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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

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For Discussion

Agenda Item 3: Trends in Science – INRM/GIS

The attached notes on GIS were prepared by the TAC Secretariat at the request of the TAC Chair. It provides part of the background material to the discussion under the above-mentioned Agenda Item 3. Distribution is limited to TAC Members only.

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

March 2001

Applications of GIS in Agricultural Research

Notes for the TAC80 meeting at ICARDA, Aleppo[1]

Background

TAC report on CGIAR priorities and strategies for 1998-2000 and the new vision and strategy for the CGIAR formulated by TAC drew attention to the importance of new science tools, such as GIS, to agricultural research. These potential tools can lead to considerable advances in many areas of biological, physical and social sciences. This document, which briefly summarises the use of GIS in agricultural research in general and in the CGIAR Centres, is meant to serve TAC in analysing the status and potential of various areas of cutting-edge research and in prioritising its focus in reviewing these areas.

1 GIS as a tool

The term GIS (Geographic Information Systems) is currently applied to computerized information storage, processing and retrieval systems that have hardware and software specifically designed to cope with geographically referenced spatial data and corresponding attribute information. The spatial data is commonly in the form of "layers", which may depict topography, water availability, soil types, forests and grasslands, climate, geology, population, land-ownership, administrative boundaries and infrastructure. Its capability of combining different map layers - in an operation known as "overlaying" - is one of the most important GIS functions.

Geographic analysis can provide a considerable input to agricultural research where the spatial dimension is relevant. Applications range from service functions such as collecting and providing geo-referenced data to modelling of crop yields, identification of key areas of population pressure, biodiversity conservation and complicated impact assessment analyses. The importance of GIS in agricultural research is increasing as environmental management gets its steady position on agricultural research agendas. GIS are in widespread use in developing countries, even including many least-developed countries. Agroecological characterization and zoning at the regional level, with data incorporated in a GIS, can already help identify areas with similar agroecological characteristics in different countries. Zoning can assist in identifying areas where a technology can be applied. A number of IARCs are engaged in this area.

The public goods research potential use of GIS lies in its capability for modelling: constructing models of the real world from digital data bases, and using these models to simulate the effect of a specific process over time for a given scenario. Modelling is a powerful tool for analysing trends and identifying factors that affect them, or for displaying the possible consequences of planning decisions or projects that affect resource use and management.

At the national and local level, possible GIS applications are almost endless. GIS provides a means of converting spatial data into digital form that can then be displayed, manipulated, modified and analysed and reproduced quickly in a new format, available for either visual

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[1] This information is taken from the Internet and therefore limited by the availability of this type of information and its up-dating by the providers of the sites. The information is by no means exhaustive of what is going on in each individual CGIAR Centre and at FAO.

display or hard copy reproduction. The digital data can also be easily transmitted from one user to another or from one GIS to another merely on disk, tape or by the Internet. As digital maps come into wider use, the cost of digitizing can be shared by many users. As networks and libraries of databases grow, information exchange should reduce the need for redigitizing regional or national maps and other geographic databases than are in common use.

2. Use of GIS as a systems method in the CGIAR

Most of the CGIAR Centres are now using GIS, which they have found to be a powerful tool for dealing with the spatial dimensions of complex agroecological problems. CIAT, CIMMYT, ICARDA, IRRI and WARDA, for example, often use GIS in combination with simulation methods for geographic extrapolation of research findings. This example of a combination of two methods offers completely new opportunities for the IARCs and the more advanced and better endowed NARS to target their research, whether for varietal improvement or NRM.

More standardisation, first among IARCs and then between them and NARS, on systems methods and their applications would be helpful. Some methods may be easier to standardise than others. For example, the only way to improve some of the limitations in hardware-software compatibility in GIS may be by agreement among users to stick to certain options. IRRI and ICARDA have adopted a modular approach to the development of systems analysis methods that others, in time, may follow. IRRI's approach employs a model called MACROS. This model includes modules for crop growth, water balance, soil-nitrogen transformations, and crop response to nitrogen. At ICARDA, the components (or modules) of the modelling system include, or will soon include, modules for a generator of spatial weather patterns, crop profitability, whole farm analysis, hydrology, and groundwater. These components are linked to a GIS.

A systems perspective requires reliable data. Agricultural research organisations are interested in terrain and soil, rainfall, and temperature, and their variations in space and time. Most of them are also interested in the seasonal course of water balance. A geographically referenced inventory of natural resources that includes this biophysical data, but also economic data from which to assess land capability and land- and water-use patterns, is a key requirement for research and development planning and for the integration of productivity and NRM research.

2.1 The CGIAR Consortium for Spatial Information (CSI)

The CSI is a global network of research laboratories using GIS technologies for land use management, sustainable agriculture, and poverty alleviation. The member institute include: CIAT, ILRI, CIMMYT, IRRI, IFPRI, ICRISAT, ISNAR, ICARDA, Texas A&M Blackland Research Centre, and UNEP Global Resource Information Database (GRID-ARENDAL in Norway).

The CGIAR chain embraced GIS over a decade ago. In May 1999, the Consortium for Spatial Information (CSI) was formed, connecting 10 GIS laboratories from around the world. The members declare their intention to continue the co-operation established through the Norwegian-funded UNEP/CGIAR project on use of GIS in agricultural research. It was felt that the development of spatial data sets and tools for analyses of geographic information, as well as spatial information management was a CGIAR research area well-suited for taking advantage of collaboration among and between member centres and other institutions like the UNEP/GRID

network. The CSI members had already developed virtually unrivalled collections of data on population, poverty, climate, soils, crops, livestock, transportation, and biodiversity.

CSI objectives are to coordinate and integrate the CGIAR Centres' various approaches to using GIS, strengthen the Centres' capacities to apply GIS to sustainable agricultural research, share methods, tools, experiences, not only within the CGIAR system, but also externally via a Web site, and contribute to the further development of global databases relevant to agricultural research. The CSI is creating mechanisms for standardizing data sets within the CGIAR, sharing methodologies and solutions, and facilitating inter-center collaboration. The Consortium also serves as a platform for joint efforts in GIS-based agricultural research at global, regional, and local levels.

Areas of high priority and common interest to the CGIAR/GIS community, coordinated by different SCI members (in brackets) include: 1) Coordinating data management and tools (TEXAS A&M), 2) Geographic dimensions of crop varieties (CIMMYT), 3) Impact assessment (IFPRI), 4) Natural resource degradation (ICARDA), Integration and training of national agriculture research systems (ISNAR) and Poverty mapping (CIAT).

GIS related activities

- Post-hurricane disaster relief atlas for Honduras (CIAT)
- Mapping of rural poverty and natural resource constraints in dry areas (ICARDA)
- Poverty mapping in Burkina Faso (ISNAR)
- Poverty mapping and spatial analysis of rural poverty in Honduras at sub-national level (CIAT)
- Mapping and analysis of rural poverty in relation to rice production (IRRI)
- Development of future human population scenarios to assess possible impact of global change and future management interventions (ILRI)
- Farm management GIS for Tel Hadya – an on-line field query system containing 21years of data related to on-farm management practices (ICARDA)
- Integration of spatial information to analyze constraints to animal agriculture (ILRI)
- Mapping of village territory and livestock migration (ICARDA)
- Study of spatial aspects of designing and targeting agricultural development strategies (IFPRI)
- Livestock early warning system for East Africa – spatially explicit analyses and direct monitoring of animal nutrition (Texas A&M)
- GIS-based agro-climatic and water balance analyses (IRRI)
- Characterization of crop/livestock production systems in Africa, Latin America, and Asia (ILRI)
- Agro-ecosystem assessment for Latin America: agricultural extent, production systems and agro-biodiversity (CIAT)
- GIS characterization of the rice/wheat region in Asia (CIMMYT)
- Mapping and analysis of rice production at international, national, and sub-national levels (IRRI)
- Development of spatially explicit crop models, using GIS (CIMMYT)
- Spatial analysis of boron limitations to legumes; GIS analysis of water for legumes in dry areas of Sri Lanka and the Indo-Gangetic Plain (ICRISAT)
- Suitability map for potential water-harvesting schemes in central Syria (ICARDA)
- Evaluation of the conversion of forest land into agricultural land, using remote sensing (ICRISAT)

- Remote sensing and GIS applications in delineating and mapping rice areas and rice cropping systems (IRRI)
- Development of climate surfaces for Africa (Texas A&M)
- FloraMap – a software tool for analyzing climate in relation to germplasm collections (CIAT)
- Almanac Characterization Tool – a packaged set of geo-referenced data and query tools targeted for use in agricultural and natural resource management activities (Texas A&M)
- Accessibility Extension - an ArcView software extension for generating grids depicting accessibility based on user-defined parameters (e.g., roads, rivers, slopes, and markets) (CIAT)
- Environmental and sustainability indicators for decision-making (CIAT)
- Development of GIS-based decision support system for analyzing rice supply and demand (IRRI)
- Development of GIS-based tool for land use planning, analysis, and decision making (IRRI)
- Millenium Assessment of the State of the World's Ecosystems – agro-ecosystem component [part of the 2000/2001 World Resources Report] (IFPRI)

Improving Methods for Poverty and Food Insecurity Mapping project
A new activity, Improving Methods for Poverty and Food Insecurity Mapping and its Use at Country Level, pools know-how, data and technical skills of the three international organisations FAO, CGIAR and UNEP/GRID and various other international expert institutions to provide the public with poverty maps from the global to the subnational level. The aim is to sharpen and enhance the use of GIS for mapping food insecurity, poverty and vulnerability. CIAT (representing the CSI), FAO and UNEP-GRID Arendal will jointly work on establishing a web-based network of individuals and institutions mapping food insecurity, poverty and vulnerability, and on developing improved methods and tools for using map-based information to combat food insecurity and poverty at all levels.

2.2 GIS in individual CGIAR Centres

CIATs GIS Facility, developed over 10 years, aims to produce maps and to provide projects with tools that improve the understanding of problems and the vision of solutions, towards the ultimate goal of decision-making. The Facility is focusing on spatial characterization of poverty, spatial analysis of biodiversity, land-use mapping, and analysis in different ecoregional settings, including hillsides. Through training and collaboration it also contributes to strengthening NARS. GIS are used, for instance, for providing detailed information for participatory research through high-resolution mapping and for developing tools for guiding and monitoring reforestation initiatives in Colombia. CIAT is also involved with UNDP in an Indicators Project to store environmental and sustainability indicators for Latin America and the Caribbean. CIAT is the CGIAR representative in the FAO-UNEP/GRID-CGIAR joint project for poverty mapping (see above).

The applications and products of GIS at CIAT available in the Internet include: Poverty in Latin America, Digital atlas of Central America, Hydrogeology map of South America, FloraMap, Mitch atlas in Honduras, Livestock in Latin America, Environmental indicators, Headland parks in Cali.

CIFOR is working to develop and refine a number of innovative tools to aid biodiversity research and analysis. These include rapid survey methods, molecular markers, computer software, new applications of GIS and remote sensing, and "criteria and indicators" to assess

biodiversity. CIFOR is also involved in a systems analysis of the world's forests by studying the relationship between forests and people in a number of tropical countries.

In the Humid Forest Zone of Cameroon GIS are used to better understand the characteristics of markets for non-timber forest products (NTFP). GIS provide a new tool for NTFP market analysis. The use of GIS has given CIFOR scientists and their colleagues a more complete understanding of the spatial structure of the markets and the dynamics of NTFP trade in the area – highly useful for more targeted policy interventions. In a project launched in 1998 in Indonesia, the GIS/spatial analysis work will measure and map land use and forest cover changes over the past decade, as a framework to support studies of local inhabitants' reliance on NTFP trade at different stages of forest development.

CIMMYTs Natural Resources Group (NRG) encompasses a GIS/modelling laboratory (GISML), which is involved in the "Country almanacs", in developing the Sustainable Farming Systems Database (SFSD, started in 1997), and in methods for spatial targeting of promising NRM practices (collaborating with Texas A&M, CIAT, IRRI, and the CSI). The NRG's aim is to integrate GIS and modelling. The resulting ability to evaluate technology options across space and time promises to add considerable value to the NRM research of CIMMYT and its partners. The types of data in the SFSD are a key ingredient for a "second Green Revolution" based on knowledge-intensive crop management. In addition, GIS and other modern research tools need voluminous and high quality data to be useful, especially when applied to studies of farming systems.

CIMMYT's "Country Almanacs" are now available for the national programmes in several African countries. In collaboration with CIMMYT's NRG, Texas A&M has developed stand-alone, CD-ROM software that combines powerful and flexible GIS tools with preloaded data on climate, topography, soils, political divisions, land use, etc. The "Country Almanacs" put the enormous power of GIS in the hands of users ranging from agricultural and natural resource scientists to policy makers. The Almanacs demonstrate a guiding principal of GIS at CIMMYT: the group is comparatively small, but the able to build strategic alliances with others who have access to resources and evolving technology, and thus offer the best of this technology to partners in developing countries. GIS applications assist maize breeders in developing drought tolerant maize germplasm for Sub-Saharan Africa. By examining spatial variation in season length and precipitation, it should be possible to target germplasm to specific regions in Sub-Saharan Africa.

CIP has in the last five years invested heavily in tools, such as GIS, to enhance NRM research capacity. GIS contributes to CIP's research on integrated disease management of late blight by incorporating spatial information on agricultural production, historical data on weather patterns, and data generated by simulation models. GIS has also been used to design a scheme for collecting samples of *Phytophthora infestans*, the fungus that causes the disease. Current GIS research on late blight aims to characterize geographic differences in the disease system, assess production risks, and forecast the impact of new technology and resistant cultivars. One of CIP's products is GCLIM10, a database of global monthly climate surfaces (grids) at a 10-minute resolution for 9 climate variables. The database has been developed for global characterization of potato growing environments, particularly for enhancing the characterization of potato late blight, but could be used for many other purposes and it is available upon request for free use.

CIP integrates remote sensing, GIS, and modelling for land-use monitoring in the arid/semi arid Andes. Also training of national collaborators in remote sensing, GIS and crop modelling in on the agenda. In CIP's CONDESAN related research, GIS is used for general benchmark site

characterization as well as for specific research projects. GIS is also included for developing decision support tools for analysing trade-offs in sustainable agriculture and the environment. Furthermore, CIP aims at using GIS in global commodity analysis and impact assessment and one of the milestones is to characterize with GIS potato and sweetpotato production ecologies. GIS is also used for guiding the in-situ conservation of wild potato species.

ICARDA has incorporated GIS to many of its projects, which include:

- Agronomic management of cropping systems for sustainable production in dry areas – cropping systems are characterised in time and space, through generalization of site-specific long-term trials to wider areas using crop models in combination with GIS technology.
- Rehabilitation and improvement of native pastures and rangelands in dry areas – rangeland inventories and GIS are used to extend work to new areas and to enable local community planning and management.
- Water resource conservation and management for agricultural production in dry areas – Use of remote sensing and GIS has been initiated in Syria.
- Agroecological characterization for agricultural research, crop management and development planning – climate databases will be integrated with land-resource databases through GIS and remote-sensing technology. The projects collaborates with specialized research institutions in advanced methodological development, like GIS.

GIS is also used for characterization and mapping different types of drought.

ICLARM[2] offers databases on aquatic resources, including: FishBase - a comprehensive database in finfish, and ReefBase – a global database on reefs and their resources containing, among other features, several types of maps and information on management and reef-related socioeconomic variables. ICLARM is developing specific management advice for the Southeast Asia region in a GIS and map-based format, as part of its Reeds at Risk study of the Coastal and marine resources research program.

ICRAF[2] develops GIS databases of biophysical and socioeconomic parameters, at different spatial scales, for Latin America, sub-Saharan Africa and Southeast Asia, and maps depicting these data, rates of deforestation, soil depletion, biodiversity losses in same areas and typologies of agroforestry systems.

ICRISAT

ICRISAT is continuously strengthening its capacity in the use of GIS techniques. ICRISAT's global GIS Unit started in 1997 at two locations - Patancheru, India and Niamay, Niger - with a mandate to provide global support to the GIS needs of the research projects. Two new GIS laboratories have been established in ICRISAT Bulawayo, Zimbabwe and in ICRISAT Bamako, Mali. The Bamako laboratory is a joint facility resulting from collaboration between ICRISAT and the Institut'd Economie Rurale (IER), Mali's National Program.

Some of the on-going applications are:

- Developing resource inventory showing distributions of crops, climate and soils resources and biotic and abiotic stresses of legume crops for the greater inclusion of legumes in the wheat/rice-based cropping systems;

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[2] ICLARM and ICRAF have very limited information about GIS on their web pages.

- Assessing spatial and temporal distribution of soil water availability, using GIS and water balance models for determining the introduction of legumes in the tropical rice-based cropping systems;
- Mapping the physical components of a watershed as well as generating digital elevation model of the watershed for sustainable management of resources
- Relating the biophysical variables and the adoption rates of improved sorghum and pearl millet varieties for a better understanding of technology diffusion/adoption;
- Estimation of spill-over impact of sorghum and pearl millet germplasm;
- Delineation of adoption and adaptation zones for sorghum and pearl millet for the regionalisation of technology development, testing and application;
- Relating pearl millet downy mildew incidence with the climate variables for better understanding of the occurrence of the disease.

IFPRI has developed a software package DREAM, which can show relative economic benefits of various research themes within each country and the region as a whole. The data can be linked to maps via GIS. IFPRI is currently working on a new GIS based software, which can assist R&D analysis in identifying the most suited location for new technologies or technology packages, in order to get the best payoffs from research technologies. Research outputs also include typologies of less-favored lands and GIS databases that can guide policy makers in planning investments in these areas.

IITA's GIS unit is an important part of the Resource and Crop Management Division. GIS system is developed to adapt it to the increasing demand from all disciplines at IITA. It will be used for research planning, for recommendation domain delineation, for scaling up research results within and beyond existing ecoregional benchmark areas and to assist in determining the potential impact of IITA technologies in sub-Saharan Africa.

GIS is currently applied in several projects, including:

- Conservation and utilization of plant biodiversity. As part of the project, a computerized database for IITA maize international trials was established. It is being linked with GIS, for use in targeting introduction and development of germplasm for specific environments, to enhance the impact at farm level.
- Agroecosystems development strategies and policies
- Integrated management of legume pests and diseases
- Integrated management of maize pests and diseases
- Cassava productivity in lowland and mid-altitude agroecologies of sub-Saharan Africa

ILRI applies GIS techniques for a range of purposes, from local-level analysis of livestock systems to continent-level models of the likely effects of disease control. These techniques are important to help identify where resources can best be focused to increase food production through livestock while minimising harm to the environment.

GIS is extremely useful tool in disease-control planning. The systems can help to refine understanding of the distribution and potential distribution of the tick causing East Coast fever and the interaction of this tick with livestock. GIS research also focuses on assessing the environmental consequences of controlling the tsetse fly and the disease trypanosomiasis that it transmits to livestock and people. GIS are used in disease reporting and management. With relevant information, stored in geo-referenced data 'layers' in the GIS system, the people organising the response to the disease outbreak can rapidly determine the size of the problem they have to deal with and what resources are available to them. Data quality is a crucial area,

and knowledge of the behaviour of a disease and its vectors is central to the development of a decision-support function.

ILRI has begun to characterise livestock and crop-live-stock production systems and their constraints in Southeast Asia. GIS maps of agroecological areas, livestock densities, socio-economic characteristics and markets are being produced. Databases in a GIS format are developed by national research groups under the direction of ILRI veterinary epidemiologist for assessing the economic importance of foot-and-mouth disease in Asia. GIS techniques are used to model local land use and its effect on productivity. A project in Niger studies nutrient flows in farming systems in the southern Sahel. GIS tools come in to make sense of all the various factors and how they affect each other and nutrient flows. Development of detailed maps of geomorphology and land use for each of the villages from aerial photographs has been the first step. GIS are also used to generate the maps that guide the field surveys and year-round monitoring of feed resources, herds and herd management practices. Field data are being stored as GIS data layers. Once the surveys and field data collection are complete, the GIS system will be used to calculate nutrient flows and test hypotheses to explain the role of herd management in natural resource and soil fertility maintenance. Ultimately, modelling will help extrapolate from the study site to the broader geographical region of the West African semi-arid zone. ILRI also uses GIS for monitoring land use changes in the Ethiopian highlands.

IPGRI[3]

IRRI uses systems analysis and GIS to evaluate over space and time where the new technologies will be most useful. IRRI is expanding and updating its rice statistics database and using GIS to integrate socioeconomic and biophysical variables at the subnational level for the big rice growing nations. The data will be analysed to monitor development in the rice sector regarding changing patterns of production, consumption, trade, input and product markets and pricing policies and to assess changes in overall socioeconomic conditions, including income distribution and poverty. GIS provide opportunities to integrate biophysical and socioeconomic parameters for analyzing yield gaps and yield constraints, to delineate the extension domains of improved technologies, and to understand the factors constraining optimal use of land and other natural resources.

GIS baseline surveys are used to study the effects of land fragmentation on genetic resources to guide on-farm conservation. The International Rice Information System (ISI) data are linked with GIS tools to analyze germplasm origins, adaptation and deployment. The GIS Electronic Atlas of Rice Production is a tool linking electronic rice statistics and socioeconomic data to geographical information in order to give insight into the interaction between man's activities and the physical environment. GIS tools are developed to identify pest risk zones in selected countries and to incorporate predictive models into district-level risk zoning. GIS are used in many ways to address ecoregional NRM issues in Asia. GIS and soils data are used for crop and resource management in deeply flooded and coastal areas. Datasets have been generated on socioeconomic statistics, and GIS is used for mapping the intensity of poverty in the flood-prone ecosystems. Using GIS among other tools, it is becoming feasible to develop site-specific adaptive varieties to specific rice ecosystems such as the rainfed lowlands.

ISNAR has contributed to the discussion and evaluation of uses of GIS by the IARCs and NARS by publishing Briefing papers on this theme. ISNAR also developed a framework for evaluating the impact of GIS on the efficiency and effectiveness of NRM research, through case studies.

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[3] IPRGI has nothing about GIS on its Internet pages, nor has it been mentioned on other sites.

ISNAR is interested in GIS as it enhances targeting the right zones so that the chosen research themes will pertain to areas within which the expected biological and physical impact of research interventions will be relatively homogeneous.

IWMI's World Water and Climate Atlas is one of the software tools, IWMI is developing and validating. It provides rapid access to basic water and climate data, to help water and agricultural planners. This atlas is a collection of water, climate and other gridded data products at various temporal and spatial resolutions. The applications include: identifying areas suitable for rainfed agriculture, determining how much irrigation is needed in relation to what the climate provides, providing inputs for hydrological modelling of river basins, and extracting climate inputs for crop modelling.

IWMI is involved in a participatory action research project in Sri Lanka, aimed at increasing productivity of natural resources in watersheds, in which participatory rural appraisal tools are linked with GIS for the extraction and dissemination of information from spatial data for collaborative planning and monitoring. IWMI is developing new satellite remote-sensing tools to provide more precise information about water use and water-crops interaction. Five applications will benefit planners in developing countries: Where is a country's water being used –daily, monthly, by seasons?, A new view of irrigation performance, Measuring the productivity of water in agriculture, Malaria risk Mapping, and Environmental monitoring.

WARDA[4] has a Systems Analysis and GIS Unit. Its early work concentrated on multi-level characterization of the biophysical environment, particularly for the inland valley consortium. WARDA is working to develop specific adaptation for the different rice systems across in West Africa. Simulation models and GIS are used to characterize the environments of major rice-producing areas. Researchers can thus improve the interpretation of the trials and the efficiency of their crop-improvement research and reach high performance without sacrificing the advantages of specific adaptation. It has begun to apply GIS for ex-ante impact analysis of promising technologies, and for setting up and impact monitoring network.

3. About GIS activities at FAO

Most sustainable development decisions are inherently multidisciplinary or cross-sectoral, because they require trade-offs between conflicting goals of different sectors. However, most natural resource development agencies are single-sector oriented. GIS technology can help establish cross-sectoral communication - by providing not only very powerful tools for storage and analysis of multi-sectoral spatial and statistical data, but also by integrating databases of different sectors in the same format, structure and map projection in the GIS system. The importance of this integrated approach to development and management of natural resources have been emphasised in many international fora on sustainable development.

3.1 FAO and Natural Resources databases

More than any other agency within the UN system, FAO deals continually with issues of development and management of renewable natural resources. Soil, water, climate, plants, animals, people - and the ways in which they interact - are at the heart of the FAO mandate to assist developing countries to increase food production and to provide food security. FAO is a

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[4] WARDA has nothing about GIS on its Internet pages. This information is from other sites and from personal communications.

source of global, regional and subregional information on land-use planning and management, and provides technical assistance in these areas to member countries.

Meeting these responsibilities requires the collection, analysis and dissemination of massive amounts of different kinds of information: about soils, rainfall, vegetation and land uses; locations of towns, highways, railroads and waterways; figures on population, income, health and nutrition, just to name a few.

In general, information in GIS maps are of two types:
- attribute data (e.g. statistics or text such as slope, soil type, vegetative cover type, etc.) contained in tables
- spatial information, contained in the lines, points or polygons on maps.

The resource planner's problem is how to compare and combine selected information from different maps, in order to evaluate a given geographic location or to assess the status of one particular area in relation to other areas (for example, which of two areas would be more suitable for a given crop).

FAO has been using GIS technology for nearly 20 years now, both at its Headquarters in Rome and in many field projects in member countries. The following projects and services using GIS are listed in the Internet:
- Animal Health Service: Programme Against African Trypanosomiasis
- Soil Resources Management and Conservation Service: e.g. soil maps, soil and terrain databases, ECOCROP, Agro-ecological Zoning System, Land and Water Resources Information System
- Water Resources, Development and Management Service: e.g. FAO/UNESCO Water Balance of Africa
- Plant Production and Protection Service: e.g. Desert Locust Information System, Desert Locust Interactive Mapper
- Global Information and Early Warning Service
- Nutrition Planning, Assessment and Evaluation Service
- Inland Water Resources and Aquaculture Service: e.g. databases on introduction of aquatic species
- Marine Resources Service: e.g. Species Identification and Data Program
- Forest Department: e.g. Forest Resources Assessment Programme
- Environment and Natural Resources Service: e.g. in agrometeorology and in global climate maps

FAO is one of the international organisations involved in the project: Improving Methods for Poverty and Food Insecurity Mapping and its Use at Country Level discussed above.

List of Internet sites that were used for information:

http://www.spatial-info.org/shtml/init_csi/shtml
http://www.fao.org/sd/EIdirect/GIS/EIgis000.htm
http://www.grida.no/prog/global/poverty/index.htm
http://www.grida.no/prog/global/cgiar/htmls/awpack.htm
http://www.cgiar.org/centers.htm, with links to Centre sites and publications therein