GRID
GLOBAL RESOURCE INFORMATION DATABASE

GRID
INFORMATION SERIES
NO. 13

NAIROBI
DECEMBER 1987

Guidelines for the Development of GRID-Compatible National Geographic Information Systems (GIS)

GEMS
[GL]OBAL ENVIRONMENT MONITORING SYSTEM
[UNI]TED NATIONS ENVIRONMENT PROGRAMME

GRID INFORMATION SERIES

1.	**Criteria, hardware and sofware for a global land and soil monitoring system**	November 1981
2.	**Report of an ad hoc expert group meeting for review of hardware and software criteria for a global resource information database** Monitoring and Assessment Research Centre London, 31 May - 3 June 1983	June 1983
3.	**Status Report: March 1985 - April 1986**	May 1986
4.	**Data sources, standards and quality control for a GEMS-GRID Kenyan case study** Woljiciech Bulski	July 1986
5.	**Interim data release policy**	September 1986
6.	**Status Report: April - September 1986**	October 1986
7.	**GIS Applications within GRID: An atlas of African watersheds and slope categories**	May 1987
8.	**Uganda Case Study: A sampler atlas of environmental resource datasets within GRID**	June 1987
9.	**GRID Pilot Project: An interim status report**	June 1987
10.	**UNEP/UNITAR Training Programme in Geographical Information System in the Field of Environment**	July 1987
11.	**An Assessment of GEMS Global Monitoring Networks: Data management and linkages to GRID** Mitchell E. Loeb	September 1987
12.	**Report of an Ad Hoc Expert Workshop on GRID Systems and Software** Weber, J.D. ed.	November 1987
13.	**Guidelines for the Development of GRID-Compatible National Geographic Information Systems (GIS)**	December 1987
14.	**GRID Pilot Phase 1985-87: Final Report**	January 1988
15.	**Report, Meeting of the GRID Scientific and Technical Management Advisory Committee** UNEP, Nairobi, 18-21 January 1988	January 1988

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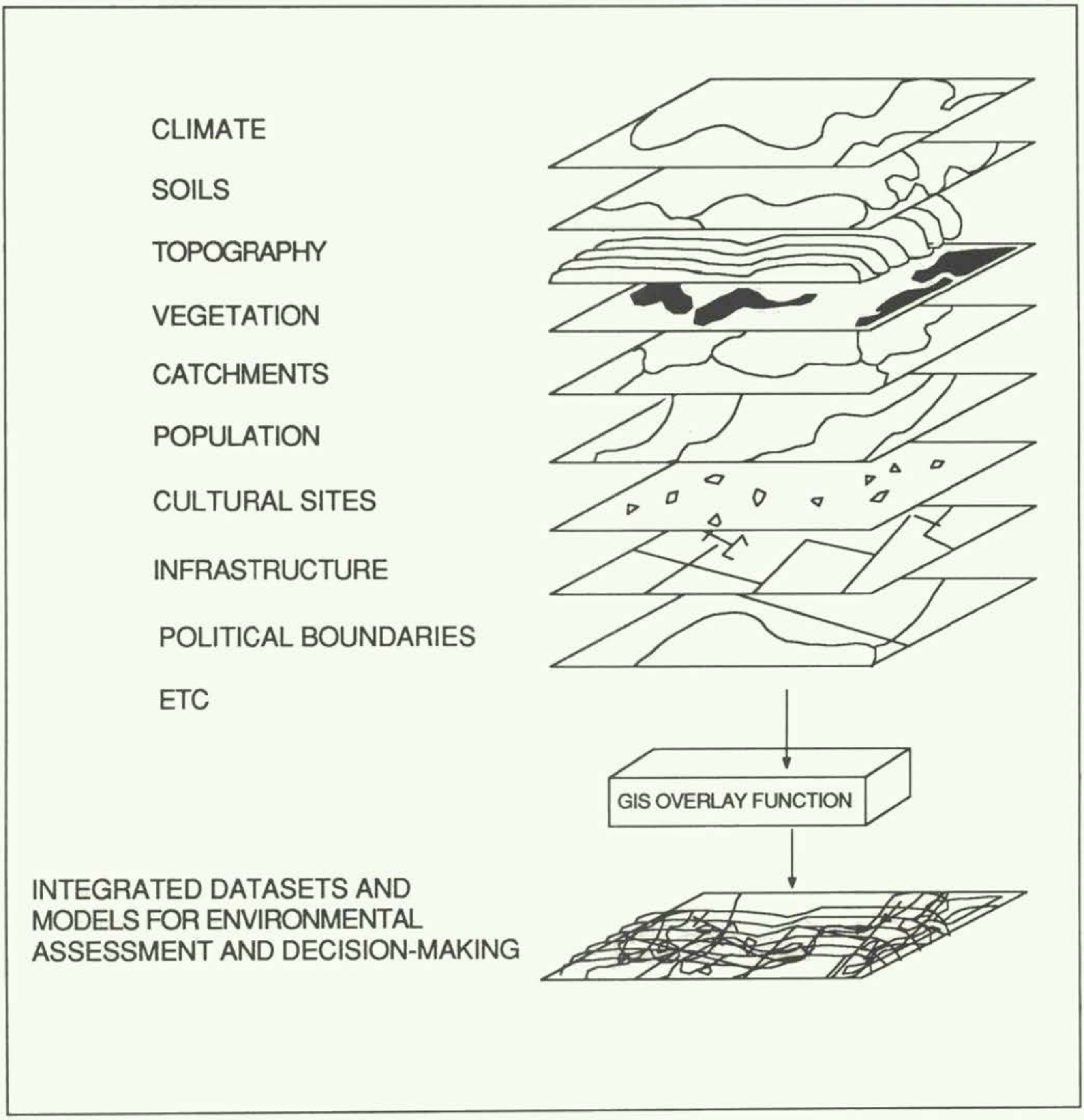
GUIDELINES
FOR THE DEVELOPMENT OF A GRID-COMPATIBLE NATIONAL GEOGRAPHIC INFORMATION SYSTEM (GIS)

INTEGRATION OF ENVIRONMENTAL DATA

WITHIN

A GEOGRAPHIC INFORMATION SYSTEM



GUIDELINES
FOR THE DEVELOPMENT OF A GRID-COMPATIBLE NATIONAL GEOGRAPHIC INFORMATION SYSTEM (GIS)

I. INTRODUCTION

This document is intended to provide guidance to countries wishing to establish a geographic information system (GIS) centre compatible with the United Nations Environment Programme's Global Resource Information Database (GRID). It assumes that a decision in principle has been taken concerning the desirability of establishing a national GIS to serve environmental assessment and management, land use planning and development-related decision-making. It deals with type of activities to be undertaken and facilities to be acquired. Section II addresses organizational and technical requirements; Section III provides guidelines for systems implementation; and Section IV outlines the assistance which UNEP may be able to provide.

A. What is a GIS?

A geographic information system, or GIS, is a system designed to enter, store and manipulate data which relate to locations on the Earth's surface. GIS technology may be used at scales ranging from global to municipal, depending on the nature of the problems and the detail of the data. Land and resource inventories, in which the data describe natural resources, are perhaps the most common applications areas.

The term GIS has come to imply computerized systems. Automated techniques have been developed over the past years and are employed increasingly to deal with the characteristically large amounts of data and to provide quick responses to resource management questions.

The implementation of a GIS at a national level requires substantial commitment and investment in:

- o specialized software and hardware,
- o suitable computer and office space, and
- o systems expertise.

It is also important to ensure that existing and future data sets are of optimal quality and appropriate format for integration, and can be applied to problems which are national priorities.

B. What is GRID?

GRID, the Global Resource Information Database, is a computer-assisted geographic information system designed to collate and organize existing environmental datasets, to provide information to people making decisions that affect the health of the environment, and to make GIS technology more readily available. GIS technology is being used more and more by planners in their job of managing the Earth's environment wisely and rationally; GRID now provides that technology from within the United Nations System.

Since its conception at the Stockholm Conference on the Human Environment in 1972, and its birth in 1974, the Global Environment Monitoring System, GEMS, has played a key role in coordinating global environmental monitoring from its Programme Activity Centre at UNEP Headquarters in Nairobi, Kenya. Associated with each of the GEMS global monitoring networks is a specialized database of monitored data. Although vital for sound environmental assessments, these immense collections of tabular information along with the myriad of other national and international data sets, lack the finger-tip accessibility which today's decision-makers require.

In order to ensure such accessibility, GRID has been designed as a system for channelling key environmental data from a wide range of sources out to people who can use them. The users may be scientists working to understand the functioning and behaviour of the biosphere, or planners making critical resource management or land use decisions about the regions under their jurisdiction. GRID is an extension of the UNEP philosophy that prudent management of the environment, based on sound information, is the only way to ensure sustainable development on an increasingly crowded planet.

GRID is a dispersed system with centres (called "nodes") linked by data transfer systems and telecommunications. GRID-Nairobi, within UNEP Headquarters, controls and manages GRID operations worldwide, is responsible for overall policy, and serves as the Regional Node for Africa. GRID-Geneva in Switzerland concentrates on data capture, georeferencing and data distribution, particularly of the global scale data sets and those related to European problem areas. A Regional Node for Southeast Asia is being designed for Bangkok, Thailand, and other Regional Nodes for West Asia and Latin America are under discussion.

Currently, the two principal UNEP-based nodes, and a third supporting node at NASA's Earth Resources Laboratory in the United States, can exchange satellite images and map data sets by high speed telecommunications links, via courier or by diplomatic pouch, whichever is appropriate. Work is in progress to enable these exchanges to take place via ultra-high-speed satellite links, and to include facilities to transmit smaller datasets to national GRID nodes which have compatible systems.

II. ORGANIZATIONAL AND TECHNICAL REQUIREMENTS

A. Institutional framework

The management of a national resource database requires the integration of cross-sectoral data sets which describe such things as topography, soils, vegetation, water, climate, population, socio-economic factors, etc. in order to analyze state, trend and dynamic interrelationships.

The data are often compiled as maps or images, but also include statistical or tabular data that can be related to map features. Typically, the different types of data are the responsibility of various ministries, each of which may have its own methods for data collection, different map bases and scales, and priorities for geographical coverage. The integration of such potentially disparate datasets is difficult: traditional institutional barriers and organizational structures do not naturally enhance the process. Yet it is the very cross-sectoral integration which is so necessary to national resource management and which is the core of the GRID philosophy.

An important consideration, therefore, is the institutional framework into which a national GIS is placed. Typical settings could be a national mapping agency, a national bureau of statistics, a research institute with a mandate related to national resource planning, a national university, a department of the environment, or the ministry responsible for planning. Wherever located, the "GIS Group" should be responsible to a national planning body or high-level committee with multi-sectoral representation. The national planning body or high-level committee is key in providing support to the Group's co-ordination and service role, in assisting the Group to have cross-sectoral access to data banks, and in guiding the Group on national priorities.

Ideally, the GIS Group should have the following:

- o Knowledge of national planning and management priorities
- o High-level access to, and support from key ministries
- o A nation-wide mandate
- o Experience with multi-sectoral data analysis
- o Knowledge of, and access to the relevant sectoral data sets
- o Access to the scientific specialists required to define the models and analyse the data
- o A source of funding.

The mandate of the GIS Group must, however, be clearly one of co-ordination as well as data management. While it may be wise for the Group to set standards for data collection in order to harmonize the various data sets, the Group must acknowledge the need for specialized sectoral data banks. It should not attempt to duplicate nor restrict the data-gathering and interpretation activities of the sectoral agencies; it should contribute to such activities through provision of specialised GIS technology.

B. Hardware

A common question is: can I make use of an existing computer already available within a government or university department? The answer, in most cases, will probably be "no". There are three reasons. First, the best GIS software is written to run on the operating systems of particular makes of computer. If the available computer is not a suitable model of one of these brands, then a great deal of investment would be necessary in modifying the software, or writing new software from scratch, a costly version of "re-inventing the wheel". Secondly, GIS applications require a rather specialised set of peripheral input-output devices (see below), and it is unlikely that the computer serving, say, the Ministry of Planning would have such devices. Finally, systems are evolving so quickly that it probably does not make economic sense to invest in refurbishing old hardware to support new applications. Typically, the annual maintenance costs of a powerful but older-generation computer are not much less than the purchase cost of an entire small GIS running on modern equipment. Nevertheless, the suitability of an existing system should be assessed in the early stages of GIS implementation.

Other important factors to be considered are the local availability of maintenance, spare parts and supplies for all components of the system, from memory boards to plotter pens to minor software modifications.

Finally, the choice of hardware may be limited by the choice of software, since a particular application package may operate only on a limited range of hardware.

There are three basic options for hardware which a newly-established national GIS may consider, ranging from the most to the least expensive:

Option 1

The minimum facility for operation of a national-level GIS will require a computer of sufficient size in terms of processing power and storage. A typical installation could be a 32-bit computer with 2-4 megabytes (Mb = million characters) of memory, 100 Mb of disc storage and at least 1 1600/6250 bpi tape drive (general readers should not concern themselves here with "bits" and "bytes"; technical colleagues and staff will know the jargon). In addition, specialised peripheral devices are required to deal with the input and output of graphic data. These "peripherals" are really what make GIS hardware special. A typical configuration of peripherals might include:

- large format (1.2 metre x 1.2 metre) high-resolution digitizing table
- monochrome graphics terminal
- colour graphics monitor or "intelligent" terminal
- small-format colour plotter or camera reproduction unit
- large-format automated plotter

Obviously, detailed requirements and the number of pieces of equipment will vary with the types of applications, the software chosen, and the resources available.

This type of equipment is available from many manufacturers and suppliers in a number of countries. Acquisition costs of such a hardware configuration have been, until recent developments in computer technology, of the order of US $300,000. This could easily rise to $1 million for a more powerful system with multiple digitizing workstations and a cartographic quality plotter. However, establishment of a national GIS need not be constrained by lack of such financial resources (see below).

Option 2

An Ad Hoc Group of Experts on GRID System and Software which met in September 1987 (See GRID Information Series No. 12) recommended that UNEP reconfigure GRID with a new series of "super-microcomputers", such as Digital Equipment Corporation's MicroVax-3600 series. These computers offer a computational power which exceeds that of the older series of "super-minicomputers" (8-32 Mb of memory, 4 mips (million instructions per second) processing speed), on-line disk storage measured in gigabytes (billions of characters), modular design for expansion and redundancy, low maintenance costs, robust components able to function in "office environments", a "local area network" architecture which makes maximum shared use of input-output and graphics peripherals, and relatively "friendly" operating systems which can be run by application scientists as well as computer scientists. The entry-level costs for such systems are of the order of $100,000.

The main GRID software systems run on such computers, or are in the process of being converted.

Option 3

A viable and much less expensive alternative to a full national GIS installation would be a more or less standard microcomputer-based system. This would consist of microcomputer workstation with selected GIS data analysis and modeling capabilities aimed at processing data obtained from external sources such as GRID and limited national datasets. The workstation is typically a powerful microcomputer, equivalent to an IBM/PC-AT, with 640 Kbytes of memory, 60-250 Mb of "hard"' disk, additional communications and graphics boards, a high-resolution colour monitor, a digitizing tablet, a colour plotter or copier and a tape drive. The typical hardware cost is less than $10,000, depending on the number and type of peripherals, whilst appropriate GIS and image processing software is between $25,000 and $50,000 depending on complexity and vendor.

Such systems are ideally suited to small-area analyses, say tens as opposed to hundreds of thousands of square kilometers. GRID analysts have used such systems at smaller (i.e. national) scales, but, of course, the resolution is less detailed due to the relatively limited capacity of the micro-computers. A PC-based system is an ideal starting point for training and preliminary analyses.

It is important to recognize that computer technology is evolving rapidly: processing power and storage capacities are increasing almost daily, and costs are falling dramatically as a result of new technologies and market competition. The result is that what we have called "Option 2" and "Option 3" above, will most likely in the near future merge into one and the same, with the power of Option 2 being available for the cost range of Option 3.

C. Facilities

Modern computer equipment is far more robust than previous generations, especially micro-computers and the so-called "office environment" minicomputers, such as the smaller machines in the range of Option 1 above, which are in any event, evolving towards the "super-micros" of Option 2. Most will tolerate a relatively broad range of ambient temperature and humidity, although certain precautions must be taken.

Dust is a major enemy of disk and tape drives, and so the surroundings must be at least reasonably dust free. With larger, Option 1 type installations, the room may have to be sealed and provided with air-conditioning and a fan to control temperature and humidity and to provide a positive air pressure in the room to keep out dust. Local conditions as well as the size of the installation will dictate the specific needs.

Even micro-computers require "clean", reliable electrical power. Power surges can damage the circuitry, and unexpected interruptions can cause expensive or irreplaceable loss of data and physical damage to disks. Relatively inexpensive "surge protectors" may be sufficient for micro-computers. Larger computers (Options 1 and 2) may require an "uniterruptable power supply" or UPS which can provide power for a sufficient period of time for the operator to safely shut down the system. These devices are available from many suppliers, and vary in cost depending on the size of equipment they support and the length of time they will function after a power cut. $5000 to $20,000 is a reasonable range of cost for a UPS. Surge protectors cost only a few hundred dollars.

D. Software

Two kinds of software are required: Operating Systems, invariably acquired with the computers and usually proprietary to a particular make of computer, and the application software which provides the GIS functions.. Many different GIS application packages are available, and each has its own strengths and weaknesses. The choice of software is best made in the context of the specific needs to be addressed. For example, if the data are to be acquired mainly via satellite imagery, then the input and processing of "raster"* data should be optimized in the systems, whereas if the data are to be primarily input from paper maps, application of software of a different type --"vector"** -- might be more appropriate. Ideally, both families of software should be available, and the best GIS software can today convert between raster and vector.

Many GIS software packages are available commercially, and some are marketed world wide. International agencies, universities and national governments are also important sources of applications software, and many may have public-domain software available for free or at very low cost. Such agencies, including UNEP-GRID, also often have lists and inventories of available software (including commercial packages) and are excellent sources for demonstrations and pilot studies. GRID for instance, utilizes four different systems in order to demonstrate a range of available software, as well as to be able to respond to a wide range of requirements.

The result of the software selection process may well be a combination of a number of modules of commercial and non-commercial software. The modules must be appropriately interfaced to each other and to specialized peripheral devices with custom-developed programmes. Such developments require specialized programming and computer systems skills and should be kept initially to a minimum.

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* In raster data format, information is stored in a grid-like cell structure. The raster format is similar to a table of rows and columns. Satellite data, made up of rows of scan lines with individual picture elements ("pixels"), are typical raster data. The main advantage of raster data is that they are relatively simple to manipulate in the computer, and powerful modeling techniques require relatively little computing power. Main disadvantages: they require relatively large data storage capacities, the cells have to be the same size, and the grid-square representation of lines on a map is somewhat less precise than the comparable vector representation.

** In vector data format, points and lines are used to represent geographical features. A series of points connected together by straight lines (also called arcs) can be used to designate linear features, such as rivers, roads, etc. Several arcs connected end to end describe polygons in the computer corresponding to a geographical zone or region on the ground. The vector format is common to most GISs because it is used for converting information on maps or drawings into computer-readable form. Vector data require quite complicated software to manipulate, but provide relatively accurate representations of areas and require less computer storage space than raster data.

E. Human Resources

The staff required for effective GIS implementation and operation fall into four categories:

1. GIS Applications Staff

GIS Applications Staff are crucial to the effective application of GIS technology to priority issues. They should be graduates in a science discipline such as biology, ecology, chemistry, geography, geology, etc., and have good general computer science knowledge. That is, they should have experience with computers as users rather than computer technicians. It would be especially useful if they have experience in GIS-related applications.

2. Data Input Technicians

The skill requirements of Data Input Technicians include cartography and drafting, an appreciation of computer technology and the nature of environmental thematic data. Basic knowledge of data storage principles in a GIS are necessary, and can generally be easily learned if the foregoing criteria are met.

3. System Maintenance Staff

The System Maintenance Staff would normally be computer science graduates or computer programming technicians who have additional background in GIS principles and the algorithms for geographic data manipulation. Hardware experience would be extremely desirable, especially for graphics input and output devices, in order to carry out diagnostics and field upgrades and repairs. With the advent of powerful super-microcomputers, Systems Maintenance Staff may have less work to do in keeping the robust little systems running. However, they can then fill their time usefully doing System Operator tasks, such as disk backups, tapefile maintenance, routine cleaning and preventative maintenance.

4. Subject Matter Specialists

Although the need would vary with the application, in general, Subject Matter Specialists would be qualified scientific experts in such disciplines as ecology, biochemistry, toxicology, meteorology, wildlife management, economics, demography, soil science, etc., etc. They would be in a position to assist with data quality control, model development and interpretation of the results.

The bare minimum complement would be a team comprised of the first two or, if possible, three categories, with access to Subject Matter Specialists from cooperating agencies.

III. IMPLEMENTATION: A PHASED APPROACH

Given the considerable time and cost required to establish a fully operational national GIS, a phased approach is recommended. A step-by-step approach allows software and hardware acquisition to be adapted to available resources and to take advantage of technological developments. It also gives an opportunity to establish the essential coordination and cooperation machineries required for data collection, collation and analysis. Such an approach should be planned to give some interim benefits -- such as catalogue of existing data sets and studies of selected resource problems -- as work progresses towards a total system.

The steps listed below are necessary, although they do not have to be undertaken in strictly sequential order. Steps 2 through 4 are essentially ground work to give a basis for future actions. They involve a commitment of national effort, but no large expenditures on systems. They may be carried out concurrently to some extent. Subsequent activities involve many more of the technological aspects of a GIS implementation.

1. Organizational infrastructure establishment

The first task should be to define and establish as necessary the infrastructure to build and operate an integrated environmental database. As was stated above, the infrastructure should involve (a) an active, high-level, cross-sectoral, national planning body, and (b) a GIS Group who would work with, and be responsible to, the national planning body. With such an organization identified and agreed to, a number of phased activities can then be undertaken.

2. Requirements definition

Define the national requirements for resource management and planning. These may be refined from the generalised statements of national resource management objectives (in Five-year development plans, national conservation strategies, etc.) to more detailed functions and specific priority areas, both geographical and thematic. There should be a mechanism for on-going review of the defined requirements in order to reflect evolving national needs.

3. Data cataloguing

Compile and maintain a catalogue of existing datasets (maps, reports, statistical tables, etc.), which should describe the form and content of datasets and would provide a basis for:

- determining priorities for new data collection activities to ensure data are available to meet the defined national priorities.

- specifying data collection parameters to ensure clearly defined and consistent data sets are obtained in line with the objective of overall integration.

4. Technological capacity review

Review and report on the available specialised technology, in fields of computer science, geography, cartography, remote sensing and so forth, both within and outside the country. There may be equipment and expertise already in place within a particular sector which may be incorporated into an integrated system, or provide the foundation on which to build.

5. National GIS expertise establishment

The development of national expertise can involve both formal training in the form of fellowships or participation in the Swiss-sponsored GRID training programme, or informal training through two-way exchange programmes or joint case studies with other countries and international agencies. The training should ensure expertise in those GIS functions particularly relevant to the national priorities.

In general, it is recommended that the trainees be applications scientists (ecologists, geographers, geologists, etc.) with some experience of computers, rather than computer scientists per se. The emphasis is on the application, rather than the technology by itself; the technology is a means to an end.

Since trained GIS staff would be most helpful in other steps, for example in data cataloguing (see 3, above), it would be wise to consider training at the very outset of GIS establishment.

6. Pilot projects selection and implementation

The selection of studies to serve as pilot projects should be made on the basis of national priorities, available data and available systems. The systems may already be in place in national agencies (but, see comments in section II.B, above). If systems are not locally available, in national agencies, the project may be conducted cooperatively at installations in international agencies (such as GRID), other governments or commercial establishments. The acquisition of a small, microcomputer-based system (Option 3) for some particular function may be appropriate and may establish the smaller type of GRID node mentioned above.

7. National GIS specification definitions

After reviewing the results of steps 1 through 6, specifications may be defined for the national system. The overall functional requirements and available technology can be considered in the light of the completed pilot studies and acquired experience and expertise to produce technical specifications for which commercial bids may be solicited.

The choice of appropriate hardware and software systems will depend on careful analysis of the foregoing steps. Considerable attention should be paid to compatibility with existing systems, both nationally and internationally.

8. System acquisition and installation

Acquisition (advertising, tendering, review, delivery and customs clearance) will have to follow the prescribed national formulae. Specifications for supply should include shipping, installation and testing of all hardware and software system components and ensuring that system interfaces operate as required.

At this point the basic GIS tools will be in place. The primary system activity for a considerable time will be data input and verification. As the database grows, the retrieval, analysis and display capabilities will be used increasingly to move towards the application of resource management techniques to help resolve national environmental issues.

9. Donor approach

In virtually every case, external support will be required to augment existing facilities or provide new systems components and formal training. Donor support should be solicited as early as possible in the development of the national GIS. A clear definition of needs and requirements, and possibly the results from a pilot project will greatly strengthen the case to donors.

IV. UNEP-GRID SUPPORT

GRID is designed and prepared to provide technical advice to Third World countries wishing to establish national GIS and to become nodes (see Section I.B.) in the GRID network.

The mandate of UNEP is such that it cannot normally provide direct funding for national development projects in the manner of external development or bilateral aid agencies. Rather, GRID seeks to augment these services through co-ordinating efforts, and by offering specific support at appropriate points in the phased approach outlined above.

Throughout all the implementation steps, GRID can assist in identification of appropriate international consultants and subject matter experts from its existing rosters and world wide contacts.

Potential areas of GRID support (keyed to the implementation steps in Section III, above) are as follows:

Steps 1 & 2

GRID can provide the advice of experts on how best to identify national needs for a GIS, and which priority issues can best be resolved with GIS techniques.

Steps 3 & 4

GRID can provide advice, guidance and standard approaches to make an inventory of existing geographic data and systems within the country and, using its international networks, assist with the identification of external sources of relevant data held by international agencies, or available from the various remote sensing sources.

Step 5

GRID has a formal training programme administered by UNITAR (the United Nations Institute for Training and Research), supported by the Government of Switzerland and hosted by the Swiss Federal Polytechnic in Lausanne (EFPL). EFPL provides advanced training in integrated resource analysis and geographic information systems. The programme also involves hands-on experience on relevant national problems using GIS tools at the GRID centre in Geneva. The programme is specifically designed for Third World professionals with some knowledge of computers who are actively concerned with the supply and management of environmental data for national decision-making.

In addition, informal training for a limited number of officials can also be arranged at GRID Headquarters in Nairobi or one of the regional centres through visits, demonstrations and experimental usage organized through the GEMS Programme Activity Centre in Nairobi. This is usually arranged in conjunction with a pilot study as described below.

Step 6

Either of the two current GRID centres (Nairobi, Geneva), or one of the centres under discussion (for Latin America, West Asia or Southeast Asia) is an ideal location for conducting a national case study. After determining with GRID staff the scope of the study and issues to be addressed, national officials would bring relevant data to the GRID centre. GRID would assist them with data entry into the appropriate systems and would provide computer processing and expert advice, in effect, on-the-job training on pertinent national problems.

Through the pilot project process, national experts would be able to test the feasibility of the GIS approach, judge the suitability of existing data, and examine at first-hand some of the alternative systems available. This would place the officials in a much better position to develop specifications appropriate to the national needs. UNEP believes that this pilot process can serve both as an important training step, as well as a means of resolving national problems and priorities before a large investment in hardware and software is made. Any databases developed during the pilot project would be readily transferable to the national "centre" to form a part and in many cases the core of the national database.

Steps 7 & 8

GRID can support these steps in several ways:

- o helping to draw up system specifications
- o assisting with evaluation of suppliers' bids
- o advising on avoidance of pitfalls in system installation, operation and maintenance
- o advising on data formats and structure in order to ensure compatibility with GRID, and
- o providing relevant national data extracted from GRID's existing data banks.

Step 9
The limited Environment Fund of UNEP is not able to guarantee resources for national GIS establishment, and in virtually all cases other donor support will be required. UNEP can assist in making contacts and drafting the requirements.

V. CONCLUSION

UNEP is prepared, in the context of its Global Resource Information Database (GRID) programme, to assist governments in establishing national geographic information system (GIS) capabilities Drawing on GRID's experience, design specifications and concrete advice can be provided concerning all aspects of GIS establishment: institutional framework, facilities, hardware and software, human resources and training, and necessary steps to be taken.

As a precursor to GIS establishment, GRID is also prepared to cooperate with national institutions and experts in the undertaking of a GIS applications case study at national scales. Such case studies have helped to create awareness of need and utility amongst both national decision-makers as well as international donors.

UNEP, together with UNITAR, offers a Swiss-sponsored training course for Third World professionals in GIS technology which is the backbone of GRID. Such training is in addition to the on-the-job training opportunities provided in the execution of the national case studies mentioned above, which typically rely heavily on national expertise for problem definition and interpretation of results.

UNEP would not normally be able to finance the establishment of a national GIS centre. It can, however, use its international contacts to help put governments in contact with potential donors in the development community, and in providing further assistance during GIS implementation.

As appropriate, UNEP can also provide staff or consultant time to tailor a GIS programme to the circumstances of a particular national context.

* * *

For further information on geographic information systems or the establishment of a GRID-compatible national GIS centre, please contact

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