivoire and The Gambia), spatial databases developed by the leading national GIS institution (CNTIG and the NEA, respectively) for public-sector clients (DPFIR in Côte d'Ivoire and DPPH in The Gambia) have failed to be exploited because of a lack of required human capacity.

Existence of a geospatial information policy. Logically, the establishment of national operational standards and rules should proceed along with the expansion of GIS technology. However, in the countries studied, national initiatives to strengthen the management of geospatial information fall far short of what one might expect after more than ten years of experience with applying GIS technology.

None of the countries studied has adopted a formal policy to guide activities in the geospatial information sphere. National committees exist—PNGIM in Burkina Faso, CNTIG in Côte d'Ivoire, and the EIS Working Group in The Gambia—and are functioning, more or less. A few core products and tools have been developed in each country: a classification scheme and series of topographic databases in Burkina Faso; various GIS databases (both topographic and thematic) in Côte d'Ivoire; and a spatial database for the Greater Banjul Area and a nationwide land-use/land-cover GIS database in The Gambia. Although there appears to be consensus within GIS circles in these countries on the use of these products as standard references, no formal rules to encourage their adoption have been established.

The lack of formal policies has already caused significant inefficiency. For example, in Burkina Faso, until recently many government agencies (including members of the PNGIM) continued to digitize various paper maps to create numeric map files of the country, even after countrywide spatial databases at scales of 1:1,000,000 and 1:200,000 had been produced. Unfortunately, it appears that GIS applications will need to become more widespread before governments start paying this policy area the attention it deserves.

Recommendations

Action is needed in all three countries studied—and most likely in other sub-Saharan countries—to nurture the basic conditions required for achieving the optimal contribution of GIS technologies to policymaking. We have identified six major recommendations ranging from expanding awareness of GIS and its potential to improving access to information. Taken together, these provide a solid framework for making progress.

1. *Expanding Awareness of GIS Value and Use.* The first necessary condition for promoting the optional contribution to GIS to policymaking is a higher level of awareness among potential users of the value and usefulness of GIS analyses. High-level political support is extremely important for an activity intended to help improve and reform policy. Support for GIS technology is no different. This can be brought about through briefings and workshops where policymakers (at all levels of government) have an opportunity to gain a better understanding of the maps and analyses that are being developed and presented by experts. It may also be useful for policymakers to include GIS experts in discussions where policy options are being deliberated. The results of GIS analyses can be incorporated in the annual reports of environmental and natural resource agencies, in national and local state-of-the-environment reports, and in national and subregional reports to international conventions and various donor agencies. GIS user groups can be established to test new technologies, discuss recent studies and their use, share job opportunities, and help bring GIS to bear on local issues. Over the long term, it will be necessary to bring GIS into the universities and various training programs, so that those who study business, education, or the sciences are exposed to its use and value.

2. *Strengthening the Policy Dialogue Process.* The processes for encouraging and enhancing dialogue between policymakers and GIS practitioners should be strengthened in all three countries studied. Ideally, the process should be user-driven: it should begin with the need to make a specific policy decision or assess an existing policy or practice. This can be initiated at the local level or even at the level of the farm, forest area, park, or coastal fishery.

   Moreover, the process should emerge from the bottom up: there is a danger of misguided demand if the direction and scope of data gathering and analysis are determined at the top and merely handed down. The mid-level government officials who are the actual day-to-day end users should have early and frequent consultations with scientists as well as with the GIS experts responsible for assembling datasets and creating data products.

   The policy dialogue process is likely to be much stronger where there is legal support for stakeholder participation in decisions affecting environmental quality and people's livelihoods and general well-being. Thus, the dialogue should be four-way, involving civil society as well as scientists, GIS experts, and policy- and decision-makers. For an optimal policy dialogue, civil society should have the means at its disposal to hold governments accountable for their decisions and actions. There should be incentives and mechanisms for bringing together various stakeholders and constituencies to discuss and debate environmental policies and their implementation.

   These incentives and mechanisms might be found or created in the context of such policy processes as environmental impact assessments and monitoring and reporting on land-use, water resources, and access to common lands and property. Natural resources often are the most important means by which people earn their livelihoods in West Africa, and GIS analyses have a powerful role to play in discovering and documenting the extent and condition of these resources. GIS also can be extremely valuable in supporting decision-making about the allocation of financial and other resources in various sectors of the economy, including health care, transportation, telecommunication, education, and energy development.

3. *Establishing National Geospatial Information Policies.* All African countries should establish national geospatial information policies that address several key problems, issues, and challenges related to geospatial information, and how this information is developed, accessed, and used.

Among the most urgent and frequently encountered of these issues and problems is the need to define strategic objectives for enhancing access to information and information sharing. In many parts of Africa, governments own much of the information generated about the extent and condition of natural resources, especially commercially important state-owned resources, such as minerals and timber. Consequently, a great deal of the information about the status of Africa's natural resources is considered proprietary, and access to it is severely limited.

There is no logical reason why policy-relevant information on natural resources cannot be treated like other nationally and internationally important information, such as economic and trade statistics. Some national statistics and related information—whether they be related to natural resources or any other economic sector—truly are proprietary and it would not be in a country's interest to allow broad access to them. However, much of the natural resources information currently tightly held by African governments can and should be made more broadly available, as economic and trade statistics are.

Another focal issue for national geospatial information policy is setting the rules that determine standards and protocols for data collection, storage, labeling, and integration. In addition, policymakers should consider such issues as: data ownership, maintaining confidentiality and privacy, protecting copyrights and other intellectual property rights, data documentation, and distribution of source materials, e.g., data and maps used to produce new analyses. Geoinformation policy will also have to grapple with the difficult problem of how to fund development and maintenance of core national datasets.

Each country in Africa will approach these issues in its own way. What is essential is that each country or cooperating group of countries develop rules or standard approaches for dealing with these issues and problems, and then apply them in a way that maximizes information flow—including data development, access, and use—in support of public decision-making. These rules and standard approaches should be continually revisited, studied, and revised, as appropriate, over time.

4. *Strengthen Local Capacity*. The need to strengthen local GIS capacity was emphasized by participants in the national workshops held in conjunction with this project. Capacity building was deemed an essential component of developing a national GIS strategy.

   Participants in the Burkina Faso workshop put forward as a goal the development of a critical mass of GIS analysts in order to break down the "isolation barrier" faced by the present generation of experts. The Banjul workshop recommended that GIS capacity receive greater attention from the government and education community.

   Historically, many African countries have considered GIS a function and responsibility of the central government and have sought to retain all or most of the national capacity for GIS within government. Experience has shown that this is less effective than a decentralized strategy in which there is a strong private sector with extensive GIS capacity, especially in universities as well as in private companies. (See the discussion above of a related recommendation concerning the need to strengthen the policy dialogue.) Thus, initiatives to build national GIS capacity should be broad-based and include the private sector among those being trained as well as those delivering training and capacity-building services.

   Moreover, capacity building need not be limited to formal training courses and educational programs. Other activities that could enhance national GIS capacity include encouraging the establishment of associations of experts as well as establishing NGOs and research centers that use GIS to carry out policy research and advocacy, related to natural resources management. These broader capacity-building initiatives would also serve to expand awareness of the value and use of GIS, another principal recommendation emerging from this project (discussed above).

5. *Expand Access to Geo-spatial Information.* The results of GIS analyses—including databases, maps, and studies—should be made available to the public through the media, through regular government and private marketing and distribution channels, and increasingly through Internet access. Also, more open access can be initiated between government agencies. Wider access will help strengthen the policy dialogue process by requiring policymakers to be more transparent in how they make decisions on resource pricing, allocations, concessions, revenues, and use.

6. *Continue to Study the Use of GIS in Policymaking*. Each African country should conduct a periodic review of the development and use of GIS, taking into account the interests of the public, government, business, NGOs, academia, and other affected parties. In addition, more countries in Africa should develop case studies on the use of GIS in policymaking, thus building a stronger network of GIS users and experts. For example, in our analysis of case studies, we were not able to adequately answer the question, "Could the project have reached its goal without the GIS component?" EIS-AFRICA, the newly established, pan-African NGO, could play a valuable role in promoting the study and use of GIS and hosting workshops and briefings for policymakers on successful applications.

Annex 1. Macro-Level Criteria

The macro-level indicators include level of national awareness and supply and demand for GIS analyses and products over the last 10 years.

Level of national awareness

- Number of staff (management level, operational level) trained in GIS.
- Number of GIS-related significant events organized (conferences, seminars, and workshops).
- Number of in-country GIS training facilities.
- Spatial distribution of GIS experts in the country.
- Number of regular publications in the GIS field and their sponsoring institutions.
- Number of known decision-makers supportive, not supportive, or even hostile to GIS.

Supply and demand for GIS analyses and products

- Demand characteristics.
    - *Key users of GIS products in the country.*
    - *How many times decision-makers requested a GIS analysis at policy and managerial levels: in governmental agencies, international organizations, NGOs, and the private sector?*
    - *How many times the analysis or GIS product was initiated by a donor agency?*
- Supply characteristics.
    - *Evaluation of the capacity of existing GIS centers to satisfy the demand in this field.*
    - *How many GIS facilities (centers, labs, training agencies, etc.) exist in the country: in governmental agencies, international organizations, NGO's, and the private sector?*
    - *What is the average duration of completed projects over the past 10 years?*
    - *How many were completed on time and how many were delayed? What is the average delay time and why?*
    - *At the time of the survey, how many projects were ongoing and how many were planned and approved for execution in 1999?*

Annex 2. Micro-Level Criteria

The micro-level indicators include considerable details on specific GIS projects, including technical aspects, GIS impacts, and policy dialogue process.

GIS component

- Introduction of the GIS component, its purpose in the framework of the project: Brief description of the technologies and the processes applied. Human resources used (local staff, external expertise, both).
- Was this component initiated or suggested by a donor? An in-country decision-maker? Or the GIS analyst(s)?
- Inputs. Which agencies or partners contributed, particularly those providing data?
- Outputs. What type of product was prepared and how was it used within the project and externally?

GIS analysis impact

- Could the project have reached its goal without the GIS component?
- What improvement or specific result(s) did the GIS component generate?
- Could the GIS output or analysis be provided with existing technical skills or was capacity building an essential component of the project?
- How has the GIS component been used since completion of the project?
- Did the actual GIS output affect management practices or any aspect of development policies? How?
- In which domain did changes occur and were these changes translated into new behavior, new regulations, or new laws?

Policy dialogue

- Did consultations take place between the beneficiaries of the output and the GIS analyst(s) during the formulation phase of the project? How were these consultations conducted? Were they undertaken at the behest of the GIS analyst(s), the client(s), or both? Were they required (i.e., imposed by external direction or voluntarily agreed to)?
- Were the analyst(s) informed of what the outputs were used for?
- Have other types of products been requested by the client as a result of consultation with the analyst(s), following satisfactory use of the initial output?
- Is the dialogue concentrated on products (output) or does it cover policy issues?
- Have policy reforms been initiated as a result of GIS analysis? Were these proposals accepted? If not, why not?
- Does the client regularly visit the GIS Unit? Does the analyst report new findings to the client?
- Does the policy dialogue process between the client and the analyst(s) need strengthening?

Annex 3. List of National Experts, Coordinator, and Project Team Leaders

Project team

- Dan Tunstall, WRI
- Jake Brunner, (formerly WRI, currently Conservation International)
- André Bassolé, Consultant and Chairman of the Board, EIS-AFRICA (Regional Coordinator of the GIS case studies)

Country team/Experts

Burkina Faso

- Frédéric Ouattara, Director, National Meteorology Service
- Nestor Compaoré, Head of the GIS Unit, Hydraulic Regional Office, Bobo-Dioulasso

Côte d'Ivoire

- Anzoumana Koné, Head of the Geomatics Department, CNTIG
- The Comité National de Télédétection et d'Information Géographique (CNTIG)

The Gambia

- Ndey-Isatou Njie, National Team Coordinator
- Abdoulie Manneh, Program Officer, EIS, National Environment Agency
- Baboucar Barry, Private Consultant
- The National Environment Agency

Annex 4. Summaries of Case Studies

BURKINA FASO

Title: ALERTE PRECOCE ET GESTION DE LA SECURITE ALIMENTAIRE A L'ISSUE DE LA CAMPAGNE AGRICOLE 1997/1998 AU BURKINA FASO

Early Warning and Food Security Management for the 1997/1998 Agricultural Campaign in Burkina Faso

- **Beneficiary agency:** National component of AGRHYMET Center for Burkina Faso (Direction de la Météorologie Nationale, Direction des Etudes et de la Planification et Direction des Productions Végétales du Ministère de l'Agriculture, Direction de l'Aménagement Pastoral et du Foncier du Ministère de l'Elevage, Direction de l'Inventaire des Ressources Hydrauliques du Ministère de l'Eau et de l'Environnement.)
- **Executive agency:** AGRHYMET Center
- **Financing agency(ies):** CILSS, WMO, USAID, ITALY, FRANCE, THE NETHERLANDS
- **Starting date:** 1996
- **Completion date:** 1997
- **Goal of the project:** To strengthen national early warning systems by building appropriate tools for monitoring agricultural production and resulting status of food security.
- **Specific objectives of the GIS component:** To process and analyze climate data, agricultural data, satellite images, topo maps, and population data in order to provide the required information for the early warning system.
- **Main achievement of the project:** Simulation of overall rainfall, spatial distribution of zones showing a deficit in crop production, availability of an accurate estimate of the crop production before the end of the agricultural season, allowing the Government to initiate the appropriate corrective measures (Emergency supply plan of action 1997/98).
- **Impact of GIS-based findings on policy and decisions (existing or new):** A positive impact on policy/decision-makers (national, regional) and the donor communities is visible. They are increasingly aware of the benefits of GIS technology and have greater trust in the predictions of the national early warning system. The information derived from the GIS analyses was used to develop a national plan of action for emergency food supply. This was made possible thanks to the spatial distribution of the areas at risk as shown by the analysis, particularly the early availability of such information (before the end of the growing season). Further impacts, particularly on information policy, are expected in the future. The system also predicted a later (i.e., 2000-01) deficit in food production before the end of the growing season.

Annex 4. *(continued)*

BURKINA FASO

Title: LE PROJET ATLAS DU BURKINA FASO ET LE SCHEMA NATIONAL D'AMENAGEMENT DU TERRITOIRE

The ATLAS Project of Burkina Faso and the National Land-Use Planning Master Plan

- **Beneficiary agency:** Ministry of Economy and Finance, in charge of physical planning, other ministries, education centers, regions as decentralized units, local governments, NGOs
- **Executive agency:** A four-member project team backed up by international and many national consultants, and an eleven-member steering committee
- **Financing agency(ies):** Government of Burkina Faso, UNDP, ADB (African Development Bank), CONAPO (National Population Council)
- **Starting date:** Approved in 1987, started on March 1st 1989, revised successively in 1990 and 1998
- **Completion date:** 2nd quarter 2000
- **Goal of the project:** To develop and maintain a spatial database allowing for a continuous updating and edition of cartographic products meeting the needs for physical planning, in particular illustrating the constraints, the potentialities and the distribution of the countries' natural resources.
- **Specific objectives of the GIS component**: To produce condensed summaries of the "diagnosis" component of the draft National Land-Use Planning Master Plan, and to derive aggregated thematic maps for the regional level.
- **Main achievement of the project**: Six condensed and descriptive summaries of the diagnosis component of the draft National Land-Use Planning Master Plan. A spatial database, source of spatial analysis capacity for both the Atlas purpose and the development of the National Land-Use Planning Master Plan.
- **Impact of GIS-based findings on policy and decisions (existing or new):** Intermediate results of the project are being used by students and researchers on a personal relationship basis for documenting their work. At the end of 2000, the project still needed an extension in order to produce one last condensed summary. Since the results of the project have not been officially published, it is difficult to assess its impact on policy. For the time being, development projects are being initiated without the required national framework that was to have been provided by the National Land-Use Planning Master Plan.

Annex 4. *(continued)*

BURKINA FASO

Title: CONTRIBUTION DE L'OUTIL SIG DANS L'ELABORATION DU PROGRAMME D'ACTION NATIONAL DE LUTTE CONTRE LA DESERTIFICATION (PAN-LCD) AU BURKINA FASO

GIS Contribution in the Preparation of the National Action Programme for Struggling Against Desertification in Burkina Faso

- **Beneficiary agency:** SP-CONAGESE (Permanent Secretariat of the National Council for Environment Management)
- **Executive agency:** Agence pour le Développement Durable de l'Afrique du 21ème siècle (ADDA 21)
- **Financing agency(ies):** Government of Burkina Faso
- **Starting date:** November 1998
- **Completion date:** 1999
- **Goal of the project:** To show the status and trends in natural resources at national, regional and provincial levels; to analyze the process of desertification and its causes; and on the basis of these results, to define indicators for monitoring and assessing the impact of priority actions against desertification.
- **Specific objectives of the GIS component:** To facilitate a spatial presentation of the desertification phenomenon, to allow for the integration of multi-source data and spatial analysis, provide national, regional, and provincial level information, and finally to provide results of analysis that are understandable by both analysts and decision-makers. Vegetation maps, land-cover maps, maps on water resources, soil maps, grazing areas maps, population and socio-economic data, data on the use of natural resources, and administrative maps were compiled, reclassified, and mapped to a common reference. Evolution maps were then produced using data at different dates to show changes (degradation, stability, or reconstitution of the ecosystem) and statistics were drawn from these changes.
- **Main achievement of the project:** State of surface and underground water resources; state of forest and fauna; livestock resources; identification and modeling of ecosystems degradation; ecosystem equilibrium; and ecosystem restoration. State of resources indicate quantitatively and qualitatively the physical amount and spatial distribution of the concerned resources.
- **Impact of GIS-based findings on policy and decisions (existing or new):** The results of the GIS analyses were used during the development phase of the National Program of Action to identify where in the country it is necessary to undertake urgent actions against desertification. The use of GIS and the results achieved led the CONAGESE to reactivate the PNGIM, a network of geoinformation producers and users in Burkina Faso. The PNGIM had been inactive for some time due to lack of financial support, but drafting the National Program of Action needed its input, hence its activation.

Annex 4. *(continued)*

BURKINA FASO

Title: PROGRAMME DE VALORISATION DES RESSOURCES EN EAU DANS LE SUD OUEST DU BURKINA ET PROJET HYDRAULIQUE RURALE 500 FORAGES

The RESO Programme and the 500 Bore Hole Project

- **Beneficiary agency:** Direction Régionale de l'Hydraulique des Hauts-Bassins - DRHB ("Hauts-Bassins" Regional Directorate of Hydraulic)
- **Executive agency:** DRHB, with technical assistance from EU
- **Financing agency(ies):** European Union
- **Starting date:** 1994
- **Completion date:** 1998
- **Goal of the project:** To develop a master plan for the management of water resources, following an ecosystem approach (by river basin) in the project area.
- **Specific objectives of the GIS component:** To ensure good planning and efficient management of water resources in the region. In the rural water supply component, the objective of the GIS tool was to show existing water supply facilities (wells and equipped bore holes) and to plan new locations (taking into account standard water needs (20 litres/person/day), figures on population, and the spatial distribution of the villages in the project area).
- **Main achievement of the project:** Development of a spatial database with more than 500 thematic derived maps on water and natural resources. These maps, produced at a standard scale of 1:500,000, cover the 9 "provinces" of southwestern Burkina. The coverage extends over 12 regional river basins that form part of 3 international river basins (Niger, Mouhoun, and Comoé). Larger-scale maps (1:300,000 or 1:200,000 scales) of smaller areas are also available from the database. In addition, a set of spatial data composed of LANDSAT T.M. images are available. The water-related data in the database were drawn from an inventory undertaken from February 1996 to December 1997. The spatial database was used recently to facilitate the implementation of 2 new projects in the region. The output of these projects was in turn used to update the content of the database. The spatial database is freely accessible for query in which resulting files can be copied. The thematic maps can be printed on demand, but the satellite data are for internal use only.
- **Impact of GIS-based findings on policy and decisions (existing or new):** The availability and quality of the spatial database raised the profile of the Directorate, including outside the country (visitors/users from Mali, Côte d'Ivoire, Togo, etc.). The ministry decided to launch a countrywide project on "integrated management of water resources" based on the successful experience of the spatial database on southwestern Burkina. Other ministries are requesting technical support for their activities in the region, based on the use of the spatial database (Ministry of Health, ministry in charge of identification and management of livestock grazing areas, and trypanosomiasis disease control).

Annex 4. *(continued)*

COTE D'IVOIRE

Title: GESTION DE L'ENTRETIEN ROUTIER GRÂCE À L'OUTIL SIG

Road Maintenance Management Using GIS

- **Beneficiary agency:** Direction des Routes et Voiries (Directorate of Roads and Urban Streets)
- **Executive agency:** CNTIG
- **Financing agency(ies):** DRV (national budget)
- **Starting date:** 1998
- **Completion date:** 1999
- **Goal of the project:** To manage road network maintenance in a rigorous manner according to a new policy that transfers the operational activities of maintenance from the traditional road network directorate (DRV) to private companies, in the framework of the national structural adjustment program.
- **Specific objectives of the GIS component:** To develop a spatial database for roads, bridges, and the like; to devise an easy-to-use query and analysis tool; to decentralize the spatial databases; and to build capacity for spatial data handling within the DRV.
- **Main achievement of the project:** A road network management system, regional and departmental thematic maps, and a user's guide for the system.
- **Impact of GIS-based findings on policy and decisions (existing or new):** Transparency in road maintenance planning, including the use of objective criteria to select the roads to be maintained. This has had a positive effect on awareness within the decision-making sphere. The system enables precise knowledge of the number of kilometers of existing asphalt roads, and the exact number and location of bridges and similar waterway crossings in the road network. This has facilitated discussions with financial institutions in the framework of the Transport Sector Adjustment Program in Côte d'Ivoire. A second phase of the program is underway, as a result of the success of the first phase. It is targeting decentralized management of the network, by setting up a road network management system in the regional directorates.

Annex 4. *(continued)*

COTE D'IVOIRE

Title: APPORT DES SIG POUR UNE GESTION OPTIMISÉE DES ÉQUIPEMENTS SOCIO-ÉCONOMIQUES: CAS DU SECTEUR DE LA SANTÉ

GIS Contribution to Optimized Management of Socio-Economic Data-structure: The Health Sector

- **Beneficiary agency:** Service de la Planification du Ministère de ia Santé (Planning division of the Ministry of Public Health)
- **Executive agency:** CNTIG
- **Financing agency(ies):** National budget
- **Starting date:** 1996
- **Completion date:** 1997
- **Goal of the project:** To reduce the imbalance in the spatial distribution of health care clinics within and between regions in Côte d'Ivoire; to improve management of medical and para-medical staff; to track health-care outcomes and optimize the decision-making process; to bring the health-care services nearer to the people. To achieve a balanced level of economic and social development for the whole of Côte d'Ivoire.
- **Specific objectives of the GIS component:** To take into account the following criteria for planning new investment in public health clinics: population (any human settlement of more than 3,000 inhabitants should have a health center); proximity (any such human settlement, not being in the catchment area (5km radius) of an existing health center should have its own health center); accessibility (availability of a road leading to that settlement); relative position (being a "central" settlement with satellite settlements around); and financial capacity (capacity of the people to contribute financially to the building of the health center).
- **Main achievement of the project:** A spatial database and a thematic map of potential new health center locations as a result of the analysis based on the above criteria. These potential locations will be compared to other criteria (geopolitics, financial capacity, etc.) in the event of actual development of a new health care center. The system provides a fair basis for planning the extension of the health-care infrastructure. Existing health sector maps were produced in order to revise the relative size of these units. Planning of new investment is made in a more transparent manner.
- **Impact of GIS-based findings on policy and decisions (existing or new):** Decision-makers in the Ministry of Health are more confident in their arguments in favor of financial resources aimed at increasing the number of health-care centers. Such requests are illustrated with thematic maps drawn from the system. Multiplier effect on other ministries because of the success of the system in terms of reliable information leading to solid arguments and increasing credibility of the minister who provides this type of information. The DRV initiative is an example of a multiplier effect. Feeling of social justice in planning extensions of the health-care infrastructure because the new centers will be developed in villages that deserve them, and not only in villages that have strong political support.

Annex 4. *(continued)*

COTE D'IVOIRE

Title: SYSTÈMES D'INFORMATION GÉOGRAPHIQUE ET GESTION URBAINE: CAS DE LA COMMUNE DE COCODY

GIS and Urban Management: Case of the Cocody Municipality

- **Beneficiary agency:** Mairie de Cocody (municipality of Cocody)
- **Executive agency:** CNTIG
- **Financing agency(ies):** Municipality of Cocody (communal budget)
- **Starting date:** 1996
- **Completion date:** 1997
- **Goal of the project:** To develop a decision-support tool for urban management based on a good knowledge of the urban land area under administration of the municipality, the citizens living or working there, and the activities they are pursuing.
- **Specific objectives of the GIS component**: To build a cadastral database by integrating various data, such as areas of the properties, level of investment, standing and rental value of the buildings, nature of activities supported, nature and level of taxes paid, etc. with a view to enhancing decision-making.
- **Main achievement of the project:** Delivery of a GIS-based tool showing all the land administered by the municipality. State of the "land reserves" of the municipality (open space belonging to the municipality and kept as reserves of land scattered across various parts of the municipal territory with a view to satisfying acute future open space needs). Easy identification of the taxpayers. Identification of all existing buildings (residential, offices, etc.), assessment of the value of the different properties, identification of all economic activities taking place on the territory of the municipality, and identification and evaluation of all the taxes paid to the municipality. Use of the system resulted in an initial increase in the daily collection of the communal tax on the Treichville market place (from 300,000 to 900,000 CFA francs).
- **Impact of GIS-based findings on policy and decisions (existing or new):** The use of the system and associated improvements in the efficiency of tax collection increased drastically the municipality's revenue. This had a multiplier effect on other municipalities because of the financial success of the system. Initiatives by the municipalities of Yopougon, Treichville (Abidjan), and three other cities are examples of this multiplier effect. Nevertheless, there was a unexpected retreat observed within the Cocody municipality due to the social and political fallout of applying the system. The system appeared to be a threat to those who lost discretionary power. Trained project staff left and were not replaced.

Annex 4. *(continued)*

COTE D'IVOIRE

Title: CONTRIBUTION DU SIG DANS LES PÉRIMÈTRES D'EXPLOITATION FORESTIÈRE EN CÔTE D'IVOIRE

GIS Contribution to Forest Concession Management in Côte d'Ivoire

- **Beneficiary agency:** DPIFR - Direction des Industries Forestières et du Reboisement (Directorate of Forest Industries and Reforestation)
- **Executive agency:** CNTIG
- **Financing agency(ies):** World Bank and national budget
- **Starting date:** 1995
- **Completion date:** 1999
- **Goal of the project:** To better manage the unclassified forest capital (south of the 8th parallel).
- **Specific objectives of the GIS component:** To show precisely the spatial distribution of all the forest concessions in Côte d'Ivoire; to identify the concessionaires for a fair assessment of taxes to be paid; to achieve a better distribution of tax revenues among the recipients (government and local entities); and to allow for a followup on the state of each concession with respect to degradation and the corrective measures applied by the concessionaire.
- **Main achievement of the project:** An accurate definition of the limits of each forest concession perimeter; accurate definition of the area of each concession, as a fair basis for tax computation and also for regulation of timber extraction; a fair redistribution of the tax among the official beneficiaries, taking into account the portion of the concession belonging to any administrative entities (sous-préfectures or districts); a fair basis for solving disputes; and the potential for decentralizing the decision process by delegation of some technical tasks at local level within the DPIFR.
- **Impact of GIS-based findings on policy and decisions (existing or new):** Greater fairness in the management of the forest concessions (regarding tax evaluation) due to the use of accurate georeferenced data on the concessions perimeters. In the past, boundary errors had led some concessionaires to work 5 or 10km away from their actual concessions. The system solved the boundary problem and also provided accurate values for the concession areas, including as a basis for tax computation. Increased efficiency and timeliness: before use of the system, the statistical data (overall volume of timber harvested during the year) necessary to compute the annual tax would take 2 to 3 years to become available. With the system, the statistical data are available soon after the fiscal year-end, allowing tax assessments to be calculated and levied on concessionaires much earlier. Prompter billing and payment of taxes has had a positive impact on the national fiscal balance.

Annex 4. *(continued)*

COTE D'IVOIRE

Title: CONTRIBUTION DU SIG DANS LA MISE EN PLACE DES OBSERVATOIRES RÉGIONAUX EN CÔTE D'IVOIRE

GIS Contribution to the Development of Regional Observatories in Côte d'Ivoire

- **Beneficiary agency:** Ministère de l'Intérieur et de l'Intégration Nationale (Ministry of Interior and National Integration)
- **Executive agency:** CNTIG
- **Financing agency(ies):** National budget
- **Starting date:** 1998
- **Completion date:** 1999
- **Goal of the project:** To integrate regional development processes into national development policy, with a view to transforming Côte d'Ivoire into a developed nation.
- **Specific objectives of the GIS component:** To create a spatial database for each region of Côte d'Ivoire; to derive thematic maps for each region.
- **Main achievement of the project:** In addition to the spatial database, delivery of regional administrative maps, regional socio-economic infrastructure maps, and electoral division maps.
- **Impact of GIS-based findings on policy and decisions (existing or new):** Beginning of a decentralized vision of development. The data from the regional observatories were used to derive administrative maps for the regions, regional maps of socio-economic infrastructure distribution, and various thematic maps for electoral purposes, including options for new administrative divisions for elections. The regional observatories have not been set up in the regions yet, because the latter do not have the required human resources to operate them. Instead, they are managed by the CNTIG in Abidjan, on behalf of the Ministry of Interior, and the analyses are performed by CNTIG on client request.

Annex 4. *(continued)*

THE GAMBIA

Title: DETERMINNATION DE SITES DE DEPOT D'ORDURES DANS LA REGION DU GRAND BANJUL

Determination of Waste Disposal Sites in the Greater Banjul Area

- **Beneficiary agency:** Environmental Quality Working Group
- **Executive agency:** Environmental Information Systems Programme in collaboration with the Environment Quality Working Group
- **Financing agency:** National Environment Agency
- **Starting date:** 6 January 1996
- **Completion date:** 13 April 1996
- **Goal of the project:** The GBA is the fastest growing urban area in The Gambia, and this is putting an increasing strain on waste management in the area. The overall goal of the project is to address the growing problem of waste disposal in the GBA by putting in place a sustainable framework for selecting new disposal sites.
- **Specific objectives of the GIS component:** To provide a comprehensive integrated database, using suitability criteria, and capable of being updated when necessary; to identify the criteria, compile the data, and develop a set of options (alternative sites) for consideration and ultimate selection as sites of future waste disposal facilities.
- **Main achievement of the project:**
- The project contributed to strengthening the dialogue between institutions. A consultation process took place among the parties involved in land and waste management in the country, leading to a consensus-based set of criteria for waste disposal suitability.
- The project produced a series of useful datasets. The data required for the analyses were collected and compiled, resulting in sets of digital data. They were first analyzed to provide potential fields—eligible sites for waste disposal. These suitable sites were then checked to test analytical findings against the reality of the terrain. Then adjustments were made and final suitable sites confirmed.
- The project has confirmed that, indeed, little land is suitable for waste disposal sites in the GBA. It enabled production of a spatial database on the Greater Banjul Area, with possibilities of updating the data as required.
- **Impact of GIS-based findings on policy and decisions (existing or new):**
- Impact on institutional cooperation: The requirements of GIS-based analysis brought together institutions involved in waste management which formerly worked in isolation.
- Impact on governance: During the field check, it was discovered that some of the potential waste disposal sites were human settlement areas. Analysis of the reasons behind this unexpected finding showed that the settlers got their lands from the customary authorities and these land transactions were not officially recorded by the land administration system. The decision was made to initiate a change in the land administration system in order to include the customary authorities as an official partner and take into account their allocation sub-system in the official land management system in The Gambia.
- Impact on EIA implementation: The project showed that GIS is a valuable tool in carrying out an EIA related to land management.

Annex 4. *(continued)*

THE GAMBIA

Title: AMENAGEMENT DU TERRITOIRE POUR LE DEVELOPPEMENT ET LA PROTECTION DE L'ENVIRONMENT

Land-Use Planning For Development and Environmental Protection

- **Beneficiary agency:** Government of The Gambia
- **Executive agency:** National Environment Agency
- **Financing agency:** FAO
- **Starting date:** February 1998
- **Completion date:** November 1999
- **Goal of the project:** The main objective of the Project was to develop policies that would enable the government to apply modern concepts of land-use planning and management in order to increase rural agricultural production.
- **Specific objectives of the GIS component:** To integrate soils data with data on climate, agro-ecological zones, and farming systems to develop land suitability models for different crop types.
- **Main achievement of the project:** The land suitability models that have been developed are currently being used by the Soil and Water Management Unit of the Department of Agricultural Services.
- **Impact of GIS-based findings on policy and decisions (existing or new):** The final results of the project have helped develop land-use policy recommendations, which have already been submitted to the Government for adoption.

Annex 4. *(continued)*

THE GAMBIA

Title: CARTOGRAPHIE DE L'UTILISATION ET DE L'OCCUPATION DU SOL

Land-Use/ Land-Cover Mapping

- **Beneficiary agency:** Government of the Gambia
- **Executive agency:** National Environment Agency
- **Financing agency:** GTZ-USAID
- **Starting date:** January 1997
- **Completion date:** March 1998
- **Goal of the project:** To provide the information on natural resource base for enhancing the planning and management of natural resources and the environment.
- **Specific objectives of the GIS component:** To provide an integrated land-use digital database as the basis for developing a framework for periodically monitoring land-use changes throughout the country. To analyze and assess these changes and thus guide development.
- **Main achievement of the project:** It is generally accepted in The Gambia that the appropriateness of the prevailing land-use pattern, upon which productivity improvement depends, is questionable.[1] The changes in land-use over time, including the pace and nature of such change, is misunderstood. This is primarily due to the lack of time-series information on past land-use patterns. This Project has generated a baseline of information that future studies of land-use dynamics can build upon.

  In addition, the project has produced a land-use database, a valuable analytical tool allowing the NEA to meet many user needs.

- **Impact of GIS-based findings on policy and decisions (existing or new):**
- Impact on the implementation of development projects: The availability of land-use maps, especially the spatial database, facilitated the launch of many development projects. The Department of Forestry used the data to carry out a national forest inventory aimed at improving forest management in The Gambia. The Department is currently using the data for management of both national and community forest parks.
- Similarly, the World Food Programme also utilized the digital data to develop a food-aid distribution strategy for The Gambia. Combined with population data, the resulting output was used to assess food-aid requirements.[2]
- Impact on awareness: The availability of a spatial database covering the entire country and its use as a source of concrete examples of GIS applications has had a positive impact on awareness. One of the many officials intrigued by the system was the head of police services, who showed a great deal of interest in it after seeing a demonstration of its possibilities at the NEA.

1. Land is deteriorating: In some places, the usefulness of the land for production purposes is being lost due to a number of reasons including inappropriate use of the land. Other factors include loss of soil nutrients, erosion, etc., most of which are man induced resulting from misuse, mismanagement or overuse. Some of the uses contributing to land degradation include overgrazing, conversion of fertile land into settlements and indiscriminate felling of trees resulting in serious deforestation. There may be a lot of land-use information but the inappropriate use of such information may also lead to degradation.
2. The idea was to determine food-aid requirements of different communities based on a number of factors including amount of cultivable land available and sustainable production levels. These are, to a large extent, dependent on land-use and other production patterns.

Annex 4. *(continued)*

THE GAMBIA

Title: REVISION DU SCHEMA DIRECTEUR D'AMENAGEMENT ET D'URBANISME DE LA REGION DU GRAND BANJUL

Revision of the Greater Banjul Area (GBA) Master Plan

- **Beneficiary agency:** Department of Physical Planning and Housing
- **Executive agency:** Department of Physical Planning and Housing, assisted by the National Environment Agency
- **Financing agency:** National Environment Agency
- **Starting date:** July 1995
- **Completion date:** September 1996
- **Goal of the project:** To revise and update the GBA master plan in accordance with the Physical Planning and Development Control Act.
- **Specific objectives of the GIS component:** To redesignate appropriate land-use classes and zones in the GBA with a view to addressing the fundamental problems associated with the existing spatial distribution of population; to map out the spatial delimitation of the Greater Banjul Area; to identify and collate all relevant land-use and other socio-economic data; to integrate all relevant datasets; to identify and delineate areas earmarked for densification, upgrading, and preservation; and to produce a land map of the GBA showing all the land-use categories as defined in the master plan.
- **Main achievement of the project:** The GBA is the largest, fastest growing urban area in The Gambia, with a projected population increase of more than half a million by 2005. In this regard, the Project has succeeded in putting in place a plan that seeks to utilize the land resources of the area in a judicious and equitable way, so as to satisfy the needs of the growing population for housing, infrastructure, social, and community facilities.
- **Impact of GIS-based findings on policy and decisions (existing or new):** The master plan is a major policy document whose implementation has far-reaching impacts on the general population. The redesignation of major land-use zones are direct consequences of the GIS findings.

Annex 5. List of Abbreviations and Acronyms

AARSE ..... African Association of Remote Sensing for the Environment
ACDI/VOCA ..... Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance
AGRHYMET ..... Centre Agro-hydro-météorologique de Niamey au Niger
ANR ..... Agriculture and Natural Resources
ARD ..... Associates in Rural Development, Inc.
BERA ..... Bureau d'Etudes et de Recherches Appliquees
BNETD ..... Bureau National d'Etudes Techniques de Développement (National Bureau for Development Studies)
CCT ..... Centre de Cartographie et de Télédétection (Center for Cartography and Remote Sensing)
CILSS ..... Comité Inter-Etats Permanent de Lutte contre la Sécheresse dans le Sahel (International Standing Committee on Fighting Drought in the Sahel)
CNTIG ..... Comité National de Télédétection et d'Information Géographique (National Committee for Remote Sensing and GeoInformation)
CRE ..... Centre de Recherche en Ecologie (Ecology Research Center)
CREPA ..... Centre de Réseau pour l'Eau Potable et l'Assainissement à Moindre Coût (Network center for Low Cost Drinkable Water and Sanitation)
CURAT ..... Centre Universitaire de Recherche et d'Applications en Télédétection (University Center for Research and Remote Sensing Applications)
DASU ..... Direction de l'Analyse et des Statistiques Urbaines (Directorate for Urban analysis and statistics)
DCGTx ..... Direction Générale de Contrôle des Grands Travaux (Directorate-General for Public Works Oversight)
DGH ..... Direction Générale de l'Hydraulique (Directorate General for Water Resources)
DPIFR ..... Direction des Industries Forestières et du Reboisement (Directorate for Forest Industries and Reforestation)
EIER ..... École Inter-Etats des Ingénieurs de l'Equipement Rural (Intergovernmental Engineering Center for Rural Development)
EIS ..... Environment Information System
ENRECA ..... Enhancing Environmental Research Capabilities
GEAP ..... Gambia Environmental Action Plan
GIS ..... Geographic Information Systems
GGEMP ..... Gambia-German Environmental Management Project
GTZ ..... Gesellschaft fuer Technische Zusammenarbeit (German Organization for Development Cooperation)
NEA ..... National Environmental Agency
IGT ..... Institut de Géographie Tropicale (Institute of Tropical Geography)
IRG ..... International Resources Group, Inc.
IWG ..... Information Working Group
LATIG ..... Laboratoire de Télédétection et d'Information Géographique (Remote Sensing and GeoInformation Laboratory)
PANE ..... Plan d'Action National pour l'Environnement (National Environmental Action Plan)
PCG ..... Policy Consultative Group
PNGIM ..... Programme National de Gestion de l'Information sur le Milieu (National Program for Environmental Information Management)
PNGT ..... Programme National de Gestion des Terroirs (National Program for Rural Land Use Management)
UNDP ..... United Nations Development Programme
UNEP GRID/Arendal ..... United Nations Environment Programme Global Resource Information Databases/Arendal
UNSO ..... United Nations Sudano-Sahelian Office
USAID ..... United States Agency for International Development
WRI ..... World Resources Institute

Annex 6. The Joint USAID/WRI Information Working Group Members

The joint USAID/WRI Information Working Group for Africa is composed of:

- Paul Bartel, Environmental Monitoring and Information Systems Advisor USAID
- André Bassolé, Chairman, EIS-Africa
- Jake Brunner, formerly Senior Associate at WRI, currently Senior Director, Mainland Asia, Asia-Pacific at Conservation International
- Leif Christoffersen, Chair, UNEP/GRID-Arendal
- Henri Josserand, Senior Associate, Associates in Rural Development
- Dan Tunstall, Director, Information Program, WRI
- Frank Turyatunga, Project Director, ACDI/VOCA, Uganda
- Bob Winterbottom, Senior Manager, Environment and Natural Resources Group, IRG.

Annex 7. Maps from Case Studies

Map 1. Number of Users per Modern Water Supply Facility by Provinces in Southwestern Burkina Faso

Map 2. Protected Areas of Côte d'Ivoire

Map 3. Identification of Possible Sites for Waste Disposal (The Gambia)

The World Resources Institute is an environmental think tank that goes beyond research to create practical ways to protect the Earth and improve people's lives. Our mission is to move human society to live in ways that protect Earth's environment for current and future generations.

Our program meets global challenges by using knowledge to catalyze public and private action:

· To reverse damage to ecosystems. We protect the capacity of ecosystems to sustain life and prosperity.

· To expand participation in environmental decisions. We collaborate with partners worldwide to increase people's access to information and influence over decisions about natural resources.

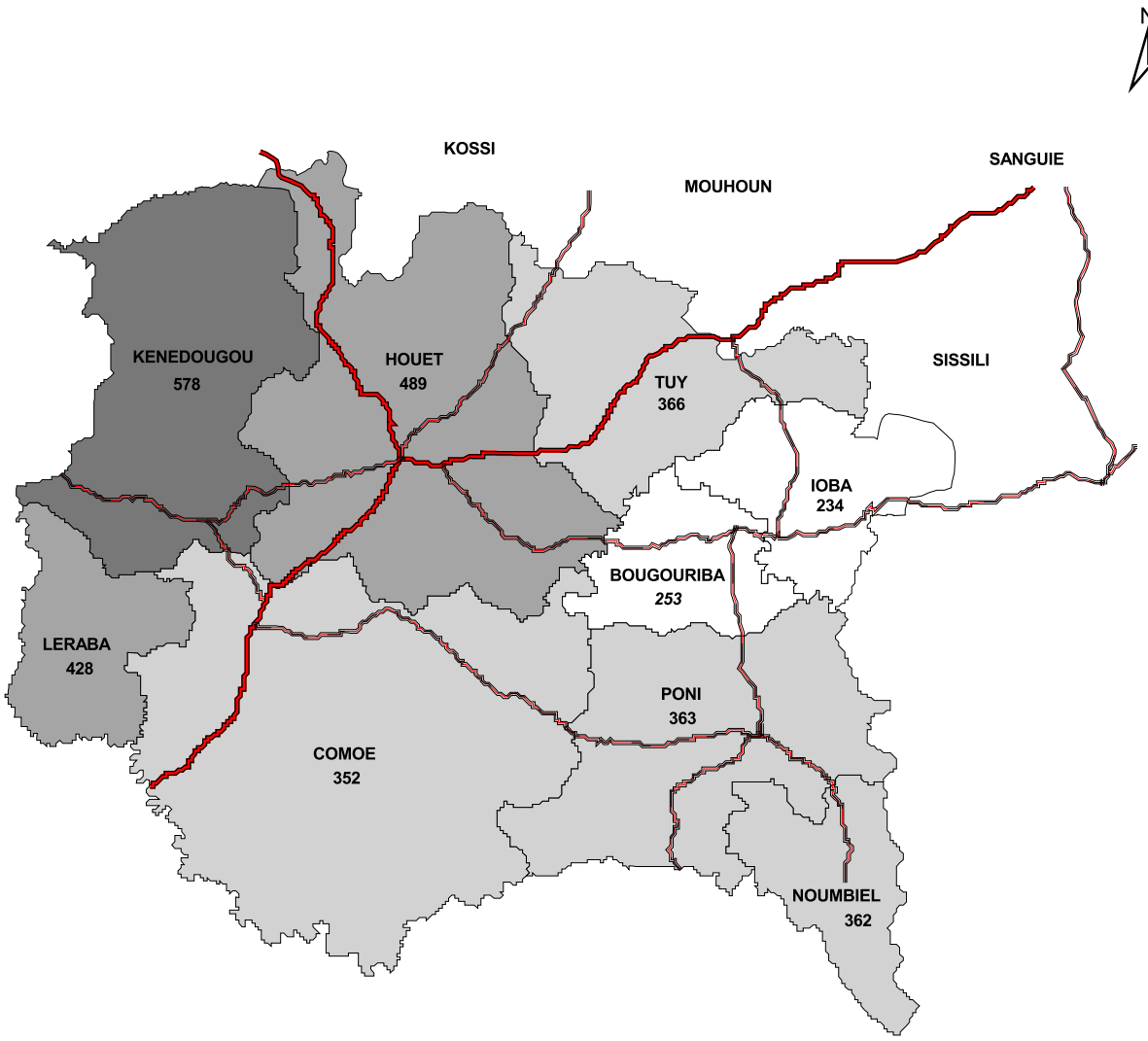
· To avert dangerous climate change. We promote public and private action to ensure a safe climate and sound world economy.

· To increase prosperity while improving the environment. We challenge the private sector to grow by improving environmental and community well-being.

In all of its policy research and work with institutions, WRI tries to build bridges between ideas and action, meshing the insights of scientific research, economic and institutional analyses, and practical experience with the need for open and participatory decision-making.

The World Resources Institute
10 G Street, NE Suite 800
Washington, DC 20002
www.wri.org

NUMBER OF USERS PER MODERN WATER SUPPLY FACILITY BY PROVINCE, SOUTHWESTERN BURKINA FASO



GIS analysis is being used to provide a comparative basis for planning new investment in water supply facilities (Point d'eau moderne - PEM) in southwestern Burkina Faso. This map illustrates an initial indicator of access to drinkable water (users per supply site, including modern well, bore hole with manual pump, small running water network with public supply points, etc.). The map was prepared as part of a broader effort to identify which provinces of southwestern Burkina Faso are meeting the government's target of ensuring supply of 30 liters of drinkable water per person per day.

LEGEND

Asphalted Road

Dust Road

Number of inhabitants per PEM

200

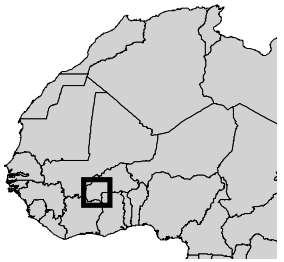
300

400

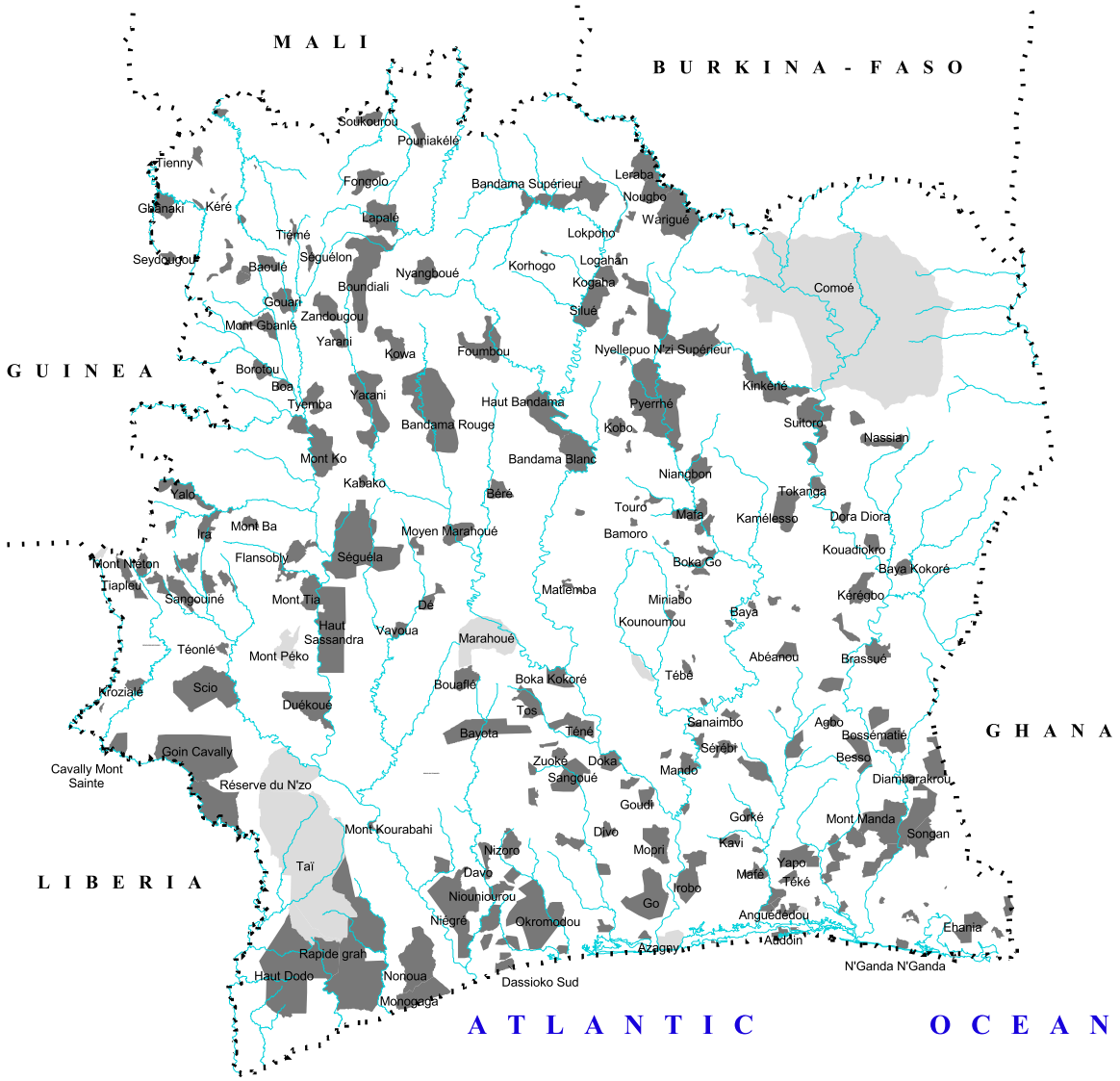
500

25 0 25 50 Kilometers

Scale: 1:2 500 000



PROTECTED AREAS OF COTE D'IVOIRE



Development of a spatial database on the forest resources of Côte d'Ivoire has helped to greatly enhance the performance of the government ministry responsible for the management of timber concessions. Concession boundaries have been accurately drawn, assisting the ministry in regulating timber extraction and in the collection and distribution of tax revenues. This map, showing the distribution of protected areas, represents one dataset used to conduct the spatial analysis.

LEGEND

Country boundary

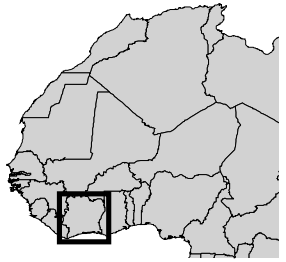
River

Protected Forest

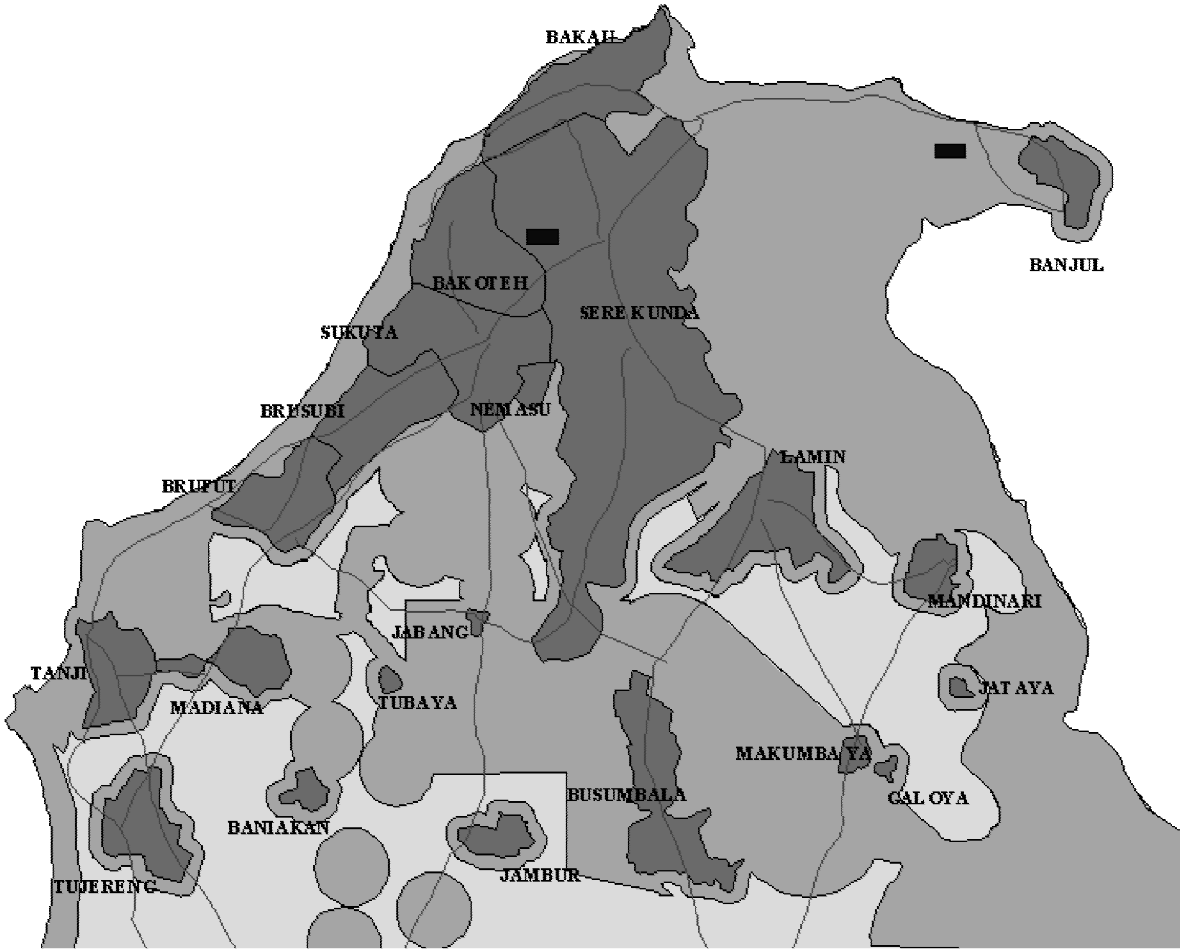
National Park

50 0 50 100 Kilometers

Scale: 1:5 000 000



POTENTIAL SITES FOR FUTURE WASTE DISPOSAL FACILITIES, GREATER BANJUL AREA, THE GAMBIA



Identifying suitable sites for future waste-disposal facilities is an urgent priority for the Greater Banjul Area, one of the fastest growing urban areas in The Gambia. Spatial analysis using suitability criteria was carried out and a map constructed to show areas satisfying the criteria for waste disposal siting, confirming that few such areas remain. Field checks of the candidate sites identified by GIS analysis revealed that some were unrecorded human settlements, spurring administrative reform of land registration procedures.

LEGEND

Road

Existing Disposal Site

Suitability of area for disposal

Suitable

Not Suitable

Settlement

5 0 5 10 Kilometers