GRID
GLOBAL RESOURCE INFORMATION DATABASE

GRID
INFORMATION SERIES
NO. 9

NAIROBI
JUNE 1987

GRID Pilot Project:
An interim status report

GEMS
GLOBAL ENVIRONMENT MONITORING SYSTEM

UNITED NATIONS ENVIRONMENT PROGRAMME

GRID INFORMATION SERIES

1.	Criteria, hardware and software for a global land and soil monitoring system Stein W. Bie and Jürgen Lamp	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 Woljciech 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

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GRID

the Global Resource Information Database:

as at June 1987

An immeasurable quantity of diverse information about the environment is stored in libraries and data banks throughout the world. Before it can be easily and effectively used, this information needs to be collated, made computer compatible and geographically registered. GRID serves as a switchboard for environmental data, and gives access to information synthesized from global, regional and national monitoring of the Earth's environment.

Key facts

- GRID was established in 1985 by UNEP as part of GEMS to improve access to environmental data
- GRID uses images, maps and tables based on data acquired by satellite, aerial and ground surveillance
- GRID processes and stores data in a way that makes them easily accessible and comparable
- GRID, currently in its pilot phase, 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

The vision of a coordinated environmental assessment and management programme 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 spring-board for the establishment of the United Nations Environ-ment Programme, UNEP.

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

The day-to-day business of GEMS monitoring has since been carried out in cooperation with a number of UN agencies -- such as the FAO, Unesco, WHO, and WMO -- and inter-governmental bodies, such as 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, the Global Resource Information Database, GRID, was created as a pilot programme 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 analysing 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 national and international programmes.

A typical example is the appproach being planned to assess the likely impacts to coastal zones of sea-level rise caused by global warming. A national or regional planner needs to know what land use types (such as agriculture, recreation areas, urban centres) together with the people and their infrastructure would be effected by a range of sea-level rise scenarios. GRID can provide maps and tabular statistics identifying andquantifying effected areas,by overlaying and processing data sets containing, for example, topography, land cover, the distribution of infrastructure and amenities, and human habitations of varying sizes.

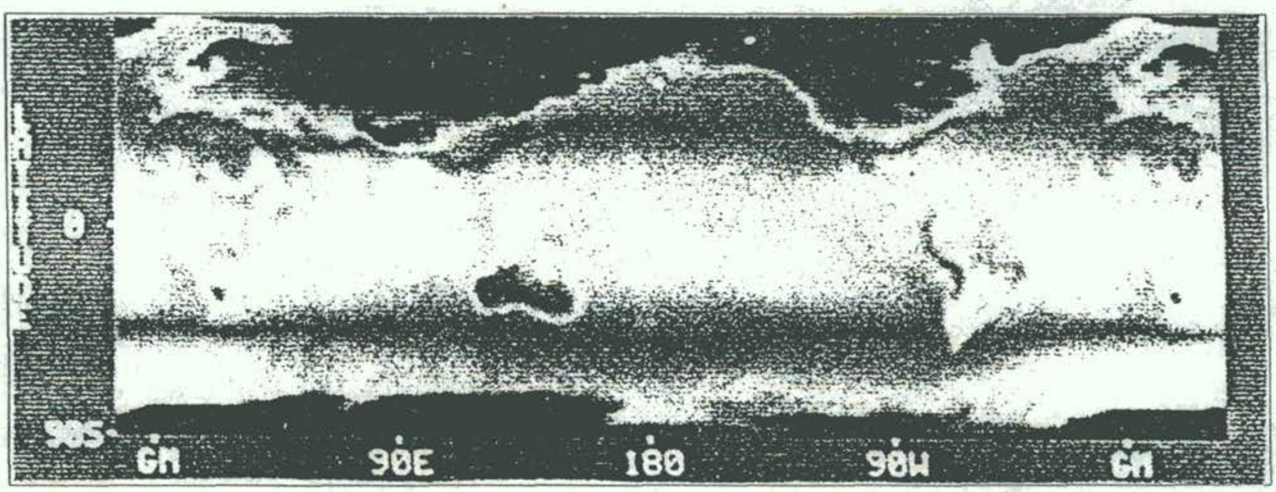
GRID technology can provide the basis for projections based on current resource data in order to alert planners to potential problems, and help them deal with the situation before the problem gets out of hand. The value of a tool that facilitates environmental vigilance and identifies problem areas in advance, cannot be underestimated.

THE GRID TIMETABLE

pilot phase (1985-87)
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 assessments
establishment of regional nodes
linkage to agencies
completed case studies
training

operational phase (1990 on)
establishment of national nodes
global application of resources information technology
training



A typical global dataset currently held within GRID: surface temperature (degrees Kelvin), which may be used, for example, in modelling climate change

Contributors to GRID

More than three-quarters of the resources necessary to establish GRID -- hardware, softeware, personnel, accomodation and training opportunities have been donated by governments, agencies, universities and private companies.

The Governments of Austria*, Canada, Denmark*, Finland, Japan*, Norway, Switzerland, the USA
The Canton of Geneva, the Canada Land Data System, the Environmental Systems Research Institute, the National Aeronautical and Space Administration, the University of Geneva
The ERDAS Corporation, the Perkin-Elmer Computer Corporation, The Prime Computer Corporation

* under discussion

GRID

acquiring the data

GRID uses information gathered by satellite, aerial survey and fieldwork, as well as existing maps. These data must be accurately related to their position on the ground, made compatible and computer processed before being made available to the users of the system.

The need for data management

"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 worldwide access is a task of great magnitude -- and perhaps the largest single challange 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)

The acquisition of detailed and up-to-date information is fundamental to GEMS's tasks of environmental monitoring and alerting interested parties to changes taking place. Points on the Earth's surface can now be observed, simultaneously, from a distance of 1000 km, 100 metres or 10 cm.

Some data are best gathered outside the Earth's atmosphere, using instruments carried by satellite. Sensors which measure reflected and emitted radiation from the Earth, for example, assist in resource monitoring by revealing such things as water depth, surface temperature or vegetation cover. Low-flying aircraft, equipped with cameras and radiometers, complement satellite imagery with, for example, more detailed records of vegetation, livestock and wildlife. At a local level, field work can report on the results of rainfall records or observe such details as species composition, soil depth, etc. Each level of surveillance can be used to confirm, refine or fill gaps left by the others. Often, for example, data gathered by satellite cannot be properly interpreted until exact correlations have been established between what the satellite observes and what is actually happening on the ground.

Data acquired by remote sensing or ground work, past and present, are stored in databases and libraries throughout the world as printed publications, maps, photographs and computer files.

For example, information on levels of atmospheric gases, supplied by the GEMS Background Air Pollution Monitoring Network, are collected by WMO and are stored by the US Environmental Protection Agency. Data on the quality of global waters are stored by the Canada Center for Inland

Waters in Burlington, Ontario. GRID can accept data from maps, satellite imagery and statistical tables, and can inter-relate them using the common denominator of geographical location. Eventually, when all this information is combined with other environmental and socio-economic data, an accurate assessment of the relationship between climate, water resources and pollution will be made available, through GRID, to the users of the system.

Although GRID will contain only selected global data sets, it can draw on additional material from specialized agencies and regional centres. Reciprocally, national databases can access regional or global data banks to fill gaps in their knowledge or to obtain a broader environmental perspective.

GRID

how it works

GRID is forming a network of sources and users, coordinated by UNEP in Nairobi. A major GRID centre in Geneva is responsible for processing large volumes of environmental information.

The need for expertise

Much of GRID's geographical information system (GIS) and image analysis technology is very new: as a result there is a shortage of people qualified to utilize and operate the system.

In order to make GRID technology widely available in developing countries, UNEP has initiated a GRID training programme which is supported by the Swiss government and administered by the United Nations Institute for Training and Research (UNITAR). Developing country scientists and professionals are familiarized with GIS and image processing at Swiss institutions. Trainees then work at GRID-Processor in Geneva, using their own national data sets to solve 'reallife' problems.

In addition, a number of demonstration case studies at national scales have been initiated to demonstrate GIS applications and provide hands-on training for national and international agency participants.

GRID is designed to be a dispersed system comprised of a network of interlinked nodes. Currently it is based on a GRID-Control unit in Nairobi, Kenya, and a GRID data processing centre in Geneva, Switzerland. Each is provided technical support by the *de facto* GRID node at the National Aeronautical and Space Administration's Earth Resources Laboratory in the United States.

GRID-Control, located within UNEP's GEMS Programme Activity Centre, is primarily responsible for international operations and overall policy. GRID-Control is an active part of the world headquarters of the only UN body charged with responsibility for the environment of the globe. 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.

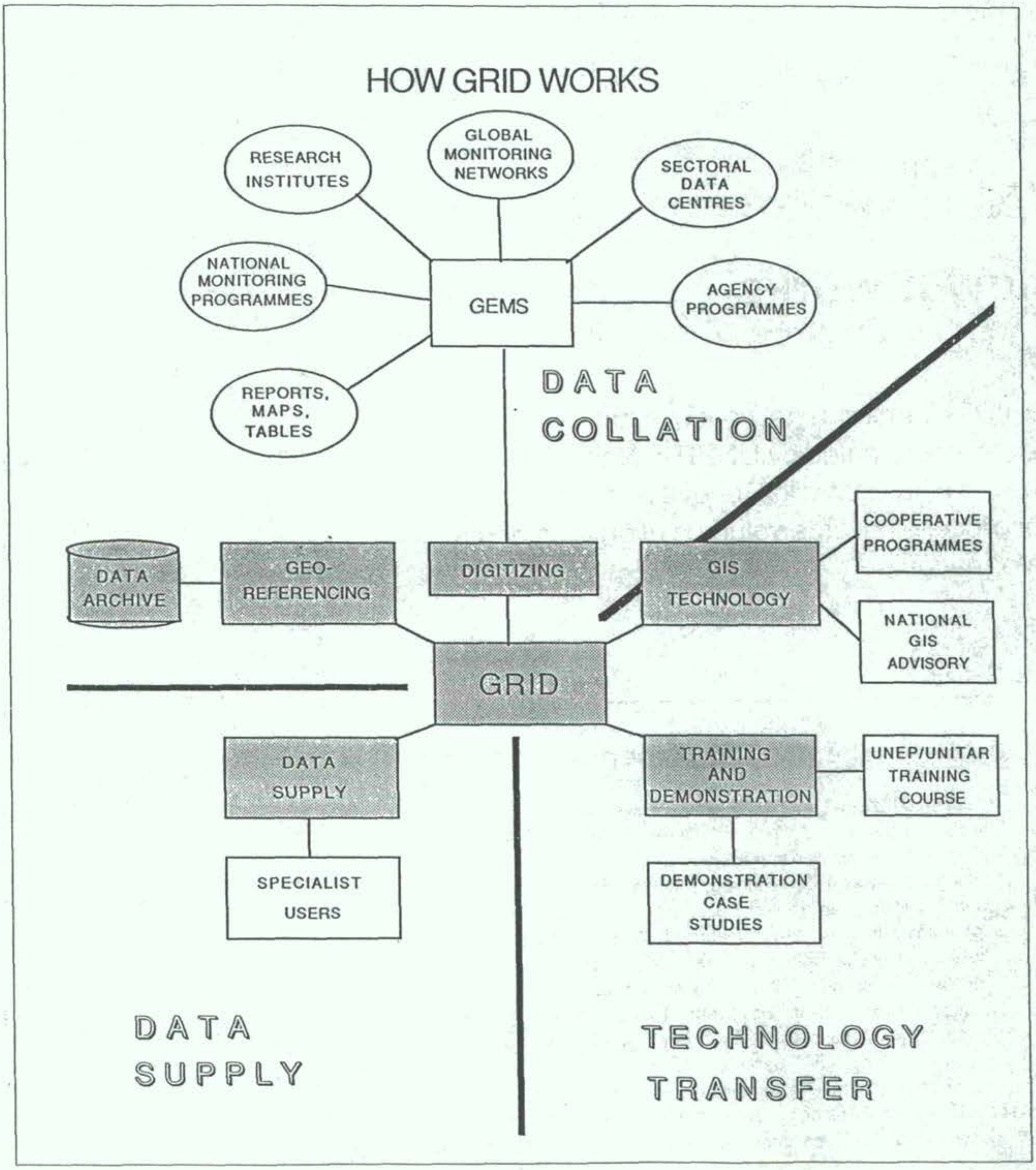
In Geneva, GRID-Processor's major functions are global data acquisition, distribution, modelling and training. Geneva houses specialized agencies such as WHO and WMO, both of which have collaborated with GRID since its inception. In both locations, the exchange of 'in-house' expertise is an essential element in GRID's successful operation.

GRID is currently run by a small UNEP core staff that collaborates with individuals and groups of international specialists, drawn from a variety of cooperating agencies and national organizations.

GRID uses a range of sophisticated computer

How GRID works

GRID works in three main areas: data collation, data supp0y and technology transfer



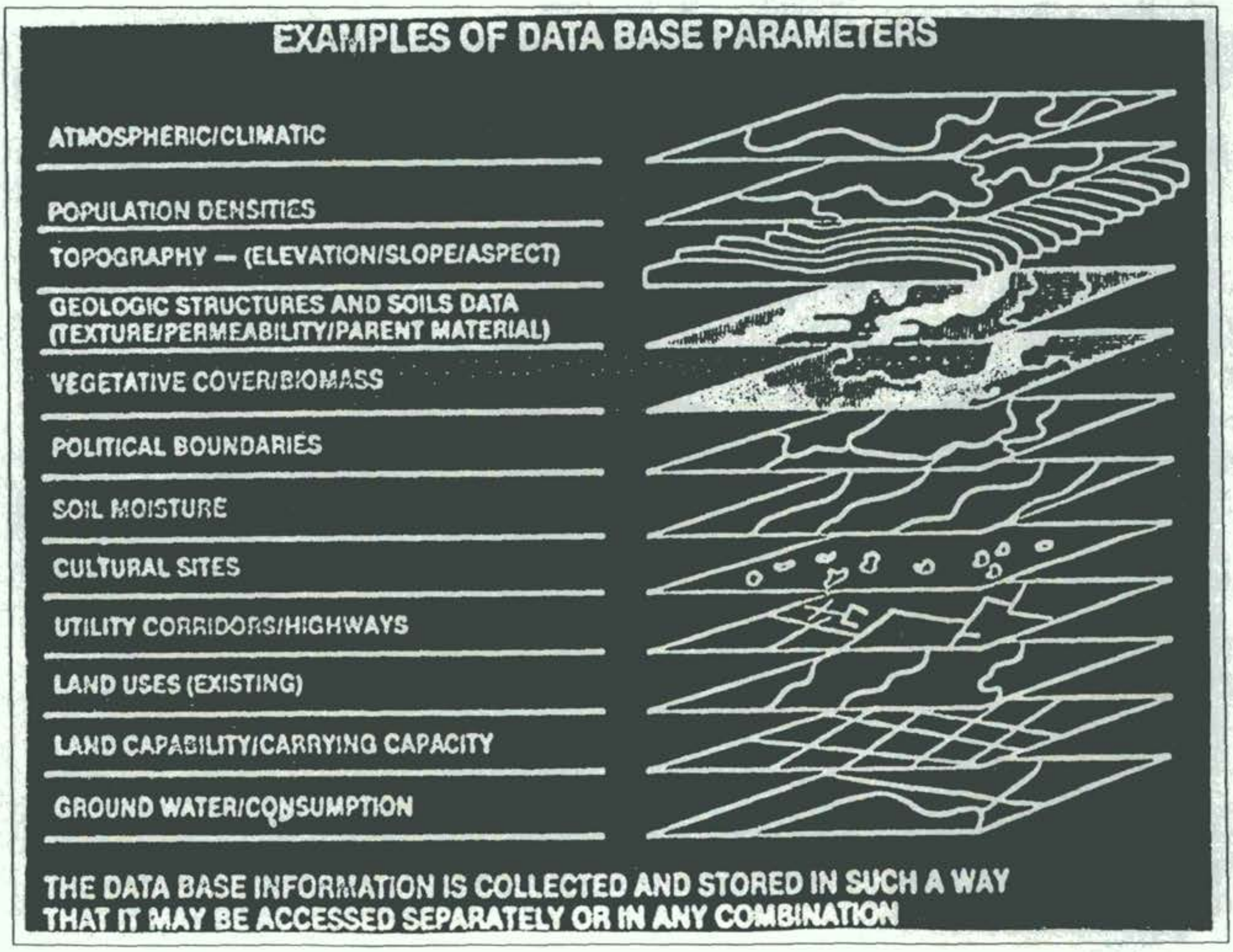
technology to manipulate acquired data into forms suitable for its users. All relevant information is processed and presented so that the inter-dependence and interaction between environmental components can be easily understood.

GRID data are geographically referenced using Geographic Information Systems (GIS). A GIS enables every item of environmental information to be related to a position on the Earth's surface. In order to understand and help resolve environmental problems of a particular area, relevant datasets are matched to the area. By, in effect, overlaying relevant data layers (*e.g.*, vegetation, soils, drainage, land use, population, and so on) the usefulness of each dataset can be greatly increased.

This is very like the approach of 19th century geographers who used transparent acetate sheets each with one set of information drawn on it: when looked through and viewed together, the relationships between the sets became more apparent. Now the process is done by computer in a fraction of the time with many more sets of information. Moreover, the relationships can be worked out --- 'model building' in 20th century jargon -- more quickly and with far greater reliability. The results can be displayed in the form of tables, diagrams and maps.

By having all of the necessary data layers in a computerized GIS, the rules of how they interact can be changed as often as the scientist guiding the analysis requires. Thus , many alternative solutions can be tested, compared and adjusted in a short time.

Overlaying is a basic tool of GIS analysis. By superimposing data on many different aspects of land structure and use, scientists and planners can build up an increasingly detailed picture of the area they wish to study. Only a few of the many possible types of information are included in the diagram below

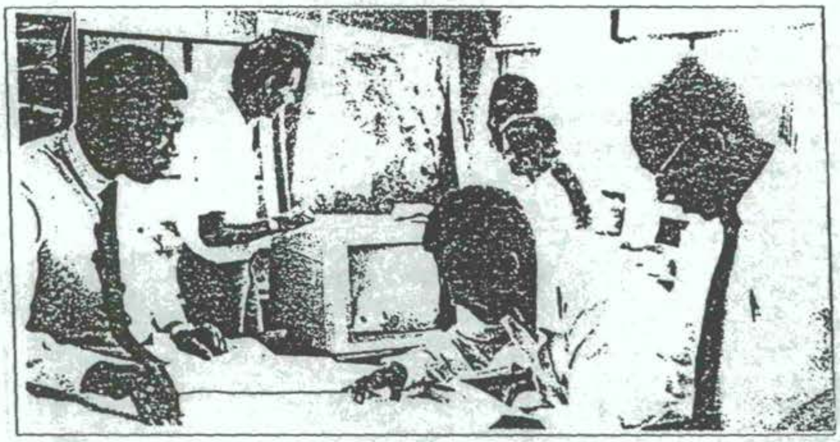


Overlaying environmental data

GRID

the system in action

Although still in the pilot phase, GRID is already providing the necessary data for concrete solutions to problems in the field, giving planners a glimpse of the potential of the fully-developed system.



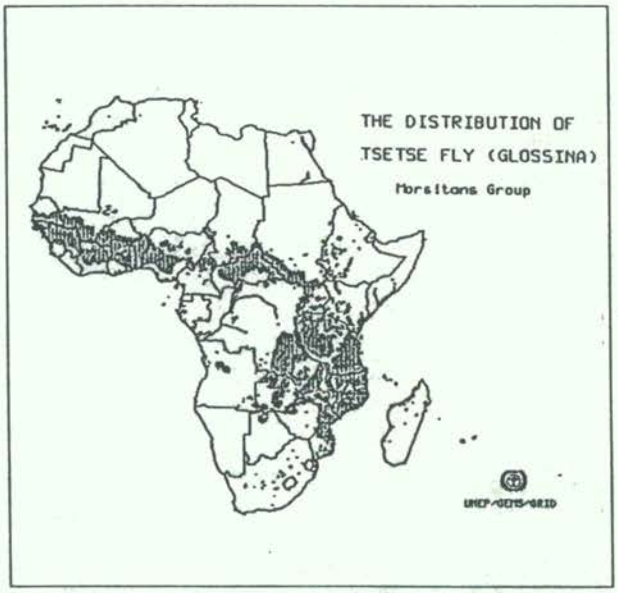
Although man is only part of the environment, he is the most influential. Local and national interests must be harmonized with wider regional, continental and global perspectives. It is here, by synthesizing national with regional and global data sets, that GRID has an invaluable role to play. Many environmental 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 examples on the facing page illustrate some of GRID's applications on regional and national scales.

A team of Ugandan experts (left) works with GRID staff to develop a comprehensive environmental database for their country

Some Global and Regional Data Sets held within GRID

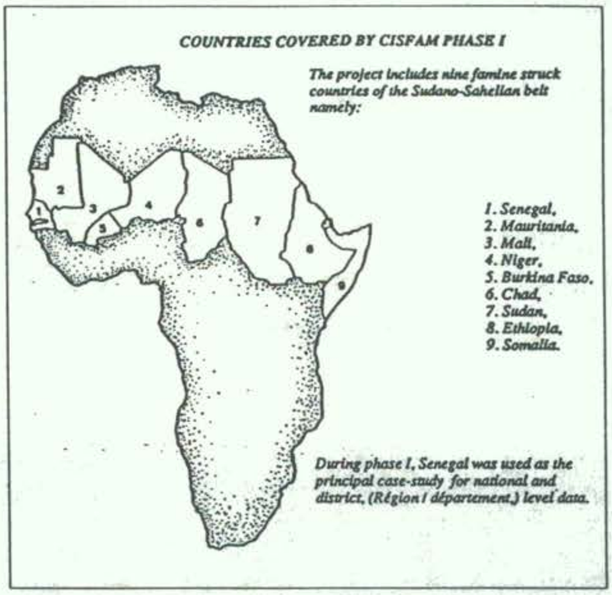
Parameter	Coverage	Source
Political boundaries	Global	World Database II—US State Department
Natural boundaries	Global	World Database II—US State Department
Elevation	Global	National Geophysical Data Centre, USA
Soils	Global	FAO/Unesco Soil Maps of the World
Vegetation	Africa	DMA topographical map
Vegetation	Africa	Unesco/AETFAT map
Vegetation	Africa	FAO/CLDS/ICIV-Toulouse map
Vegetation index (seasonal)	Africa	NASA
Vegetation index (weekly)	Global	NOAA
Watersheds	Africa	UNEP/FAO
Rainfall (mean annual)	Africa	UNEP/FAO
Number of wet days (mean annual)	Africa	UNEP/FAO
Wind speed (mean annual)	Africa	UNEP/FAO
Rain anomalies	Global	Climate Analysis Centre, NOAA/WMO
Temperature anomalies	Global	Climate Analysis Centre, NOAA/WMO
Surface temperature	Global	NASA
Endangered species	Africa	IUCN/CMC (20 endangered plants and animals)
Protected areas	Africa	IUCN/CMC
Ozone distribution	Global	NASA, TOMS

Africa



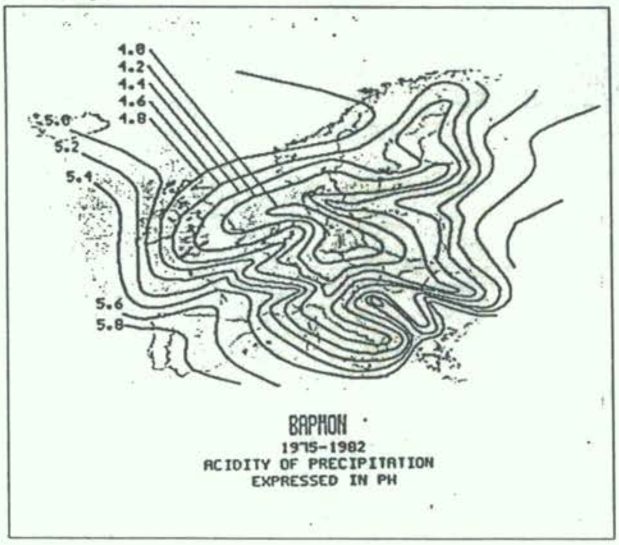
Problem: to ensure a future for the African elephant
Action: after estimating the number and distribution of African elephants, scientists from the World Wildlife Fund and the Elsa Wild Animal Appeal are using GRID to determine what environmental and socio-economic factors constrain elephant distribution, such as the distribution of the vectors of diseases like sleeping sickness which effect man, the elephant's most important compeditor for living space.
Result: a management model, which can be used by African governments, for protecting endangered species in areas of diminishing natural resources.

Africa



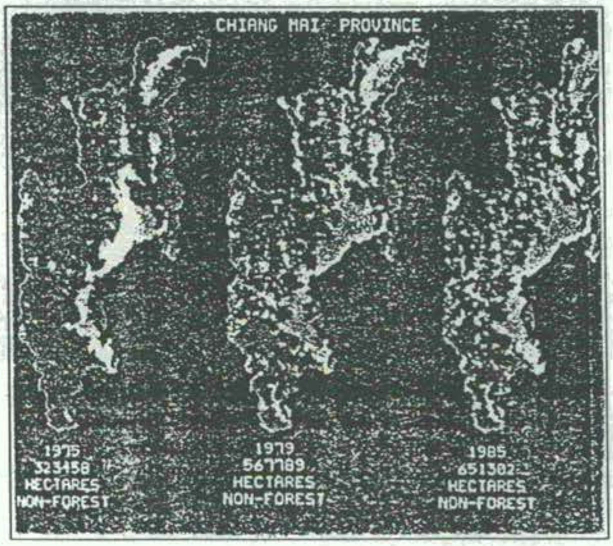
Problem: to optimize information exchange for famine prevention in Africa
Action: the Consolidated Information System for Famine Management in Africa (CISFAM), funded by WHO and implemented by the University of Louvain, is making use of GRID to model biological, infrastructure and population constraints to human health in 9 African countries.
Result: model outputs which pin-point likely trouble spots in order to direct preventative action.

Europe



Problem: imacts of global acidic depositions
Action: for over 15 years, the WMO/UNEP Background Air Pollution Monitoring Network (BAPMoN) has monitored precipitation chemistry (pH, S,N) world-wide. The most reliable data are being put into GRID, such as precipitation pH over Europe from 1975 to 82.
Result: BAPMoN data can now be combined with other environmental parameters (for example, soil buffering capacity , forest mortality patterns, etc.) to analyse their spatial relations and thus contribute to determining the causal ones

Thailand

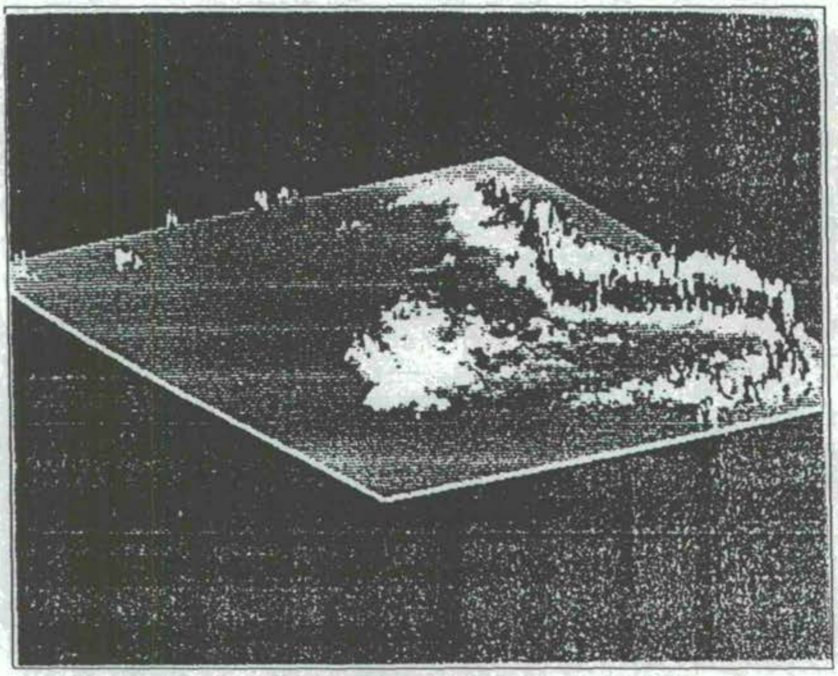


Problem: to discover the extent to which deforestation over the past decade has contributed to soil loss in the Mae Chaem watershed, in Chiang Mai province.
Action: combining digitized thematic maps and remotely sensed information with models and ground data provided by Thai agencies , GRID staff identified the relationship between deforestation and soil loss
Result: information for better watershed management.

GRID

the future

By the year 2000, GRID could have centres in every region, each connected to national nodes able to exchange data of national and international importance.



Three-dimensional model of South America prepared from GRID's global elevation data set; the view is toward the south-west, roughly from the mouth of the Amazon

As the GRID pilot phase draws to a close in 1987, UNEP will evaluate, with expert advice, what changes need to be made before GRID becomes truly operational.

When fully developed, GRID will serve a network of regional centres (*see diagram*) which will be located in the regional headquarters of UN or other appropriate intergovernmental bodies. Each centre will be equipped with mini- or advanced micro-computers, image analysers 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.

The pilot application of GRID is limited to proving the technology and conducting specific case studies. By the year 2000, with a reasonable investment of material and human resources, GRID will be making a unique contribution toward monitoring and managing the Earth's environment.

A future structure for GRID: cooperating centres linked through satellite telecommunications