GRID

OBAL RESOURCE INFORMATION DATABASE

GRID
INFORMATION SERIES
NO. 14

NAIROBI
JANUARY 1988

GRID Pilot Phase 1985-87: Final Report

GEMS

AL ENVIRONMENT MONITORING SYSTEM

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

GRID
GLOBAL RESOURCE INFORMATION DATABASE

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UNITED NATIONS ENVIRONMENT PROGRAMME

Na.88-5169

GRID PILOT PHASE FINAL REPORT

Nairobi, January 1988

Contents

I. Introduction

The concept of a coordinated environmental assessment and management program for the planet was first given form at the United Nations Conference on the Human Environment, held in Stockholm in 1972. The Conference was the springboard for the establishment of the United Nations Environment Programme, UNEP.

It was realized then that assessments on the state, trends and problems of the environment require high-quality data collected in a coordinated way. Thus, after Stockholm, responsibility for co-ordination of monitoring and assessment was vested in the UNEP Programme Activity Centre of the Global Environment Monitoring System, GEMS.

GEMS monitoring has since been carried out in co-operation with a number of UN agencies -- such as the FAO, UNESCO, WHO, and WMO -- and inter-governmental bodies, such as ICSU and IUCN, in five key GEMS areas: climate, the oceans, renewable resources, atmospheric pollution and the threats of all kinds of pollution to health.

Ten years after Stockholm, UNEP saw the need to rationalize the huge quantity of information acquired from environmental monitoring, often coming from widely differing sources and stored in different forms. In response to this need, a Pilot Phase of the Global Resource Information Database, GRID, was established in 1985. The intention was to give scientists and planners access to integrated, environmental data sets and data management technology, using common formats and systems of storage and retrieval.

Harmonizing new information with existing data sets, can help decision makers identify areas of environmental stress, and focus effective remedial action. Rather than analyzing a problem in isolation, GRID provides an opportunity to examine problems in a global, continental or national context. GRID serves as a switchboard that can process, and make the appropriate connections between, the diverse sets of information that are gathered by GEMS and other environmental monitoring programmes, both national and international.

II. Pilot Phase Objectives

The pilot phase of GRID had four objectives:

The development of geographic information systems (GIS) methodologies and procedures for constructing, manipulating and making available to users global environmental data sets for the purpose of conducting environmental analyses and assessments.

Demonstration of the application of GIS technology within GRID to combine global and national datasets for resource management and environmental planning applications at the national level in a number of demonstration case studies.

Establishment of a framework for cooperation and data exchange between international and inter-governmental organizations

which deal with environment-related matters, such as FAO, WHO, WMO, ICSU, ILCA, IUCN, etc.

Provision of exposure to GIS technology and of training opportunities in GIS and data management technologies employed by GRID to scientists and resource managers from participating developing countries.

III. Pilot Phase Approach

Operations during the Pilot Phase of GRID fell into three functional areas: data collation, data supply/GIS advice and technology transfer (see Figure 1). Data collation involved the task of indentifying, verifying and geo-referencing global and regional datasets, both within and outside he GEMS network. The need to provide GIS advisory services to both agencies and national governments was deemed during the Pilot Phase to at least as important as the provision of data. Technololgy transfer was a major preoccupation, both in the form of formal training as well as in demonstration case studies (see below).

GRID has been designed to be a distributed system, a network of interlinked nodes. During the pilot phase it comprised a control centre within the GEMS Programme Activity Centre in Nairobi, Kenya, and a large-data processing centre in Swiss-donated premises in Geneva, Switzerland (see Annex1for other donors to GRID). Each has been provided technical support by the *de facto* GRID node at NASA's (National Aeronautics and Space Administration) Earth Resources Laboratory in the USA.

GRID-Nairobi has been primarily responsible for international operations and overall policy. This GRID facility is an integral part of the world headquarters of the only United Nations body charged with responsibility for the global environment. It is, in addition, well sited for the introduction of GRID technology to developing countries, and to serve as a prototype regional node for Africa. A number of national case study applications were thus undertaken (see below), on-the-job training provided during case study analyses, and demonstrations given, for example, during sessions of the Governing Council of UNEP.

In Geneva, major functions of the GRID facility have been global data acquisition, distribution, modelling and formal training (see Section IV.D.) Geneva hosts UN Specialized Agencies, such as WHO and WMO, which have collaborated with GRID since its inception. In both Geneva and Nairobi, the exchange of "in-house" expertise with cooperating agencies has been an essential element in GRID's successful operation.

GRID currently has a small UNEP core staff (see Figure 2) which collaborates with individuals and groups of national and international specialists from a variety of cooperating organizations.

GRID uses a range of sophisticated geographical information system computerized technology to manipulate data into forms suitable for its users. All relevant information is processed and presented so that the inter-dependence and interaction between environmental components can be easily understood.

Fig. 1

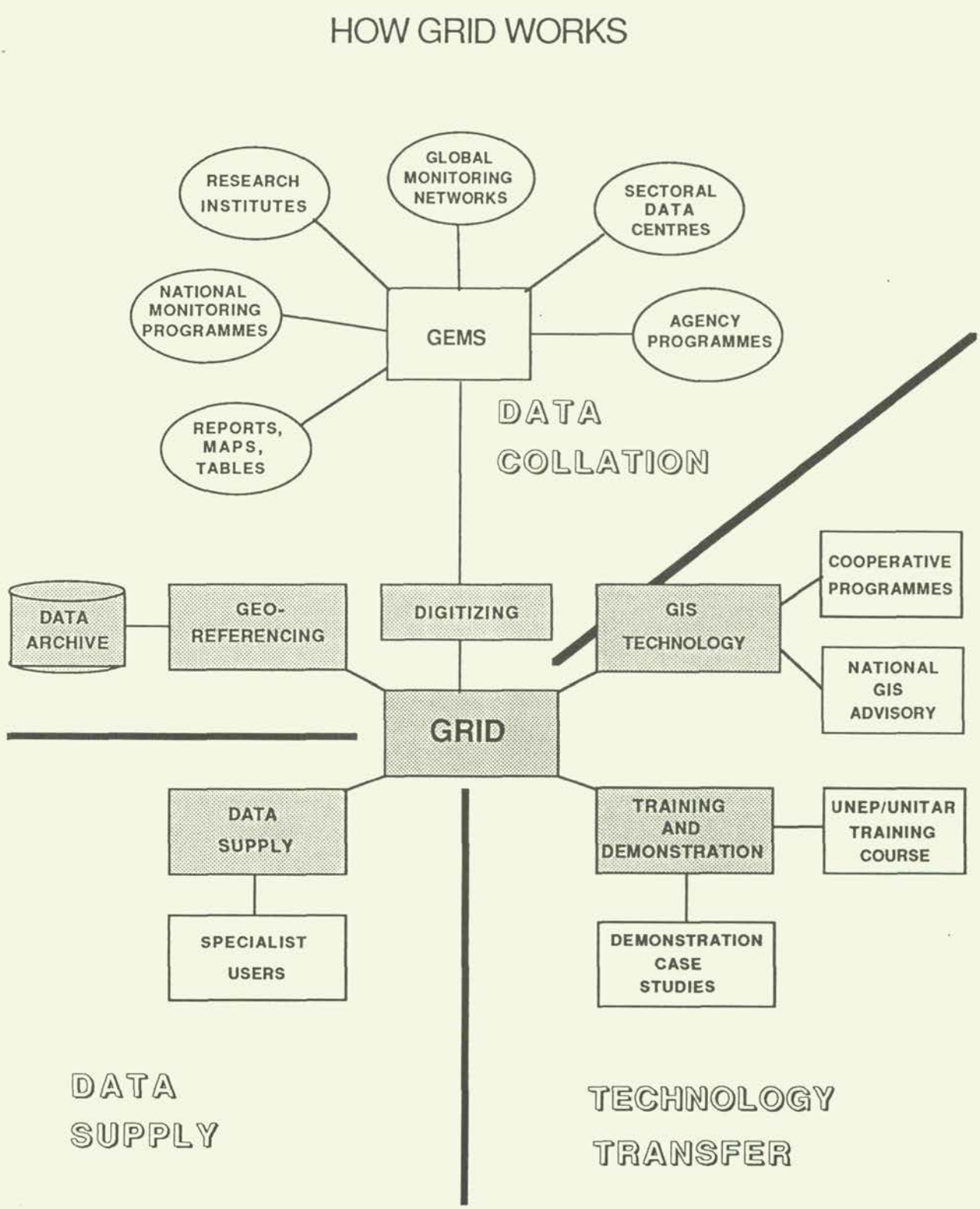
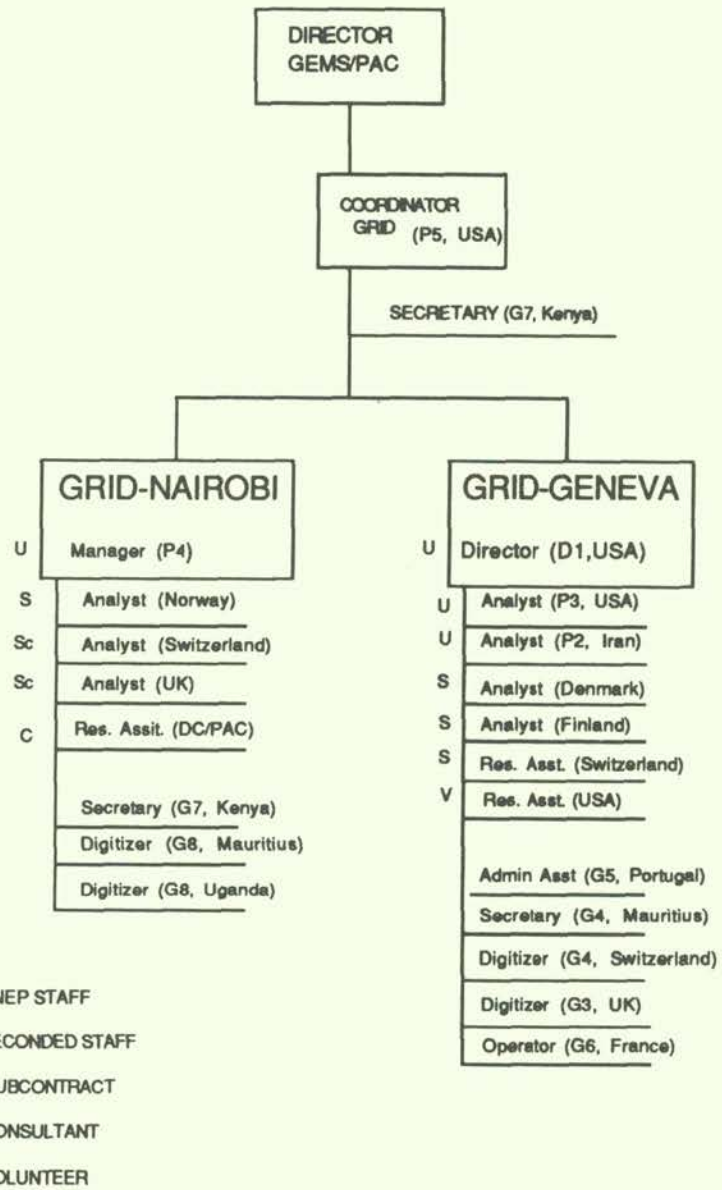

HOW GRID WORKS
RESEARCH INSTITUTES
GLOBAL MONITORING NETWORKS
SECTORAL DATA CENTRES
NATIONAL MONITORING PROGRAMMES
GEMS
AGENCY PROGRAMMES
REPORTS, MAPS, TABLES
DATA COLLATION
DATA ARCHIVE
GEO-REFERENCING
DIGITIZING
GIS TECHNOLOGY
COOPERATIVE PROGRAMMES
NATIONAL GIS ADVISORY
GRID
DATA SUPPLY
SPECIALIST USERS
TRAINING AND DEMONSTRATION
UNEP/UNITAR TRAINING COURSE
DEMONSTRATION CASE STUDIES
DATA SUPPLY
TECHNOLOGY TRANSFER

Fig. 2

PILOT PHASE ORGANIZATION AND STAFFING
GLOBAL RESOURCE INFORMATION DATABASE (GRID)



U - UNEP STAFF

S - SECONDED STAFF

Sc - SUBCONTRACT

C - CONSULTANT

V - VOLUNTEER

A. Hardware

The computer equipment used in the pilot project at both GRID-Nairobi and GRID-Geneva has been for the most part donated (See Annex 1). Some system peripherals have been purchased by UNEP. Present super-minicomputer and microcomputer systems and software used in the Nairobi and Geneva facilities are shown in Annex.2

B. Software

The following software systems, mostly donated or provided at reduced cost (see Annex 1), were utilized during the Pilot Phase:

ELAS

NASA's ELAS (Earth Resources Laboratory Application Software) is operated by GRID on Perkin-Elmer machines in both Geneva and Nairobi (and the Prime in Geneva). ELAS is capable of both image processing and GIS functions. It is a raster based system, although data may be stored in vector format as well. Large satellite data sets require assistance from powerful, off-line array processors. ELAS has many applications sub-programmes and therefore requires about a year to learn to use the entire package effectively. ELAS is used as the principle system for processing and archiving global datasets, and for processing remotely sensed data.

ARC/INFO

ARC/INFO, developed by the Environmental Systems Research Institute, runs on PRIME machines in both Geneva and Nairobi, with a IBM-PC/AT version installed in Nairobi. ARC/INFO is a vector-based GIS system capable of a wide variety of functions, from simple overlays to complex modelling, for point, line and polygon data. It is probably the most popular commercial GIS system available today. It includes INFO, a relational database manager which allows for the storage and manipulation of attribute information. Image processing cannot be done on ARC/INFO. Vector-based GIS packages utilize complex algorithms, so ARC/INFO generally requires more computer processing time than do the raster-based systems, a trade-off for greater analytical capabilities.

ERDAS

ERDAS (Earth Resources Data Analysis System) is a raster-based system the microcomputer version of which is run on IBM/PC-ATs in Geneva and Nairobi. It has both image processing and GIS capabilities with the usual limitations associated with small systems. The software is user-friendly, menu driven, and it can be relatively quickly learned in six to eight weeks.

TYDAC/SPANS

SPANS (Spatial Analysis System) is another raster-based GIS system which runs on the IBM/PC-ATs in both Nairobi and Geneva. The

Fig. 3

GRID PILOT PROJECT

DATA COLLATION

- 25 GLOBAL AND REGIONAL DATASETS
- GEMS DATABASES
- NATIONAL RESOURCE DATASETS

GIS SUPPORT /DATA SUPPLY

- UN AGENCIES
  (FAO, World Bank, WMO...)
- UNEP
  (DC/PAC, OCA/PAC...)
- INTERGOVERNMENTAL BODIES
  (IUCN, ISRIC...)
- NGOS
  (Sierra Club, CRED...)
- NATIONAL AGENCIES
  (in Costa Rica, Jordan, Kenya, Peru, Uganda, Saudi Arabia...)
- RESEARCH BODIES
  (Universities, NASA Goddard Space Flight Centre...)

TECHNOLOGY TRANSFER

- UNEP-UNITAR TRAINING COURSE

  15 Developing Country Experts
  (Argentina, China, Costa Rica, Ghana, Indonesia, Kenya, Madagasgar, Peru, Philippeans, Sudan, Thailand, Uruguay, West Samoa)
- NATIONAL-SCALE CASE STUDIES

  (National experts participate in a dozen case studies)
- NATIONAL GIS ESTABLISHMENT ADVICE

  (Brazil, Jordan, Thailand...)
- REGIONAL BRIEFINGS

  (ROAP, ROWA, Nordic countries...)

system stores data in variable-sized grid cells depending on the heterogeneity of the area using a "quad-tree" algorithm. This data structure can reduce storage requirements by a factor of ten. The system has a wide range of GIS capabilities and will accept satellite image data.

SPSS/PC

SPSS (Statistical Package for the Social Sciences) is a powerful statistical analysis system run on the IBM/PC-AT in Nairobi. It can work with data entered interactively or taken from ASCII files in most formats. Available analyses include regression analysis, factor analysis, cluster analysis and a variety of non-parametric tests. It is used for off-line analyses of GRID datasets.

IV. Results of the Pilot Phase

A summary of the results of GRID Pilot Phase activities in the areas of data collation, GIS support and data supply, and technology transfer is shown in Figure 3. A number of technical and organizational issues were encountered and largely resolved during the Pilot Phase. Discussions of these may be found in Crain *et al.* (1986) and GRID Information Series No. 12. Countries which participated during the Pilot Phase, -- in national case studies, in the formal GRID training programme, as GIS advice recipients, or as donors -- are shown in Figure 4. Highlights of the Pilot Phase results are given below.

A. Global and regional datasets

During the Pilot Phase of the GRID Project, a number of global datasets were selected and entered into ELAS in a common raster format and georeferenced to a longitude/latitude base (see Annex 3). Global datasets are held at the raster cell size of the original data or at 30 seconds longitude/latitude, whichever is greater. The latter represents a cell area of about 0.86 km2 at the equator and is approximately equivalent to the resolution of a scale of 1:5m. As an example of the type of work load this represents, the continent of Africa (23% of the earth's land mass) requires 30 hours of CPU time on the Perkin-Elmer 3241 system to georeference one dataplane. Other major computer intensive operations are vector to raster conversions, transformations from one map projection to another (32 different projections are currently available), and the processing of satellite data.

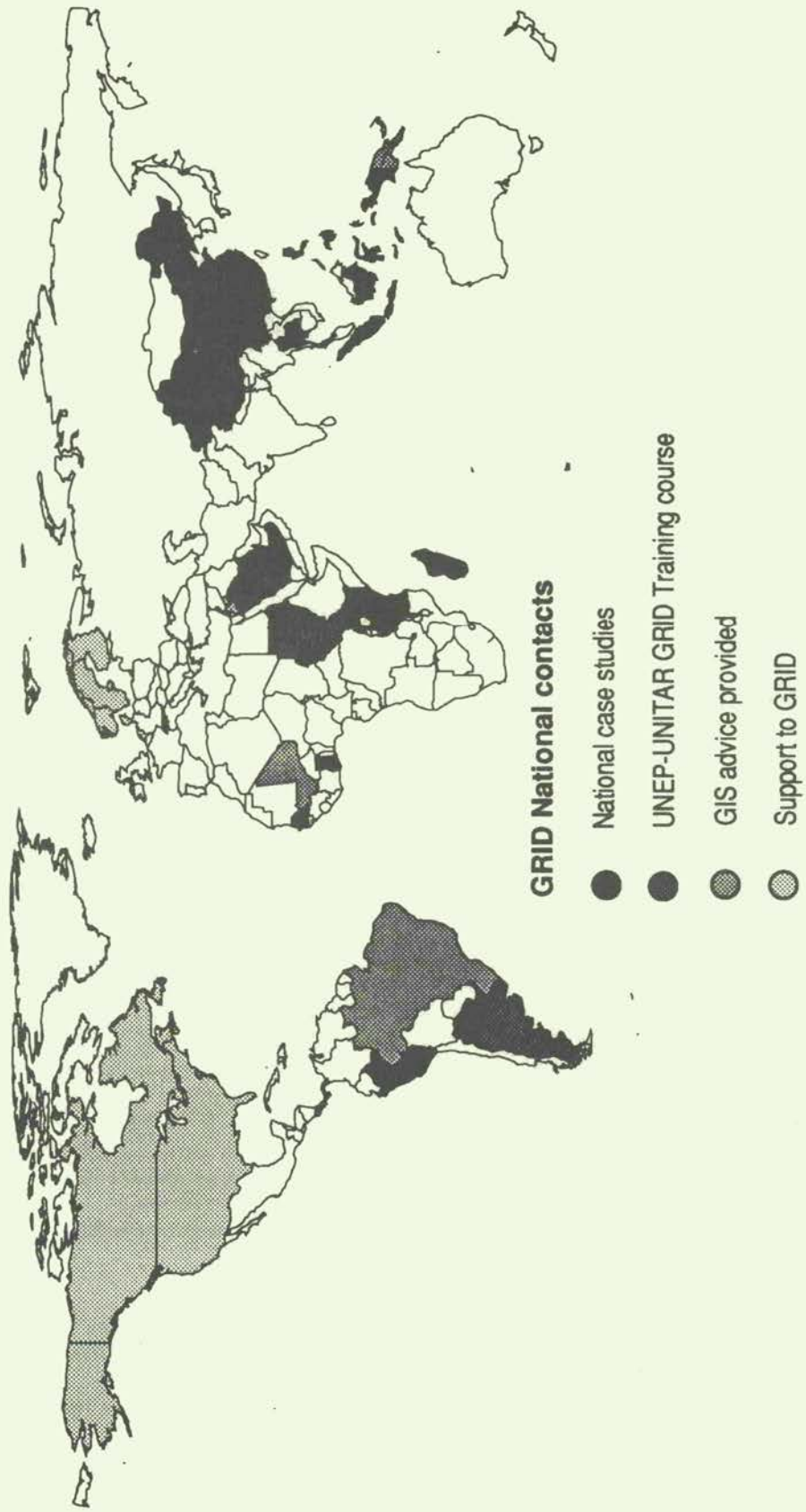
Continental focus during the Pilot Phase was on Africa. Most of the African continental datasets are also available in ARC/INFO Vector format in which they were originally digitized (see Annex 3 and GRID Information Series No.5).

B. Regional Applications

1. Climate Impact in the Mediterranean

GEMS and UNEP's Oceans and Coastal Areas Programme Activity Centre are cooperating along broad fronts to examine the impacts of climate change. A Mediterranean Action Plan Task Force on Climate Change is making use of GRID data management capabilities to simulate sea-level rise and to

Fig. 4


GRID National contacts
National case studies
UNEP-UNITAR GRID Training course
GIS advice provided
Support to GRID

model likely effects on urban centres, agriculture and natural ecosystems, beginning with five major river deltas: Ebro, Rhone, Po, Nile and Medjerda.

2. African Elephant Database Project

The objective of this continent-wide GRID application was to provide information on total elephant population numbers, distribution and trends. On the basis of a range of thematic data for sample areas, the factors correlated with elephant density were determined and a computer model was developed (Burrill and Douglas-Hamilton 1987). The model was used to estimate total elephant numbers across the continent. The information is being used by countries in reviewing and setting elephant off-take and ivory export quotas under the CITES Ivory Export Quota agreement.

C. National Case Studies

GRID has undertaken a number of national-scale case studies in order to demonstrate a wide range of applications, to create awareness of GIS technology possibilities, and to expose national experts to GIS technology. The following are typical:

1. China

Landsat Multispectral Scanner (MSS) data have been processed in anticipation of developing strategies for the resettlement of nearly a half a million people who would be affected by the construction of the proposed Three Gorges Dam. Final assessments, when approved by the Chinese authorities, will involve land use as derived from satellite data, soils information, topographic data and population statistics.

2. Costa Rica

A 13-tier database was developed to model suitability for intertidal, subtidal and suspended aquiculture including on-shore shrimp farming in the Gulf of Nicoya region. Landsat Thematic Mapper (TM) data were processed and analyzed to develop a vegetative cover (with specific interest on coastal vegetation such as mangroves) and land use datasets. TM data were also used to calculate the shoreline length and shoreline complexity. The project was a joint effort among UNEP, the FAO Fisheries Division and National Fisheries Department of Costa Rica (Kapetsky *et al* 1987).

3. Kenya

A country-wide natural resource database is being developed as a joint effort between UNEP and the Government of Kenya, which has established a World Bank financed ARC/INFO within the Kenya Rangeland Ecological Monitoring Unit (Bulski 1986). Satellite, aircraft and ground-derived data are utilized in the database. A special effort to extrapolate and test a UNEP-derived desertification assessment methodology as a joint GEMS-Desertification Control PAC activity is included in the project.

4. Panama

A joint project between UNEP and the government of Panama to develop a natural resource database for the purpose of analyzing the siting of a proposed sea level canal and assessing its potential resource demands and environmental impacts is underway. All available forms of remote sensing

data, combined with existing thematic maps, are being utilized in the database.

5. Peru

The first phase of a project to develop land use potential in the Chumbivilcas Province of southern Peru was completed in 1987. (Gonzales-Ormeno 1987, ONERN 1987). The joint effort between UNEP and the GIS section of ONERN (Oficina Nacional de Evaluacion de Recursos Naturales) involves the use of Landsat data to determine land use changes between the mid-1970s and 1986. The database includes digitized thematic map data for soils, ecozone class, vegetation cover, geomorphology, geology, topography, and hydrology. The results showing various land use options have been presented to and discussed with local management and authorities.

6. Saudi Arabia

A study conducted jointly among UNEP, IUCN and the Meteorology and Environmental Protection Agency (MEPA) of the Kingdom of Saudi Arabia examined the near-shore habitats of marine mammals in 1986. Subsurface, shallow water vegetation was mapped using Landsat TM data. Special image enhancements were produced for the entire eastern coast enabling IUCN and MEPA experts to pin-point particular habitats (MEPA *et al.* in press).

7. Switzerland

A water quality study of Lac Leman (Lake Geneva) utilized Landsat TM and historical Landsat MSS data in conjunction with 30 years of in situ sample data. The study was conducted by University of Geneva researchers working jointly with UNEP (Jaquet and Zand, in press). The results will be used to influence lake margin land use decisions .

8. Thailand

Landsat MSS data from 1975, 1980 and 1985 were analyzed to determine changes in forest cover in the Mae Chang watershed of northern Thailand. The assessment, which is a joint effort among UNEP and several agencies of the Thailand Government (National Environment Board, Forest Department, Agriculture Department., Department of Planning) included development of aland cover dataset from MSS data for use in a soil loss model for the watershed (Hutacharoen 1987, UNEP in press). The results of the project have been very effective in sensitizing Thai scientists and decision-makers to the utility of GIS, and have led to the initiation of both a national GIS and regional GRID facility in Bangkok.

9. Uganda

More than 30 thematic maps were digitized to establish a basic national database and then used in analyses of erosion hazard, crop potential and climate change impact on major cash crops. In addition, Landsat MSS data from 1973 and 1986 were analyzed to assess changes in distribution of forest, wetlands and agricultural activity for the entire country (see GRID Case Study No. 1). UNEP is assisting the Government of Uganda to establish a national geographic database facility within the government for national resource assessment and management.

D. Training

The Swiss Development Agency is financing a major GRID formal training programme for developing country professionals. The Training Programme in Geographical Information System Technology in the Field of Environment is ad administered for UNEP by UNITAR, the United Nations Institute for Training and Research. Academic training is provided by the Swiss Federal Polytechnic at Lausanne. Trainees then work on national case studies at the GRID facility in Geneva with close supervision of GRID data analysts (see GRID Information Series No. 10). The fifteen trainees in the first round of courses are listed in Annex 4.

A number of national experts have also benefited from exposure to GRID technology during the course of national case studies (see Section IV.C. above). During the Ugandan case study, for example, four Ugandan professionals worked as UNEP consultants with GRID staff to interpret and analyze national data. Similarly, a number of Thai professionals participated actively in ground-truth and data analysis during the Mae Chang case study.

E. Publications

A number of scientific and technical publications have been produced and widely distributed during the pilot phase of the GRID project (see Annex 5).

V. Future Activities

The Pilot Phase of GRID was limited to providing the technology and conducting specific case studies. By the year 2000, with a reasonable investment of material and human resources (see Figure 5), GRID will be making a unique contribution toward monitoring and managing the Earth's environment. The following timetable shows the evolution of GRID to the operational readiness for making this contribution:

Pilot Phase (1985-87)

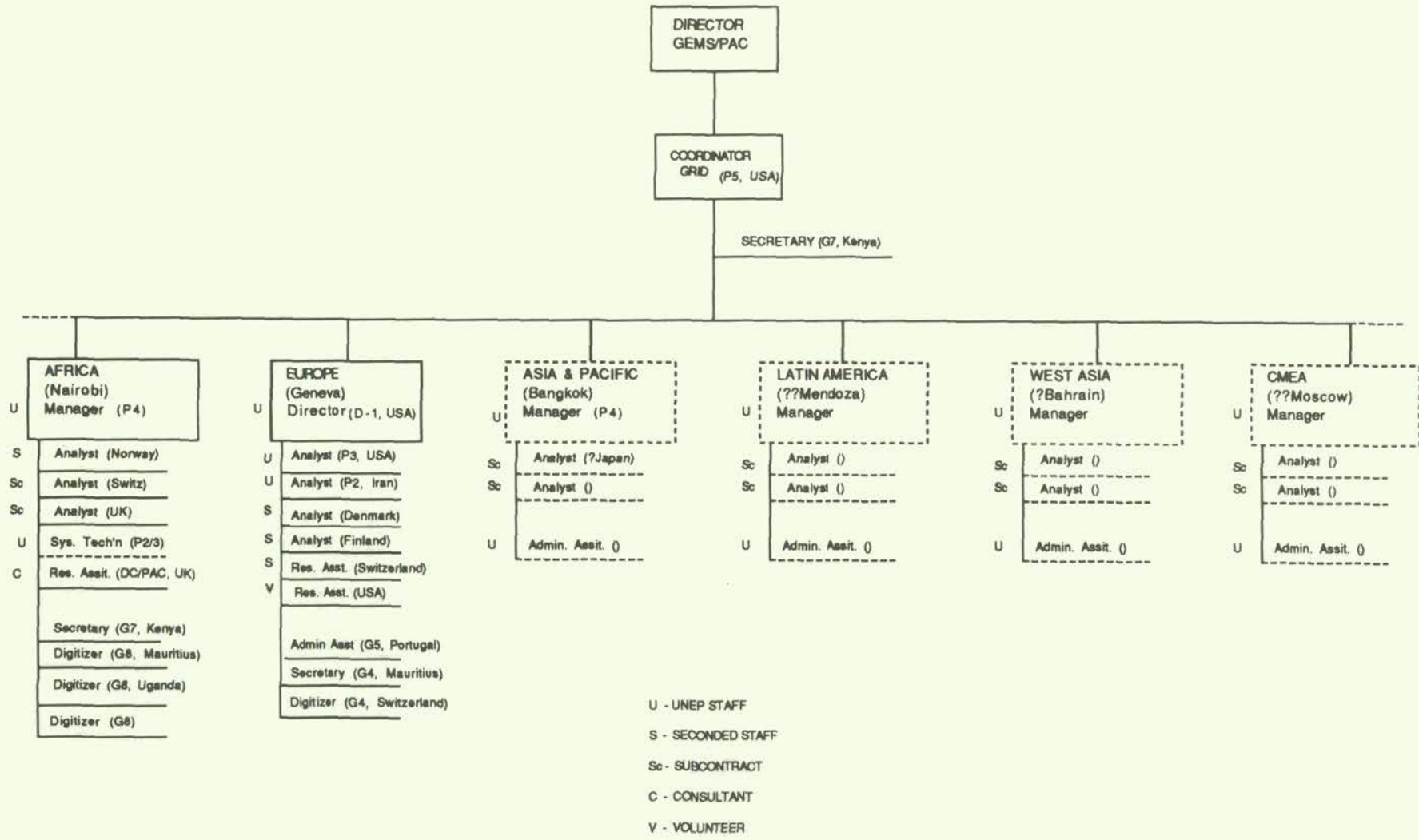
Pilot systems installation
Testing data-handling technology
Collation of global data sets
Initial data supply
Demonstration case studies
Training

Implementation phase (1988-90)

System specification
Dataset expansion and refinement
Contribution to global research and assessments
Establishment of regional nodes
Linkage to agencies
Completed case studies
Training

Fig. 5

PROJECTED ORGANIZATION AND STAFFING
GLOBAL RESOURCE INFORMATION DATABASE (GRID)



Operational phase (1990 on)

Establishment of national nodes
Global telecommunications links
Global application of GRID information technology
Training

When fully developed, GRID will serve a network of regional centres (see Figure 6) which will be located in the regional headquarters of UN or other appropriate inter-governmental bodies. Each centre will be equipped with mini- or advanced microcomputers, image analyzers and a geographic information system. It will be a training centre and the nucleus from which national nodes may be assisted. Global and regional data sets, acquired from organizations such as FAO, WHO, NASA and SPOT-Image will be transmitted to national nodes, which in turn will send back locally-based data which may be of international benefit in the quest to improve understanding of global processes.

VI. Summary Facts

GRID is a geographical information system (GIS) established initially as a two-year Pilot Phase in 1985 by UNEP as part of GEMS to improve access to environmental data.

GRID's principle tasks during the pilot phase were data collation, GIS support and data supply, and technology transfer.

GRID uses images, maps and tables derived from data acquired by satellite, aerial and ground surveillance.

GRID processes and stores data in a way that makes them easily accessible and comparable.

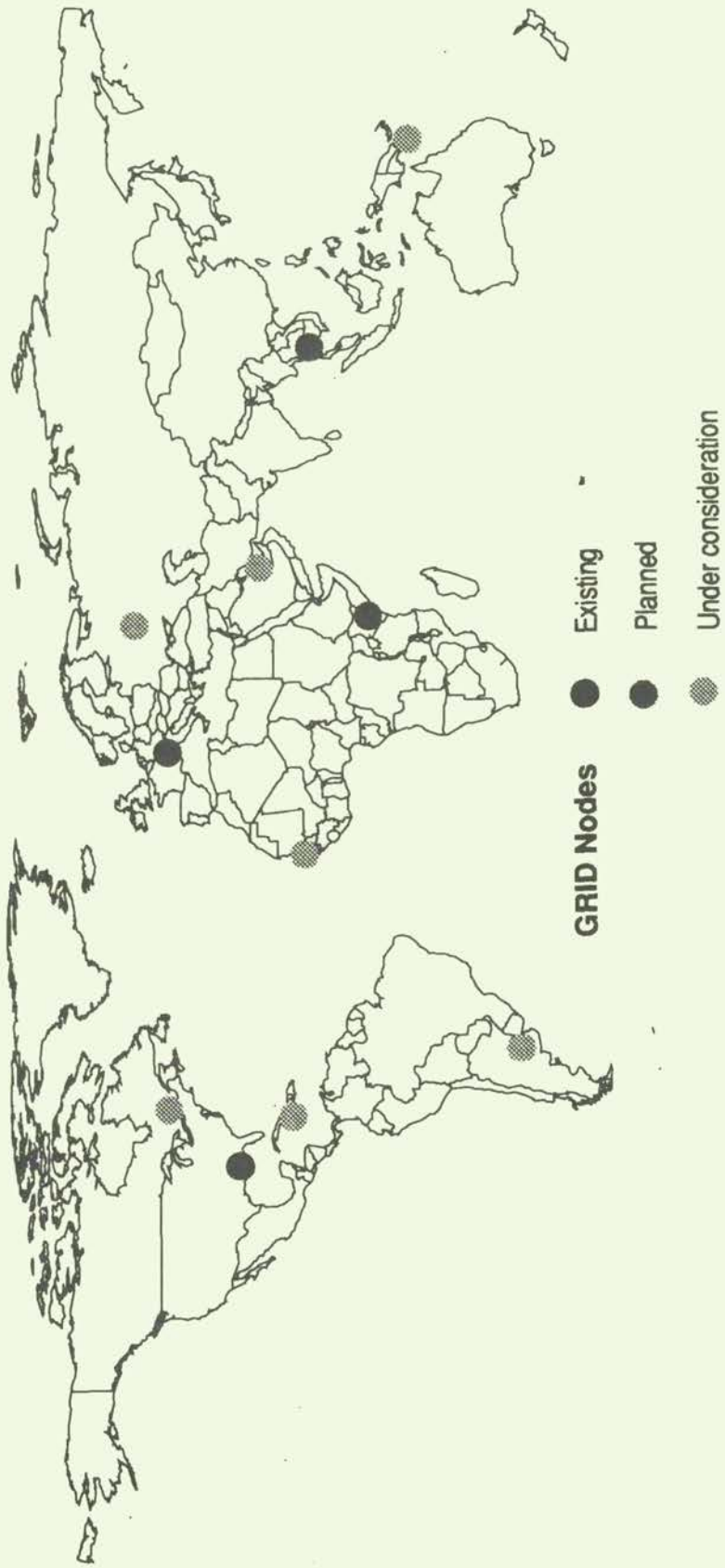
GRID data and GIS technology may be used at global, continental or national scales.

GRID collaborates with UN organizations, national governments, environmental groups and scientific bodies.

GRID provides training to enable developing countries to benefit fully from the system.

GRID's long-term aim is to establish a world-wide environmental data network that is easily accessible from any country in the world.

Fig. 6



VII. Conclusion

Although man is only part of the environment, he is certainly the most influential. Local and national interests must be harmonized with wider regional, continental and global perspectives. It is here, by beginning to synthesize national, regional and global data sets, that GRID has an invaluable role to play. Many environmental problems, even if concentrated in one area, are global in consequence. GRID technology provides an excellent opportunity to highlight the interaction of environmental components, and give the earliest warning of possible conflicts of interest. GRID can also be used to predict the effects of specific human intervention or select the most suitable location for an enterprise. The following endorsements, emanating from the deliberations of major environmental planning groups, illustrate the need for GRID's applications on regional and national scales.

> As the century closes, not only do vastly increased human numbers and their activities have the power to radically alter planetary systems, but major unintended changes are occurring in the atmosphere, in soils, in waters... The rate of change is outstripping the ability of scientific disciplines and our current capacity to assess and advise... the development of the Global Resource Information, Database should be accelerated to bridge the gap between environmental assessment and management. *(Report of the World Commission on Environment and Development, March 1987)*

> A comprehensive data system employing modern techniques of data storage and world wide access is a task of great magnitude - and perhaps the largest single challenge of the International Geosphere-Biosphere Programme. Its design must be an integral part of the overall programme, carried out in close and continued contact with the design and development of the research elements of the Programme. Planning for this essential activity must begin early, following the better definition of the scientific components. UNEP's Global Resource Information Database (GRID) is an example of the type of database that is needed. *(ICSU IGBP Ad Hoc Planning Group on Global Change, August 1986)*

• • •

Annex 1

Contributors to GRID during Pilot Phase

Canada (Canada Land Data Systems Division, Environment Canada):

- Inputting and data capture (pre-processing in Ottawa of selected data sets).
- Expert advice on GIS technology and secondment of GRID-Nairobi facility manager
- SPANS GIS software system, Tydac Technologies Ltd.

Denmark

- One Professional Officer

Finland

- One Professional Officer

Norway

- One Professional Officer

Switzerland (Republic and Canton of Geneva and the University of Geneva):

- Computer accommodation and running costs for GRID-GENEVA
- Research Assistants

(Swiss Development Co-operation):

- Fellowships for Third World participants in GRID.

USA (National Aeronautical and Space Administration)

- Perkin Elmer mini-computers plus peripherals and uninterruptable power supply (long-term loan)
- ELAS Image-analysing/GIS software
- Guarantee of running and maintenance of above for fixed period
- Operations staff

(PRIME Computer Corporation)

- Three PRIME mini-computers plus basic peripherals (grant)

(Environmental Systems Research Institute)

- ARC/INFO GIS and database management system software

(ERDAS Corporation)

- ERDAS GIS and image analysis system software

Annex 2

GRID Hardware, Pilot Phase

GRID-Nairobi

SUPER-MINICOMPUTER SYSTEMS

2 Prime 2250 CPUs
2 158Mb Disc Drives
2 9-Track Tape Drives (1600bpi)
1 Tektronix Graphics terminal
1 Calcomp 9100 X-Y Digitizer
1 Tektronix 4695 colour plotter
1 Calcomp 1044GT drum plotter
2 printers
1 Solanar Graphics black/white monitor
3 Prime terminals

1 Perkin-Elmer 3 220 CPU
2 80 Mb Disc Drives
1 9 Track Tape Drive (1600/800bpi)
1 Comtal/Image Analysis System
3 PE-550 terminals
1 Dunn camera
1 Okidata printer
Accessory equipment (spare parts, tools)

MICROCOMPUTER SYSTEMS

1 IBM/PC-AT
1 60Mb hard disk
1 monochrome monitor
1 Mitsubishi 19" RGB Colour Monitor
1 Cipher streamer Tape drive (1600bpi)
1 IBM Line Printer II
1 Tektronix 4695 Colour Plotter

1 IBM/PC-AT
2 100Mb + 1 60Mb internal hard disk (=260Mb)
1 Enhanced Colour Monitor
1 19" Colour Monitor
1 Pertec Tape drive (1600bpi)
1 Okidata printer
1 Tektronix 4695 colour plotter
1 Franklin Telecom Optical disk reader/writer
1 Calcomp 9100 X-Y Digitizer
1 Fastlink internal modem

GRID-Geneva

SUPER-MINICOMPUTER SYSTEMS

1 Prime 750 CPU
1 675 Mb Disk. Drives
1 9-track Tape Drive
1 600 LPM Printer

6 Terminals
2 Tektronix Graphics Workstation
1 CALCOMP Plotter
1 Calcomp X-Y digitizer
1 Gould Image Analysis Station

1 Perkin-Elmer 3241 CPU
4 CDC 300Mb Disc Drives
2 9-Track Tape Drives 800/1600/6250 bpi
1 AP120B Array processor
2 COMTAL Image Analysis Stations
1 Versatec Printer/Plotter
1 Matrix Color Copy Camera
1 CALCOMP X-Y Digitizer

MICROCOMPUTER SYSTEM

1 IBM-AT
1 60 Mb Disc Drive
1 9 Track Tape Drive
1 Image Display
1 Plotter
1 X-Y Digitizer

Annex 3

Global and Regional Data Sets held within GRID

Parameter	*Coverage*	*Source*
Political boundaries	Global	World Database II—US State Dept.
Natural boundaries	Global	World Database II—US State Dept.
Elevation	Global	National Geophysical Data Cen, USA
Soils	Global	FAO/Unesco Soil Maps of the World
Vegetation	Global	Goddard Institute for Space Studies
Veg'n. index (weekly)	Global	NOAA
Vegetation	Africa	DMA topographical map
Vegetation	Africa	Unesco/AETFAT map
Vegetation	Africa	FAO/CLDS/ICIV-Toulouse map
Veg'n. index (seasonal)	Africa	NASA
Cultivation intensity	Global	Goddard Institute for Space Studies
Watersheds	Africa	UNEP/FAO
Rainfall (mean annual)	Africa	UNEP/FAO
No. wet days (mean ann.)	Africa	UNEP/FAO
Wind speed (mean ann.)	Africa	UNEP/FAO
Precipitation anomalies	Global	Climate Analysis Centre, NOAA/WMO
Temperature anomalies	Global	Climate Analysis Centre, NOAA/WMO
Surface temperature	Global	NASA
Albedo (4 seasons)	Global	Goddard Institute for Space Studies
Ozone distribution	Global	NASA, TOMS
Population density (1960)	Africa	Philips Series
Tse-tse fly distribution	Africa	IBAR/OAU
Elephant range & dens.	Africa	WWF/ELSA/IUCN
Endangered species	Africa	IUCN/CMC (20 plants and animals)
Protected areas	Africa	IUCN/CMC

Annex 4

GRID Trainees in UNEP-UNITAR Swiss-sponsored training course

Mr. Harry Harsono Amir, Ministry of Population and Environment, Jakarta, Indonesia.

Mr. Percy E. Zorogastua, Land Use Specialists, San Ramon Agricultural State University, Lima, Peru.

Mr. Cesar Cervantes Galvez, Soils Specialist, National Office for the Evaluation of Natural Resources (ONERN), Lima, Peru.

Ms. Xiulan Gao, National Environment Protection Agency, Beijing, China.

Mr. Jacob Gyamfi-Aidoo, Information Officer, Environmental Protection Council, Accra, Ghana.

Mr. Jose Jackson, Professor of Geography and Geomorphology, Department of Geography, Montevideo University, Uruguay.

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Annex 5

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